



30th SBAOI Annual Meeting,
12th STERMI Annual Meeting &
**International Virtual
Conference on
Biomedical Materials
Innovation**

06th to 09th DECEMBER 2020

**Programme
&
Abstracts**



Organised by
**Department of Nanoscience and Technology
Bharathiar University
Coimbatore - 641 046
Tamilnadu, India**



30th SBAOI Annual Meeting, 12th STERMI Annual Meeting &

International Virtual Conference on Biomedical Materials Innovation

06th to 09th DECEMBER 2020



Inaugural Function

06th DECEMBER 2020

Time (IST)

6.00 - 6.02 pm (2 Mins)

TAMIL THAI VAAZHTHU

6.02 - 6.07 pm (5 Mins)

WELCOME ADDRESS

Dr. A.M BALLAMURUGAN

CONVENER- ICBMI 2020

DEPARTMENT OF NANOSCIENCE AND TECHNOLOGY
BHARATHIAR UNIVERSITY, TAMIL NADU, INDIA

6.07 - 6.12 pm (5 Mins)

THEME ADDRESS

Prof. T.M. SRIDHAR

CO-CONVENER- ICBMI 2020

DEPARTMENT OF ANALYTICAL CHEMISTRY
UNIVERSITY OF MADRAS, TAMIL NADU, INDIA

6.12 - 6.22 pm (10 Mins)

PRESIDENTIAL ADDRESS

Prof. P. KALIRAJ

HONOURABLE VICE CHANCELLOR

BHARATHIAR UNIVERSITY, TAMIL NADU, INDIA

6.22 - 6.32 pm (10 Mins)

INAUGURAL ADDRESS

Prof. SHIV KUMAR SARIN

DIRECTOR

INSTITUTE OF LIVER & BILIARY SCIENCES

NEW DELHI, INDIA

6.32 - 6.37 pm (5 Mins)

GUEST OF HONOUR

Prof. S. GOWRI

HONOURABLE VICE CHANCELLOR

UNIVERSITY OF MADRAS, TAMIL NADU, INDIA

6.37 - 6.42 pm (5 Mins)

FELICITATION ADDRESS

Prof. C.P. SHARMA

FOUNDER PRESIDENT-SBAOI

6.42 - 6.47 pm (5 Mins)

C.P.SHARMA AWARD ANNOUNCEMENT

Prof. VEENA KOUL

PRESIDENT - SBAOI, IIT DELHI, INDIA

6.47 - 6.52 pm (5 Mins)

VOTE OF THANKS

Prof. N. PONPANDIAN

CHAIRMAN ICBMI-2020

DEPARTMENT OF NANOSCIENCE AND TECHNOLOGY
BHARATHIAR UNIVERSITY, TAMIL NADU, INDIA

6.52 - 6.55 pm (3 Mins)

NATIONAL ANTHEM



ABINNOVUS
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ICBMI 2020



நாள் 03.12.2020

வாழ்த்துச்செய்தி

தமிழக முதல்வர் அவர்களின் சிரிய தலையையில் நடைபெறும் மாண்புமிகு அம்மா அவர்களின் ஆட்சியில் கோவை பாதியார் பல்கலைக்கழக நானோ அறிவியல் மற்றும் தொழில்நுட்பத்துறை இணைந்து நடத்தும் International Virtual Conference on Biomedical Materials Innovation - 2020 (ICBMI) எனும் தலைப்பின் கீழ் நடைபெறும் இதுகருத்தாங்கு சிறக்க எனது நல்வாழ்த்துக்களை அன்போடு தெரிவித்துக்கொள்கிறேன்.

பரந்து விரியும் அறிவியல், உடல்நலம் சார்ந்த மருத்துவ தொழில்நுட்பம் ஆகியவை யேன்மேலும் நுட்பமடைந்து விரிவுபெறும் நிலையில், தற்கால நானோ தொழில்நுட்பம் சார்ந்த அறிவியல் தளத்தில் உயிரி மருத்துவ பொருட்கள் கண்டடைதல் என்ற இந்த இணையவழிக் கருத்தரங்கு வெற்றி பெற வாழ்த்துகிறேன்.

கருத்தாங்குகளும், கல்விக்கூடங்கள் தொழிற்சாலைகளுக்கிடையே பயான ஒருங்கிணைந்த செயல்பாடுகளும், மாணவருள் உறைந்து கிடக்கும் அறிவிபல் உள்ளுள்ளத் திறனை மேம்படுத்தி வாழ்க்கையை எதிர்கொள்ளும் ஆற்றலைத் தருகின்றன.

தகவல், தொழில்நுட்பம், அறிவியல், போக்குவரத்து, மருத்துவம் ஆகியவை பெறும் வளர்ச்சி கண்டு உலகின் எல்லைகள் கருங்கி வரும் நிலையில், மனிதரின் உடல்திறன் மற்றும் உறுப்புகளின் செயல்பாடுகளை மேம்படுத்தும் நுண்ணிய நானோ அறிவியலில் நமது நாடும் பிற வளர்ந்த நாடுகளோடு சமன் பெறும் வண்ணம் இக்கருத்தாங்கு முடிவுகள் அமைய வேண்டும் என வாழ்த்துகிறேன்.

X. P. Anbogen
3/12/20
கே.பி.அன்பழகன்

Prof. Dr. P. KALIRAJ

Vice-Chancellor



**BHARATHIAR
UNIVERSITY**

State University
Coimbatore - 641 046.
Tamil Nadu, India

Date: 01.12.2020



Message

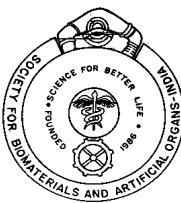
I am very happy to note that the Department of Nanoscience and Technology, Bharathiar University, Coimbatore along with Society for Biomaterials and Artificial Organs India and Society for Tissue Engineering and Regenerative Medicine India are jointly organising a International Virtual Conference ICBMI-2020 which is covering the areas of Regenerative Medicine, Materials in Medicine, Drug Delivery and Wound Care, Bioceramics & Bioglasses for Biomedical Applications and Nanobiotechnology in Health Care. The theme of the Conference is very apt for the current times, particularly for a country like India. India suffers from a huge healthcare burden and affordable and accessible healthcare is indeed the need of the hour. One needs to keep in mind that over 500 million people live in areas in the country, there is no significant healthcare infrastructure available. Over 15 million people in India are pushed below poverty line annually due to the healthcare expenditure. Problem oriented research, keeping in mind the social and economically aspect of the end users, is key to addressing the problem facing the society. Such research also tends to be inherently multi-disciplinary and happy to note that ICBMI-2020 is specifically looking at integrating, analysing and strengthening these interdisciplinary areas of research with a goal to develop efficient and reliable healthcare technologies.

I wish the organisers of the conference for its success and I am sure that conference will go a long way in providing a roadmap for healthcare related research activities in the country and abroad.

A handwritten signature in black ink, appearing to read "P. Kaliraj". To the right of the signature, the date "01/12/2020" is written in green ink.

[P. KALIRAJ]





Society for Biomaterials and Artificial Organs (India)

(Regd. No. 110/86), C/o Central Analytical Facility, Room No. E-208
Sree Chitra Tirunal Institute for Medical Sciences and Technology
Biomedical Technology Wing, Poojappura, Thiruvananthapuram - 695 012 INDIA
Phone: +91-471-25 20 434, Fax: +91-471-23 41 814, <http://www.sbaoi.org>

Founder

Dr. Chandra P.Sharma
SCTIMST, Trivandrum
drsharmacp@yahoo.com

President

Prof. Veena Koul
IIT Delhi, New Delhi
veenaK_iitd@yahoo.com

Vice-Presidents

Dr. Bikramjit Basu
IISc, Bangalore
bikram@nrc.iisc.ernet.in

Dr. R. Jayakumar
AMRITA, Kochi
rjayakumar@aims.amrita.edu

Secretary

Dr. T.M. Sridhar
University of Madras, Chennai
tmsridhar23@gmail.com

It. Secretary

Shri. Willi Paul
SCTIMST, Trivandrum
paulw@sctimst.ac.in

Treasurer

Dr. P.R. AnilKumar
SCTIMST, Trivandrum
anilkumarpr@sctimst.ac.in

Executive Committee Members

Dr. Bhuvanesh Gupta
IIT Delhi, New Delhi
bgupta@textile.iitd.ernet.in

Dr. H.K. Varma
SCTIMST, Trivandrum
varma@sctimst.ac.in

Dr. Hari Pandurangan
Teeth 'N' Jaw Center, Chennai
teethnjaws@rediffmail.com

Dr. N. Rajendran
Anna University, Chennai
nrajendran@annauniv.edu

Dr. A. Balamurugan
Bharathiar University, Coimbatore
balamurugan@buc.edu.in

Dr. B. Venkatachalam
Rajalakshmi Engineering College
bv1967@yahoo.co.in

Dr. N. Ramesh Babu
NIT Trichy
nrb@nitt.edu

Dr. Biman B. Mandal
IIT Guwahati
biman.mandal@iitg.ernet.in

Dr. A. Siddharthan
MIT, Anna University, Chennai
sidharth@annauniv.edu

Shri DS Nagesh
SCTIMST, Trivandrum
nagesh@sctimst.ac.in

MESSAGE



I am glad to note that in this COVID-19 pandemic year, an ***International Conference on Biomedical Materials Innovation-2020*** (ICBMI-2020) is being organized virtually by the *Bharathiar University, Coimbatore* and co-organized by *University of Madras, Chennai, Indian Institute of Science, Bangalore, Indian Institute of Technology, Delhi, Indian Institute of Technology, Guwahati* and *Abinnovus Consulting Private Limited*. The conference is organized in association with the *Society for Biomaterials and Artificial Organs (India)* (SBAOI) and the *Society for Tissue Engineering and Regenerative Medicine* (STERMI) headquartered at *Sree Chitra Tirunal Institute for Medical Sciences & Technology*, Trivandrum, India. This is also the XXX Annual Meeting of SBAOI and XII Annual Meeting of STERMI. SBAOI is a member of the International Union of Societies for Biomaterials Science and Engineering (IUS-BSE).

The conference is planned to serve as a forum for exchanging ideas among undergraduate, postgraduate students and research scholars working in these emerging areas. It would also facilitate the students and scholars to interact with eminent personalities and researchers from India and abroad. Further, it would provide an opportunity for the industry, academic institutions, hospitals and research laboratories to build partnerships and exchange of brains in this vital area of health care.

This is for the first time in the history of the society that 6 institutions have joined hands to organize this conference. I record my appreciation for the enormous efforts taken by the members of various committees for organizing this International conference.

I hope this conference will be a great learning experience for all of us. I wish success to the conference.

Chandra P. Sharma FBSE, FBAO

Founder, SBAOI & STERMI

**Former Senior Scientist G & Head, Biomedical Technology Wing (Rtd.),
Sree Chitra Tirunal Institute for Medical Sciences & Technology, Trivandrum (SCTIMST)**

**Former Adjunct Professor, Department of Pharmaceutical Biotechnology,
Manipal College of Pharmaceutical Sciences, Manipal University, India**

Former Hon. Emeritus Professor, CBEAS, Purbanchal University, Kathmandu, Nepal

Vice President Asia Pacific Society for Artificial Organs (HQ: Japan)





प्रोफेसर (डा.) बलराम भार्गव, पदम श्री

एमडी, डीएम, एफआरसीपी (जी.), एफआरसीपी (ई.), एफएसीसी, एफएएचए, एफएएमएस, एफएएससी, एफएएससी, एफएएसएस, डी.एस.सी.

सचिव, भारत सरकार

स्वास्थ्य अनुसंधान विभाग

स्वास्थ्य एवं परिवार कल्याण मंत्रालय एवं

महानिदेशक, आई सी एम आर

Prof. (Dr.) Balram Bhargava, Padma Shri

MD, DM, FRCP (Glasg.), FRCP (Edin.),
FACC, FAHA, FAMS, FNASC, FASc, FNA, DSc

Secretary to the Government of India

Department of Health Research
Ministry of Health & Family Welfare &
Director-General, ICMR

भारतीय आयुर्विज्ञान अनुसंधान परिषद

स्वास्थ्य अनुसंधान विभाग

स्वास्थ्य एवं परिवार कल्याण मंत्रालय

भारत सरकार

वी. रामलिंगस्वामी भवन, अंसारी नगर

नई दिल्ली - 110 029

Indian Council of Medical Research

Department of Health Research

Ministry of Health & Family Welfare

Government of India

V. Ramalingaswami Bhawan, Ansari Nagar
New Delhi - 110 029

Message

I am very happy to learn that the Department of Nanoscience and Technology, Bharathiar University, Coimbatore along with the Society for Biomaterials & Artificial Organs India & Society for Tissue Engineering and Regenerative Medicine India are jointly organizing, International Conference on Biomedical Materials Innovations (ICBMI-2020) covering the areas of Regenerative medicine, Scaffold Engineering, Nanobiomaterials, Drug delivery and Wound Care, Biosensors, and Bionano products. These are emerging areas in medical practice which need the combination of Cutting edge results, innovation, and clinical applications. The rapidly growing problem of organ dysfunction or damage due to damaged cancer, trauma, and metabolic diseases can be effectively managed by replacing it with nanotechnology enabled tissue-engineered scaffold impregnated stem cells. The nanotechnology-based targeted drug delivery systems, Nanobiosensor, laboratory on a chip are projected to revolutionize the medical practice shortly. Considering the rapid advancement in the international scenario, there is an urgent need to develop this interdisciplinary technology platform in India. Participation of engineers, doctors, basic scientists from different institutions of India and abroad in this conference will be very helpful in this regard.

I wish this event a grand success.

(Balram Bhargava)

The 30th International conference of Society for Biomaterials and Artificial organs 2020 (SBAOI) is being organized virtually, by Department of Nano Science and Technology , Bharathiar University , Coimbatore , Tamil Nadu ,India from 6th Dec to 9th Dec 2020. It gives me great pleasure to welcome both International and National delegates to the virtual conference platform. The Society for Biomaterials and Artificial Organs, India (SBAOI), was established more than three decades ago, to bring the biomaterial, medical device professionals and clinicians to a common platform to promote health care related research in India. The conference is held annually and this year SBAOI 2020, where large number of researchers will deliver plenary, key note and invited talks on various thematic topics. I am sure that professionals and budding young researchers will be benefited from the deliberations. I congratulate the organizing committee members for their tireless efforts in organizing ICMBI-2020. I am sure the conference will be a great success. Finally, a warm welcome to all the delegates on the virtual platform.



01.12.2020

Veena Koul (Indian Institute of Technology, New Delhi)



MESSAGE

The Department of Nanoscience and Technology, Bharathiar University, in association with Society for Biomaterials and Artificial Organs–India, Society for Tissue Engineering and Regenerative Medicine–India, IISc and IITs, is organizing an ***International Virtual Conference on Biomedical Materials, Innovation-2020*** from 6th to 9th December 2020.

I am very impressed by the outstanding scientific program developed by the Scientific and the Organizing Committees. This conference lays emphasis on Additive Manufacturing, Biomedical Materials, Biosensors, Drug Delivery, Tissue Engineering, Scaffolds, Diagnostics & Regenerative Medicine, and many more.

I wish them all the best for its success.

A handwritten signature in blue ink that reads "Sarin". The signature is fluid and cursive, with a long horizontal stroke extending to the right and a vertical stroke extending downwards from the top left.

Dr. Shiv Kumar Sarin, M.D., D.M.
Director
Institute of Liver and Biliary Sciences
New Delhi



UNIVERSITY OF MADRAS

Chepauk, Chennai - 600 005, Tamil Nadu, India.

(State University - Established in 1857 under the Act of incorporation XXVII - Madras University Act 1923)



Prof. S. Gowri M.Tech. (IITM), Ph. D. (IITM), P.D.F. (NTU, Singapore), MSME (USA)
Vice - Chancellor

30.11.2020



Message

Greetings!

I am extremely happy to note that this year an INTERNATIONAL CONFERENCE ON BIOMEDICAL MATERIALS INNOVATION-2020 (ICBMI-2020) is being virtually organized by Bharathiar University, Coimbatore and co-organized by University of Madras – Chennai, Indian Institute of Science-Bangalore, Indian Institute of Technology- Delhi and Indian Institute of Technology- Guwahati and Abinnovus Consulting Private Limited. I would like to congratulate the Department of Analytical Chemistry, University of Madras for their commitment and industrious drive in co-organizing this conference. Further, I am glad to know that the 30th Annual meeting of The Society for Biomaterials & Artificial Organs India (SBAOI) and 12th Annual meeting of Society for Tissue Engineering and Regenerative Medicine India (STERMI) also form a part of this Conference, which has been scheduled from Dec 6 to Dec 9, 2020.

I came to know that delegates including eminent speakers from Belgium, Canada, Japan, Germany, Italy, Netherlands, Malta, Malaysia, Morocco, Singapore, South Korea, Switzerland, USA, UK and from various states of India will be participating in the Conference. The plenary lectures, invited talks, oral and poster presentations will provide an opportunity for exchange of knowledge on recent developments in the field of Biomaterials and Tissue Engineering. I am sure that the conference would bring together Chemists, Material Scientists, Engineers, Biotechnologists, Biologists and Medical Practitioners to a common platform for a fruitful interaction leading to the outcome of creative ideas and innovative solutions for the various challenging problems in the field of health-care. I appreciate the enormous efforts taken by the members of various committees representing several institutions for organizing this International conference.

I wish ICBMI– 2020 a grand success!

Sd/----
Prof. Dr. S. Gowri



தமிழ்நாடு அறிவியல் தொழில்நுட்ப மாநில மன்றம்

TAMIL NADU STATE COUNCIL FOR SCIENCE AND TECHNOLOGY

(Established by Government of Tamilnadu)
Directorate of Technical Education Campus, Chennai - 600 025

Phone : 044 - 2230 1428
Telefax : 044 - 2230 1552

Web : www.tanscst.nic.in
E-mail : ms.tanscst@nic.in/enquiry.tanscst@nic.in

DR. R. SRINIVASAN, M.Sc., Ph.D., F.I.C.S., M.A.C.S. (USA).
Member Secretary



Message

It gives me great pleasure to note that the “**International Virtual Conference on Biomedical Materials Innovation-2020 (ICBMI-2020)**” is being organized by the Department of Nanoscience and Technology, Bharathiar University during 06 to 09 December 2020.

Over the past three decades or so, the area of Biomaterials Science has matured to a marked level, that it contributed several viable medical products. A host of devices and implants for health care is in the international market which originated solely out of the research and development in biomaterials science. This achievement has been realized through the efforts of various research groups across the world and their meticulous collaborative action. A number of academic and industrial research laboratories are contributing towards the development of biomaterials and devices in India. Now we need the establishment of a strong medical materials and device platform in India and help to create new industries to produce biomedical devices and materials at an affordable cost.

I am confident that this Conference will provide an ideal platform for the participants to exchange new ideas, establish advanced research relations and find global partners for future collaborations. The debates and deliberations would also provide the vision of research in forthcoming decades.

I congratulate Dr.A.M.Ballamurugan, Convener, the staff and students of Department of Nanoscience and Technology for organising the International Conference. I also convey my best wishes for the success of this important Conference and extend my warm greetings to all the participants.

(DR.R.SRINIVASAN)

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Epione Swajal solutions India LLP
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PROGRAMME

DAY-1 (06.12.2020)

Inaugural Function BU & UOM (Host)	6.00 pm to 6.47 pm
C.P. Sharma Award Announcement by Prof. Veena Koul	6.50 pm to 6.55 pm

Session -1 Regenerative Medicine Chair - Prof. C.P. Sharma / Co-Chair - Prof. Veena Koul

Cato T. Laurencin University of Connecticut USA	C.P. Sharma Award Plenary Lecture Regenerative engineering biomaterials : Convergence and grand challenges	7.00 pm to 8.00 pm
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DAY-2 (07.12.2020)

Session - 2 Materials in Medicine Chair - Prof. Bikramjit Basu / Co-Chair - Prof. N. Rajendran and Prof. Geetha Manivasagam

Raja Sabapathy Ganga Hospital & Research Centre Tamilnadu, India	Plenary Lecture Tissue engineering in reconstructive surgery and what is in the horizon ?	10.00 am to 10.45 am
Ashok Kumar IIT - Kanpur India	Keynote Address Exosomes functionalised biomaterials: A promising therapeutic tool for diabetic secondary complications	10.50 am to 11.20 am
Rajasekaran Ganga Orthopaedic Res. & Edu. Found. Tamilnadu, India	Plenary Lecture The science of metallurgy regarding implants in orthopaedic surgery	11.25 am to 12.10 pm
Anna Tampieri ISTEC-CNR Italy	Plenary Lecture Nature inspired smart device for regenerative medicine and nanomedicine	12.15 pm to 1.00 pm

Lunch Break

Session - 3 Drug Delivery and Wound Care Chair - Dr. T. Anoop Kumar / Co-Chair - Dr. Neetu Singh

Aravind Sinha CSIR-NML, Jamshedpur India	Keynote Address Biomaterials: An ongoing journey from biomimetics to biodegradable alloys	1.30 pm to 2.00 pm
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Venugopal Universiti Malaysia Pahang, Malasiya	Invited Talk Nanofibrous structured porous biomaterials scaffolds to mimic native ECM for regenerative medicine	2.10 pm to 2.30 pm
Annabel Braem KU Leuven Belgium	Keynote Address Anti-infective strategies for next generation dental implants	2.40 pm to 3.10 pm
Prakriti Tayalia IIT - Bombay India	Invited Talk Biomaterial-based bioactive dermal patch for wound healing and platform for cancer immunotherapy	3.20 pm to 3.40 pm
Samir Mitragotri Harvard University USA	Plenary Lecture Cellular hitchhiking for targeted drug delivery	3.50 pm to 4.35 pm
Rohit Srivastava IIT - Bombay India	Keynote Address Affordable healthcare technologies in sensing, drug delivery and therapy	4.45 pm to 5.15 pm
Praveen Raj GEM Obesity & Diabetes Surgery Centre India	Invited Talk Science behind surgical cure for diabetes	5.20 pm to 5.50 pm
Shamik Sen IIT - Bombay India	Invited Talk Targeting the glycocalyx for diabetic wound healing	5.55 pm to 6.15 pm
Maya Nandkumar Sree Chitra Tirunal Inst. Med. Sci. & Tech. Kerala, India	Invited Talk Nanoparticles and vaccine delivery	6.20 pm to 6.40 pm
Lorenzo Moroni Maastricht University Netherlands	Plenary Lecture Biofabrication technologies to control cell fate	6.45 pm to 7.30 pm
Prasad Shastri University of Freiburg Germany	Plenary Lecture 3D-Bioprinting - Challenges and the Future	7.40 pm to 8.25 pm

Session -4 Nanobiotechnology in Healthcare

Chair - Prof. Biman B. Mandal / Co-Chair - Dr. Gnanamani and Dr. Deepa P. Nambiar

Tejal Desai

University of California
USA

Plenary Lecture

Therapeutic biomaterials: engineering material “Structure”
to modulate biologic delivery

**9.00 am
to
9.45 am**

B.D. Malhotra

Delhi Technological University
India

Keynote Address

Nanostructured metal oxides-enabled biosensors
for oral cancer detection

**9.55 am
to
10.25 am**

Padmanabhan

Nanyang Technological University
Malasiya

Keynote Address

Nano-technological approach for the early detection of
Alzheimer's disease

**10.35 am
to
11.05 am**

Atsushi Suzuki

Yokohama National University
Japan

Plenary Lecture

Recent advances in gelation techniques of PVA gels
for medical applications

**11.15 am
to
12.00 noon**

Yashveer Singh

IIT - Ropar
India

Invited Talk

Diphenylalanine-based self-assembled peptide gels
for biomaterial-associated infections

**12.05 pm
to
12.25 pm**

Arulselvan

Royal Care Super Speciality Hospital
India

Keynote Address

Brain & Nanotechnology

**12.30 pm
to
1.00 pm**

Lunch Break

Session-5 Bioactive Ceramics and Glasses

Chair - Dr. H.K. Varma / Co-Chair - Dr.T.M. Sridhar and Dr. Sasikumar

Ashutosh Kumar Dubey

IIT (BHU), Varanasi
India

Invited Talk

Piezobiomaterials: New generation prosthetic
orthopedic implants

**1.30 pm
to
1.50 pm**

Artemis Stamboulis

University of Birmingham
UK

Keynote Address

Antimicrobial methodology for orthopaedic applications

**2.00 pm
to
2.30 pm**

Aldo R. Boccaccini

Univ. of Erlangen-Nuremberg
Germany

Plenary Lecture

Bioactive glasses and biofabrication in tissue engineering:
Achievements and new developments

**2.40 pm
to
3.25 pm**

Rupak Dua
Hampton University
USA

Invited Talk
Novel approaches to develop and evaluate biomimetics surfaces on orthopedic implants to provide inherent anti-bacterial and enhanced osseointegration properties

3.35 pm
to
3.55 pm

Pamela Habibovic
Maastricht University
Netherlands

Plenary Lecture
Applying novel design- and screening tools to advance the field of organ and tissue regeneration

4.05 pm
to
4.50 pm

SBAOI-MAHE YOUNG SCIENTIST AWARD CONTEST

5.00 pm
to
6.00 pm

Session-6 Biomedical Implants in Healthcare

Chair - Prof. Dhirendra S. Katti / Co-Chair - Dr. A.M. Ballamurugan and Dr. S. Kannan

Jayakumar

Amrita Vishwa Vidyapeetham
Kerala, India

Invited Talk

Vasoconstrictor and coagulation activator incorporated chitosan hydrogel for rapid and effective hemostasis

6.05 pm
to
6.25 pm

Suresh S. Pillai

Baby Memorial Hospital
India

Invited Talk

Evolution and present status of implants in spine surgery

6.30 pm
to
6.50 pm

Subrata Saha

University of Washington
USA

Keynote Address

Ethical challenges in biomaterials research & practice

7.00 pm
to
7.30 pm

Khalil El Mabrouk

Euromed University
Morocco

Invited Talk

3D metallic porous structure coated with bioactive glass for orthopaedic application

7.40 pm
to
8.00 pm

SBAOI-AGM Meeting

8.00 pm

Day-4 (09.12.2020)

Session-7 Regenerative approaches in Healthcare

Chair - Dr. Santanu Dhara / Co-Chair - Prof. Kanagaraj and Prof. Kavitha

Ravi Selvaganapathy
McMaster University
Canada

Keynote Address

Biofabrication techniques for tissue engineering and cultivated meat

9.30 am
to
10.00 am

Kaushik Chatterjee IISc, Bangalore India	Invited Talk Nanoscale surface engineering of metallic biomaterials for orthopedic applications	10.05 am to 10.25 am
Nathaniel S. Hwang Seoul National University South Korea	Keynote Address Injectable and anti-inflammatory hydrogel for tissue repair	10.35 am to 11.05 am
Abhijit Chakraborty Guru Nanak Institute of Dental Sc. & Res. India	Invited Talk Journey of nanobioceramics in functional and aesthetic dentistry	11.15 am to 11.35 am
Harikrishna Varma Sree Chitra Tirunal Insti. Med. Sc. and Tech. Kerala, India	Keynote Address In search of ideal biomaterials	11.40 am to 12.10 pm
Subhadip Bodhak CSIR-CGCRI, Kolkata India	Invited Talk Functional biomaterials for spinal reconstruction applications	12.15 pm to 12.35 pm
Anuya Nisal CSIR-NCL-Pune India	Invited Talk Comparative studies of silk fibroin and calcium ceramic in bone void filling	12.40 pm to 1.00 pm

Lunch Break

Session-8 Additive Manufacturing of Biomaterials & Metallic Implants

Chair - Dr. D.S. Nagesh / Co-Chair - Dr. Naresh Kasoju and Prof. C. Viswanathan

Santanu Dhara IIT - Kharagpur India	Keynote Address Design, development and validation of customized Implants using ethically sourced material	1.30 pm to 2.00 pm
Mauro Petretta Regen HU Switzerland	Invited Talk The 3D bioprinting revolution – expanding the horizons of biomedical science	2.10 pm to 2.30 pm
Joseph Buhagiar University of Malta Malta	Invited Talk A paradigm shift: A low-wearing novel hip joint prosthesis	2.40 pm to 3.00 pm
Bharath Raja Guru Manipal Institute of Technology India	Invited Talk Targeting cancer cells for their over expressed receptors using biodegradable nanoparticles for the therapy	3.10 pm to 3.30pm

Debrupa Lahiri

IIT - Roorkee
India

Invited Talk

Bioengineered smart trilayer skin tissue substitute for efficient deep wound healing

3.40 pm
to
4.00 pm

Suman Bhutoria

Alfatek Systems
India

Invited Talk

3D bioprinting - revolutionizing healthcare and medicine

4.10 pm
to
4.30 pm

Bala Vaidhyanathan

Loughborough University
UK

Plenary Lecture

Additive manufacturing of nanostructured bioceramic implants

4.40 pm
to
5.25 pm

SBAOI-BAJPAI-SAHA STUDENT AWARD CONTEST

5.30 pm
to
6.30 pm

Session-9 Organoids and Bio-Engineering

Chair - Prof. N. Ponpandian / Co-Chair - Prof. Ravichandran and Prof. D. Gopi

Ipsita Banerjee

University of Pittsburgh
USA

Keynote Address

Bioengineering pancreatic islet organoids from iPSCs for regenerative therapy and disease modeling applications

6.35 pm
to
7.05 pm

Francis B. Fernandez

Sree Chitra Tirunal Inst. Medical Sci. & Tech.
Kerala, India

Invited Talk

Engineered bioceramic matrices for sustained active factor delivery

7.15 pm
to
7.35 pm

Aline Miller

BIOGEL, UK

Invited Talk

Tunable Peptide Hydrogels for 3D cell culture and 3D bioprinting

7.40 pm
to
8.00 pm

Valediction & Announcement of Awards [IISc, IIT-D & IIT-G (Host)]

8.05 pm
to
8.35 pm

HONORARY CHAIR: PROF. C.P. SHARMA, PROF. VEENA KOUL & PROF. BIKRAMJIT BASU

DATE	SESSION NO.	SESSION CHAIR DETAILS		TIME (IST)	
		FROM	TO		
06.12.2020	Session-1 Regenerative Medicine	Chair	Prof. C.P. Sharma	6.50PM	8.00PM
		Co-chair	Prof. Veena Koul		
07.12.2020	Session-2 Materials in Medicine	Chair	Prof. Bikramjt Basu	10.00AM	1.00PM
		Co-chair	Prof. N. Rajendran & Prof. Geetha Manivasagam		
07.12.2020	Session-3 Drug Delivery and Wound Care	Chair	Dr. T. Anoop Kumar	1.30PM	8.25PM
		Co-chair	Dr. Neetu Singh		
08.12.2020	Session-4 Nanobiotechnology in Health Care	Chair	Prof. Biman B. Mandal	9.00AM	1.00PM
		Co-chair	Dr. Gnanamani & Dr. Deepa P. Nambiyar		
08.12.2020	Session-5 Bioactive Ceramics and Glasses	Chair	Dr. H.K. Varma	1.30PM	4.50PM
		Co-chair	Dr. T.M. Sridhar & Dr. Sasikumar		
08.12.2020	Session-6 Biomedical Implants in Health Care	Chair	Prof. Dhirendra S. Katti	6.05PM	8.00PM
		Co-chair	Dr. A.M. Ballamurugan & Dr. S. Kannan		
09.12.2020	Session-7 Regenerative Approaches in Health Care	Chair	Dr. Santanu Dhara	9.30AM	1.00PM
		Co-chair	Prof. S. Kanagaraj & Prof. Kavitha		
09.12.2020	Session-8 Additive Manufacturing of Biomaterials & Metallic Implants	Chair	Dr. D.S. Nagesh	1.30PM	5.25PM
		Co-chair	Dr. Naresh Kasoju & Prof. C. Viswanathan		
09.12.2020	Session-9 Organoids and Bioengineering	Chair	Prof. N. Ponpandian	6.35PM	8.00PM
		Co-chair	Prof. Ravichandran & Prof. D. Gopi		

PLENARY LECTURE



Prof. Cato T. Laurencin

Regenerative Engineering Biomaterials, Convergence, and Grand Challenges

Cato T. Laurencin

The Connecticut Convergence Institute for Translational in Regenerative Engineering

University of Connecticut, Storrs, CT 06269-3136

Email: laurencin@uchc.edu

Abstract

We define Regenerative Engineering as the Convergence of Advanced Materials Science, Stem Cell Science, Physics, Developmental Biology, and Clinical Translation. Our focus has been musculoskeletal tissue regeneration and involves a transdisciplinary approach. Polymeric nanofiber systems create the prospect for biomimetics that recapitulate connective tissue ultra structure allowing for the design of biomechanically functional matrices, or next generation matrices that create a niche for stem cell activity. Polymer and polymer-ceramic systems can be utilized for the regeneration of bone. Hybrid matrices possessing micro and nano architecture can create advantageous systems for regeneration, while the use of classic principles of materials science and engineering can lead to the development of three dimensional systems suitable for functional regeneration of tissues of the knee. Engineered systems for soft tissues take advantage of architectural, biomechanical and biochemical cues. Drug Delivery approaches utilize conventional and unconventional concepts. New work in advanced polymeric materials and advanced biological materials offer important possibilities for meeting grand challenges. Through the deep integration of a number of technologies, we can approach regeneration in a more holistic way.

Plenary Lecture

Profile

PROF. CATO T. LAURENCIN

Professor Cato T. Laurencin is internationally renowned and recognized in Biomaterials Science. He is the **University Professor and Albert and Wilda Van Dusen Distinguished Endowed Professor** at the University of Connecticut. Professor Laurencin is an Academician of the Chinese Academy of Engineering, a Fellow of the Indian National Academy of Engineering, a Fellow of the National Academy of Sciences, India, a Fellow of the African Academy of Sciences and a Fellow of The World Academy of Sciences.

He earned his B.S.E. in Chemical Engineering from Princeton University, then earned his Ph.D. in Biochemical Engineering/Biotechnology from the Massachusetts Institute of Technology where he graduated with a 4.9/5.0 grade point average and was designated a Hugh Hampton Young Fellow. At the same time he earned his M.D. from the Harvard Medical School where he graduated *Magna Cum Laude*, the highest honours given in his class year, and received the Robinson Award for surgery.

Laurencin published the seminal papers and patents on nanomaterials science for tissue regeneration. His pioneering work on the development of polymer-ceramic systems for bone regeneration was specifically cited in being named one of the 100 Engineers of the Modern Era by the American Institute of Chemical Engineers. His basic and applied polymer research has resulted in technologies for soft tissue regeneration. This work was specifically highlighted by National Geographic Magazine in its “100 Discoveries That Changed The World” edition. In Biomaterials, Professor Laurencin received the Founders Award, the Clemson Award for Contributions to the Biomaterials Literature, and the Technology Innovation and Development Award from the Society for Biomaterials. The Society for Biomaterials created the Cato T. Laurencin Travelling Fellow Award in his honour. He received the first Biomaterials Global Leadership Award from the Chinese Association of Biomaterials and has received the Acta Biomaterialia Gold Medal.

Professor Laurencin is the recipient of the Von Hippel Award, the highest honour of the Materials Research Society.

Professor Laurencin is the pioneer of the field of Regenerative Engineering. He is the first to receive both the National Institutes of Health (NIH) Director's Pioneer Award, and the National Science Foundation (NSF) Emerging Frontiers in Research and Innovation Award for this field. For his work, the American Association for the Advancement of Science awarded Dr. Laurencin the Philip Hauge Abelson Prize given ‘for signal contributions to the advancement of science in the United States’. He received the National Medal of Technology and Innovation, America’s highest honour for technological achievement, presented to him by President Barack Obama in ceremonies at the White House.

Professor Laurencin is an elected member of the National Academy of Engineering, an elected member of the National Academy of Medicine, and an elected member of the American Academy of Arts and Sciences. He is the first and only individual to receive both the oldest/highest award of the National Academy of Engineering (the Simon Ramo Founder's Award) and the oldest/highest award of the National Academy of Medicine (the Walsh McDermott Medal). He received the Founder's Award for ‘fundamental, critical, and groundbreaking scientific advances in the engineering of tissues’.



Pfof. Anna Tampieri

Nature inspires smart device for regenerative medicine and nanomedicine

Anna Tampieri, Simone Sprio, Monica Sandri, Monica Montesi and Silvia Panseri

*National Research Council, Institute of Science and Technology for Ceramics: ISTEC-CNR,
Granarolo, Faenza, Italy*

Email: anna.tampieri@istec.cnr.it

Abstract

Materials science is today experiencing a paradigmatic change. New societal needs of high impact are increasingly pushing towards the development of smart devices with functionalities enabling multiple applications. In this respect traditional manufacturing methods have now reached their frontier and new approaches are required to overcome this limitation and generate new materials with smart properties to face the urging needs of the next decades. *Bio-inspiration* is an emerging fabrication concept. Indeed, nature can inspire material scientists with innumerable products, coming from the animal and vegetable kingdom, that are nanostructures hierarchically organized into 3D bodies with outstanding structural and mechanical properties (such as woods, spiderweb). On this basis, transformation of natural structures into large ceramics with designed composition and 3D structure with complex hierarchical organization is a new approach that is still at its infancy but promises to transform labile functional chemical composition into 3D complex ceramic structures, prevented by the traditional processes.

Similarly, natural biominerization process generates smart hybrid nano-composites formed by building blocks self-assembled into complex objects deputed to protection and sustain such as exo/endo-skeletons and shells. The translation of this process in the lab yields hybrid fibrous structure mineralized with nano-phases with tailored composition thus providing smart properties for wide applications in medicine, energy and environment, also taking advantage of the use of environmental-safe and abundant raw materials that are

Plenary Lecture

processed by green chemistry procedures to significantly reduce the impact on the environment.

Applying nature-inspired technologies, it is today possible to develop highly bioactive and bioresorbable materials with high similarity with the tissue to be regenerated, even in highly complex and multifunctional anatomical districts. Such non-conventional processes yield devices with unique functional features at the multiscale level, able to instruct cells to different and specific commitments.

To respond to specific needs, personalized approaches are also required and their development is another emerging topic among material scientists. In this respect the implementation of bio-inspired materials with switching systems is today enabled by the recent development of a biocompatible, safe and bio-resorbable superparamagnetic iron-substituted hydroxyapatite that has already proven to be promising as a new platform for wide applications in theranostics.

Plenary Lecture

Profile

PROF. ANNA TAMPIERI

Director of ISTE-CNR and Head, Department of Bio-ceramics and Bio-hybrid composites. Institute of Science and Technology for Ceramics of the National Research Council (ISTEC-CNR)

Research Topic: Nanomaterials for Regenerative Medicine and Theranostics

Anna Tampieri, Chemist, 30 years of experience in Material Science, particularly addressed to biomimetic materials and devices for regeneration of hard tissues and organs.

She authored more than 250 scientific papers published on peer-reviewed Journals and about 20 book chapters (**H index= 50**).

She is inventor of 16 National and International patents, several of which are licensed to companies acting in the biomedical fields and translated to 7 commercial products.

She is Editor of a monography dealing with bio-inspired approaches in regenerative medicine, and Guest Editor of several international scientific journals.

Tutor of 11 Ph.D, 14 M.Sc students, and more than 20 National and International fellowships.

Coordinator of 8 EC-funded Projects and **WP Leader** in 6 EC-funded Projects. Coordinator of several national projects. Since 2009 she is member of the “European Technology Platform for Nanomedicine”.

She is Scientific Advisor of European Commission for funding scheme ERC-projects. Organizer and Chair of several National and International Symposia, Schools and Conferences on Biomaterials. Since 2011 is Senior Affiliate Member at the Methodist Hospital Research Institute, Houston, U.S.A. Associated Professor in Medical Science and Applied Biotechnology, since 2014. Founder of the company FINCERAMICA Biomedical Solution S.p.A, she was the Idea-woman, then President and today is the Head of the Scientific Advisory Board. Consultant for several chemical, biochemical and pharma companies (e.g. Johnson & Johnson, FIN-CERAMICA Biomedical Devices, Menarini Pharma). Former scientific advisor of the Italian Ministry of Economic Development and Industry and of the Ministry of the French Industrial Research in 2011 Awarded by the TIME Magazine for “from Wood to Bone” as the 30° research among the most important 50 researches in 2009 Awarded from Massachusetts Institute of Technology Review for the project GreenBone (biomimetic bone implants). Founder of the Start UP GreenBone Ortho Srl in 2014.



Prof. Samir Mitragotri

Cellular Hitchhiking for Targeted Drug Delivery

Samir Mitragotri

John A Paulson School of Engineering & Applied Sciences,

Wyss Institute, Harvard University, Cambridge

E.Mail: mitragotri@seas.harvard.edu

Abstract

Nanoparticle-based drug delivery systems are widely explored for treating cancer. However, poor vascular circulation, limited targeting and the inability to negotiate many biological barriers are key hurdles in their clinical translation. Biology has provided many examples of successful “carriers” in the form of circulatory cells, which routinely overcome the hurdles faced by synthetic nanoparticle systems. Our laboratory has explored blood-cell inspired drug delivery systems that take advantage of the abilities of red blood cells and macrophages. We have explored “cellular hitchhiking” which involves combining synthetic particles with circulatory cells to drastically alter the *in vivo* fate of the synthetic particles. I will provide an overview of the principles and two examples of hitchhiking-based cancer chemo and immunotherapy.

Plenary Lecture

Profile

PROF. SAMIR MITRAGOTRI

Samir Mitragotri is the Hiller Professor of Bioengineering and Wyss Professor of Biologically Inspired Engineering at Harvard University. His research has provided new insights into biological barriers of skin, blood-brain barrier, immune clearance and gastrointestinal tract, among others. His research has also led to new methods of transdermal, oral, and targeted drug delivery systems. He is an author of over 300 publications and is a Thomson Reuters Highly Cited Researcher. Prof Mitragotri is an inventor on over 180 patent/patent applications. He is an elected member of the National Academy of Engineering, National Academy of Medicine and National Academy of Inventors. He is a foreign member of Indian National Academy of Engineering. He is also an elected fellow of AAAS, CRS, BMES, AIMBE, and AAPS. He received BS in Chemical Engineering from the Institute of Chemical Technology, India and PhD in Chemical Engineering from the Massachusetts Institute of Technology. He is the Editor-in-Chief of AIChE's and SBE's journal Bioengineering and Translational Medicine.



Prof. Lorenzo Moroni

Biofabrication Technologies to Control Cell Fate Lorenzo Moroni

Complex Tissue Regeneration Department, MERLN Institute for Technology-Inspired Regenerative Medicine, Maastricht University, Universiteitssingel, Maastricht, the Netherlands

E-mail: l.moroni@maastrichtuniversity.nl

Abstract

Organs are complex systems, comprised of different tissues, proteins, and cells, which communicate to orchestrate a myriad of functions in our bodies. Technologies are needed to replicate these structures towards the development of new therapies for tissue and organ repair, as well as for in vitro 3D models to better understand the morphogenetic biological processes that drive organogenesis. To construct tissues and organs, biofabrication strategies are being developed to impart spatiotemporal control over cell-cell and cell-extracellular matrix communication, often through control over cell and material deposition and placement [1]. Here, we present some of our most recent advancements in biofabrication that enabled the control of cell activity, moving towards enhanced tissue regeneration as well as the possibility to create more complex 3D in vitro models to study biological processes.

Keywords: Biofabrication, additive manufacturing, bioprinting, stem cells,

References

1. Moroni L, Burdick JA, Highley C, Lee SJ, Morimoto Y, Takeuchi S, Yoo JJ. Biofabrication strategies for 3D in vitro models and regenerative medicine. *Nature Reviews Materials* 2018; 3(5): 21–37.

Plenary Lecture

Profile

PROF. LORENZO MORONI

Prof. Dr. Lorenzo Moroni studied Biomedical Engineering at Polytechnic University of Milan, Italy, and Nanoscale Sciences at Chalmers Technical University, Sweden. He received his Ph.D. cum laude in 2006 at University of Twente on 3D scaffolds for osteochondral regeneration, for which he was awarded the European doctorate award in Biomaterials and Tissue Engineering from the European Society of Biomaterials (ESB). In 2007, he worked at Johns Hopkins University as a post-doctoral fellow in the Elisseeff lab, focusing on hydrogels and stem cells. In 2008, he was appointed the R&D director of the Musculoskeletal Tissue Bank of Rizzoli Orthopedic Institute, where he investigated the use of stem cells from alternative sources for cell banking, and the development of novel bioactive scaffolds for skeletal regeneration. From 2009 till 2014, he joined again University of Twente, where he got tenured in the Tissue Regeneration department.

Since 2014 he works at Maastricht University, where he is a founding member of the MERLN Institute for Technology-Inspired Regenerative Medicine. In 2016, he became full professor in biofabrication for regenerative medicine. His research group interests aim at developing biofabrication technologies to generate libraries of 3D scaffolds able to control cell fate, with applications spanning from skeletal to vascular, neural, and organ regeneration.

In 2014, he received the prestigious Jean Leray award for outstanding young principal investigators from the ESB and the ERC starting grant. In 2016, he also received the prestigious Young Scientist Award for outstanding principal investigators from TERMIS. In 2017, he was elected as faculty of the Young Academy of Europe and in the top 100 Italian scientists within 40 worldwide by the European Institute of Italian Culture. Since 2019, he is chair of the Complex Tissue Regeneration department and vice-director of MERLN. From his research efforts, 3 products have already reached the market.



Prof. V. Prasad Shastri

3D-Bioprinting - Challenges and the Future

V. Prasad Shastri

*Institute for Macromolecular Chemistry, Faculty of Chemistry and Pharmacy,
University of Freiburg, Freiburg, GERMANY*

Abstract

Advances in biology and materials science have enabled us to take enormous strides in decoding the secrets of life. Notwithstanding, our understanding of cellular programming, tissue morphogenesis and repair and aberrant process such as tumor formation in mammalian systems remains rather limited. 3D-Bioprinting holds much promise as a tool to replicate cellular complexity of tissue environment *ex vivo*, for drug screening and as a means of engineering well-defined functional tissue units for transplantation. In regards to the latter, 3D-bioprinting offers a critical link between principles of tissue engineering and patient-specific delivery of healthcare. The potential of 3D-bioprinting to advance medicine hinges on the ability to develop a clinically and commercially viable translation pipeline. This talk will highlight and discuss the challenges associated with translation of 3D-bioprinting into the clinic and the perceived bottlenecks. Additionally, a case for the development of a standardization platform/metrics for 3D-bioprinting and the development of translational bioink platform will be presented.

Plenary Lecture

Profile

PROF. PRASAD SHASTRI

Prasad Shastri is a Professor at the University of Freiburg, Germany where he holds the Hermann Staudinger Chair for Biofunctional Macromolecular Chemistry and the BIOSS Professorship of Cell Signalling Environments. He is also the Director of the Institute for Macromolecular Chemistry and one of the core faculties at the BIOSS Centre for Biological Signaling Studies, which is one of the national clusters of Excellence in Germany. He received his Ph.D. from Rensselaer Polytechnic Institute (Troy, NY) in 1995 and carried out his post-doctoral work with Robert Langer at MIT. He has published over 150 peer-reviewed papers, and several proceedings, and extended abstracts, and several book chapters. He has also authored over 50 issued and pending patents in materials science, regenerative medicine and tumor biology and is founder of startups commercializing these patents. In addition to pioneering several technologies in biomaterials, drug delivery, and nanotechnology, including the In Vivo Bioreactor, a groundbreaking approach for autologous engineering of bone and cartilage, his laboratory is active in the development of biomaterials for controlling cellular microenvironments, in vivo engineering of tissue, 3D-bioprinting, intracellular delivery, cancer therapeutics, cancer biology and functional imaging.



Prof. Tejal Desai

Therapeutic Biomaterials: Engineering Material “Structure” to Modulate Biologic Delivery

Tejal Desai

University of California, San Francisco

Email: tejal.desai@ucsf.edu

Abstract

The ability to deliver therapeutics within and across biologic barriers is a much sought after goal. In this talk, I will discuss our recent work in developing nanostructured materials for biologic delivery as well as injectable micro/nanoscale materials for the modulation of fibrosis and immune activation. By incorporating micro and nanoscale features into biomaterials, one can modulate properties such as tissue permeability, matrix production, and cell activation. The understanding of how small scale topographies can influence the biological microenvironment allows us to design platforms for applications in therapeutic delivery and tissue regeneration. Micro and nanostructured materials can add functionality to current drug delivery platforms while becoming an enabling technology leading to new basic discoveries in the pharmaceutical and biological sciences.

Plenary Lecture

Profile

PROF. TEJAL DESAI

Tejal Desai is the Ernest L Prien Endowed Chair and Deborah Cowan Endowed Professor of the Department of Bioengineering & Therapeutic Sciences, Schools of Pharmacy and Medicine at University of California, San Francisco (UCSF) and Professor in Residence, Department of Bioengineering, UC Berkeley (UCB). She serves as director of the NIH training grant for the Joint UCSF/UCB Graduate Program in Bioengineering, and founding director of the UCSF/UCB Masters Program in Translational Medicine. She was recently named the Inaugural Director of the UCSF Engineering and Applied Sciences Initiative known as HIVE (Health Innovation Via Engineering). Desai's research spans multiple disciplines including materials engineering, cell biology, tissue engineering, and pharmacological delivery systems to address issues concerning disease and clinical translation. She has published over 230 peer-reviewed articles. Her research is at the cutting-edge in precision medicine, enabled by advancements in micro and nanotechnology, engineering, and cell biology directed to clinical challenges in disease treatment. She seeks to design new platforms to overcome existing challenges in therapeutic delivery. Her research efforts have earned recognition including Technology Review's "Top 100 Young Innovators," Popular Science's Brilliant 10, and the Dawson Biotechnology Award. She is President-Elect of the American Institute for Medical and Biological Engineering. In 2015, she was elected to the National Academy of Medicine and in 2019 to the National Academy of Inventors. Desai is a vocal advocate for STEM education and outreach to underrepresented students. She received her B.S. from Brown University in biomedical engineering in 1994 and was awarded a Ph.D. in bioengineering jointly from UCSF and UC Berkeley in 1998.

Plenary Lecture



Dr. S. Raja Sabapathy

Tissue Engineering in Reconstructive Surgery and What is in the Horrison

S Raja Sabapathy

Chairman, Dept of Plastic Surgery, Hand and Reconstructive Microsurgery and Burns Director,

Ganga Hospital, Coimbatore, India.

E mail : rajahand@gmail.com

Profile

DR. S. RAJA SABAPATHY

Chairman, Department of Plastic Surgery, Hand and Microsurgery and Burns, Ganga Hospital, Coimbatore, Tamilnadu, India

- ✓ Hon Consultant and Advisor to the Armed Forces Medical Services.
- ✓ President Elect – Asia Pacific Federation of Societies for Surgery of the Hand (APFSSH).
- ✓ Sushruta - Guha Professor in Plastic Surgery and Wound Healing of the Royal College of Surgeons of Edinburgh, UK 2016 Member EC, IFSSH.
- ✓ Association of Plastic Surgeons of India – 2011
- ✓ Indian Society for Surgery of the Hand 2010 – 12
- ✓ Indian Society for Reconstructive Microsurgery 2004- 2006
- ✓ International Trauma Care (Indian Section) Brachial Plexus Surgery Group of India 2011 – 13

Member of the Executive Committee

Diabetic Foot Society of India

National Liaison

World Society for Reconstructive Microsurgery (WSRM)

Head Quarters Coordinator

Association of Plastic Surgeons of Tamil Nadu and Pondicherry region

Plenary Lecture

Secretary

Association of Plastic Surgeons of Coimbatore Region

Member of the Editorial Board

- Journal of Plastic Reconstructive and Aesthetic Surgery (JPRAS) formerly the British Journal of Plastic Surgery
- Journal of Hand and Upper Extremity Surgery (USA)
- Hand Surgery (Springer).
- Hand (AAHS)
- Hand Surgery (Asia Pacific)

Member of the Reviewer Board

- Indian Journal of Plastic Surgery (Editor – IJPS 1994 – 1999).
- Founder Secretary
- Brachial Plexus Surgery Group of India (2004 - 2007)
- Editor Indian Journal of Plastic Surgery (1994-99)

Member Executive Committee

- Association of Plastic Surgeons of India (1994-1999)
- National Association of Burns of India – 2013 to 2016
- Secretary Indian Society for the Surgery of the Hand (2002 - 2008)
- Secretary Indian Society of Reconstructive Microsurgery (2000-02)
- Member, Armed Forces Medical Research Committee

Educational Qualifications

Dr S Raja Sabapathy M.B.B.S : 1979 Stanley Medical College, Madras Best outgoing student of the Year M.S. General Surgery : 1982 Madras Medical College, Madras M. Ch (Plastic Surg) : 1985 Stanley Medical College, Madras Dip NB (Plastic Surg) : 1985 National Board of Exams, N Delhi FRCS : 1989 Royal College of Surgeons, Edinburgh, UK Fellowship in Hand & : 1990 Christine M Kleinert Institute for Hand and Microsurgery Microsurgery, Louisville, USA FAMS : 2018 Hon FRCS : Royal College of Surgeons and Physicians of Glasgow



Prof. Atsushi Suzuki

Recent advances in gelation techniques of PVA gels for medical applications

Atsushi Suzuki

*Department of Materials Science & Faculty of Environment and Information Sciences,
Yokohama National University, Yokohama, Japan*

*Email: asuzuki@ynu.ac.jp

Abstract

Poly(vinyl alcohol) (PVA) hydrogel has excellent mechanical properties, water retention, and high biocompatibility. In the last decade, the development of sample preparation techniques has received increasing attention, especially in the field of biomedical engineering. Several years ago, a lamination method (a hybrid technique) using FT [1] and CD [2] gels was examined in order to improve the tribological properties [3]. Higher mechanical joint was achieved by the additional microcrystallites formed at the interface. More recently, novel preparation method for physical PVA gels has been explored by controlling the polymer networks of repeated freeze-thawed gels via a unidirectional freezing method [4]. This anisotropic network structure can lead to higher mechanical performance along the fibril direction. These techniques provide hierarchical network structures that could not be obtained by the conventional single process.

Recently, novel gelation techniques have been developed to obtain non-conventional mechanical properties. One is dual crosslinked PVA hydrogels of single network, which was obtained by chemical crosslinking of physical PVA gels. Using this technique, multi-layered cylindrical gels as well as gradient gels with single network can be easily obtained. Second is multi-gradient PVA hydrogels, which was obtained by using the water-soluble thin PVA cast films. It has been well established that both the swelling and elution ratios rapidly increased with decreasing the thickness of CD film gels since the microcrystallites are not formed during the rapid drying [5]. On the basis of this finding, the

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water-soluble PVA film was prepared, and applied for the adhesion between PVA gel surfaces. The film conditions (thickness,drying conditions, etc.) and the method for introducing crosslinking were optimized, which affected the adhesion strength. Modifying this diffusive adhesive, the film can be used for the modification of a gel surface. When a film was put on a PVA gel surface, a wrinkle structure was generated on the surface during the film swelling process. By controlling the experimental conditions, the surface patterns can be easily controlled, and a variety of texture of PVA gels can be obtained.

This talk reviews the *recent developments* in the preparation techniques of PVA hydrogels with higher swelling and mechanical performances, which are promising materials in the applications of biomedical engineering, such as human body phantoms.

Keywords:Poly(vinyl alcohol) / Hybrid gel / Multi-gradient gels / Medical phantoms.

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Profile

PROF. ATSUSHI SUZUKI

Dr. Atsushi Suzuki is a Professor at Department of Materials Science & Faculty of Environment and Information Sciences, Yokohama National University. He received his BS and MS from the University of Tokyo and joined the faculty of YNU as an assistant professor in 1983. He received Doctor of Engineering from the University of Tokyo in 1987 (supervisor: Prof. Masao Doyama). In 1989, he started gel science and technology at MIT under the direction of late Prof. Toyoichi Tanaka. In 1990's he stayed at MIT as a visiting scientist several times and collaborated with Toyo on fundamental topics of gels. His research covers the principles of phase transitions of gels, smart gels, which undergo phase transitions in response to the changes in environmental conditions. After 2000, his interests extended to the development of new clean technologies as well as biomaterials for healthcare with the use of hydrogels for practical applications. Dr. Suzuki served as a member of the Japan-India Science Council in 2008-2019. He was installed as a specially appointed Member of the Science Council of Japan (SCJ) from 2018. He organized many domestic and international conferences, and now he has been exerting himself in establishing the new platform of advanced materials research in Japan, and organizing MRM2021 (<https://mrm2021.jmru.org>) in Yokohama, December 2021.

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Dr. Aldo R Boccaccini

"Bioactive glasses and Biofabrication in Tissue Engineering: Achievements and New Developments"

Aldo R Boccaccini

Institute of Biomaterials, University of Erlangen-Nuremberg, Erlangen, Germany

Email: aldo.boccaccini@fau.de

Abstract

Bioactive glass (BG) was discovered by the late Prof. Larry L. Hench 50 years ago [1]. The “traditional” applications of BG have been as a material for bone replacement, for example as bone defect filler, small bone and dental implants and coatings for orthopedic applications. More recently, BGs have started to be highly considered in the tissue engineering (TE) field, expanding from bone to soft TE. The success of BGs in hard and soft TE applications is based on the biochemical reactions occurring at the interface between BGs and the biological environment, involving the release of biologically active ionic dissolution products from the BG matrix [2]. The progress in the development and characterization of TE scaffolds made purely from BGs or by combining BGs and biopolymers, including their application in biofabrication approaches, e.g. developing of composite bioinks, will be discussed with focus on the effect of different biologically active ions released from BGs on osteogenesis and angiogenesis. Research involves BGs incorporating metallic ions such as B, Sr, Cu, Nb, Co, Li, Mn among other active ions. The variation of ion concentration in the medium as function of time and the time dependent effects on stem cells will be discussed, which is required for the comprehensive assessment of the long-term biological performance of BGs with implication for clinical applications. Moreover in-vivo investigations to determine the vascularisation potential of new bioactive glass scaffolds will be discussed in relation to the current main challenge of TE, namely that the biomaterial construct supports vascularisation. The key characteristics of BGs in terms of inorganic bioactivity (ability to bond to biological tissues via specific surface reactivity) and their angiogenic potential

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coupled with antibacterial and hemostatic properties, are the key elements enabling such applications in contact with soft tissues [3]. In the emerging field of bioactive glasses for soft tissue engineering, an overview of such applications will be presented with focus on our current work on wound healing based on combinations of BGs and phytotherapeutic agents[4] and on hydrogel-bioactive glass composites for biofabrication of cell laden scaffolds.

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Profile

PROF. ALDO R BOCCACCINI

Aldo R. Boccaccini is Professor of Biomaterials and Head of the Institute of Biomaterials at University of Erlangen-Nuremberg, Germany. He is also Visiting Professor at Imperial College London. His research activities are in the broad area of glasses, ceramics and composites for biomedical applications. He has pioneered the use of bioactive composite scaffolds incorporating bioactive glasses for tissue engineering. Boccaccini has co-authored more than 850 scientific papers. His work has been cited more than 43,000 times (h -index = 92, Scopus®, h -index = 108, Google Scholar®) and he was included in the “Highly Cited Researchers” list (Clarivate Analytics) in 2014 and 2018. Boccaccini is a Fellow of four international organizations: the Institute of Materials, Minerals and Mining (UK), the American Ceramic Society, the Society of Glass Technology (UK) and the European Ceramic Society. He is the Editor-in-Chief of the journal “*Materials Letters*” and founding Editor-in-Chief of the Open Access journal “*Biomedical Glasses*”. Boccaccini has received numerous international awards, including the Materials Science Prize of German Materials Society and Turner Award of International Commission on Glass. He is also a member of the World Academy of Ceramics, and the National Academy of Engineering and Applied Sciences of Germany. A native from Argentina, Boccaccini is an advisor to Argentina’s Science and Technology Ministry. He serves also in the Executive Committee of the Federation of European Materials Societies (FEMS) (since 2016) and in the Council of the European Society for Biomaterials (ESB) (since 2015).



Dr. S. Rajasekaran

The Science of Metallurgy regarding Implants in Orthopaedic Surgery

S. Rajasekaran

Chairman, Department of Orthopaedics & Spine Surgery,

Ganga Hospital, Coimbatore, India

Profile

Dr. S. Rajasekaran

Managing Director, Chairman of the Department of Orthopaedics, Trauma & Spine Surgery, Ganga Hospital, Coimbatore, Tamilnadu, India

Leadership in Profession

Current Positions

- Chair, International Research Commission of AO Spine (2016 – 2019).
- President of SICOT (2016 – 2018)
- President- CSRS-AP 2018. Past Positions:
- President of the Indian Orthopaedic Association (2012)
- President of the Association of Spine Surgeons of India for four years (2008 – 2012)
- President of International Society for the Study of Lumbar Spine, Canada (2012),
- President of the World Orthopaedic Concern, UK (2005-2007).
- Chief National Delegate of Asia Pacific Orthopaedic Association

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Other Academic Distinctions

- Hunterian Professor for the year 2011-12 by the Royal College of Surgeons of England
- ‘Distinguished Visitor’ to Harvard Medical International, Boston, USA
- Grand Rounds Lecturer of Dartmouth University, USA and Mayo Hospital, USA
- Adjunct Professor of Orthopaedic Surgery, Tamilnadu Dr MGR Medical University.
- Member of Faculty of Medicine, Annamalai University
- Member of the Planning Board, Bharathiar University.
- Deputy Editor of the Journal of SPINE, USA
- Deputy Editor of Global Spine Journal, USA,
- Editorial board of European Spine Journal. Research Awards
- ISSLS Prize for Spine Research four times for the years 2004, 2010, 2013 and 2017.
- ‘EuroSpine Open Paper Award’ for 2008 for his research demonstrating that Disc Nutrition in spine can be modified by Calcium channel Blockers.
- Macnab LaRocca Research Award of ISSLS in 2005
- Sofamer Danek Award for the best Scientific presentation internationally by the International Society for the Study of Lumbar Spine thrice for the years 1996, 2002 & 2006.

Dr Rajasekaran has 193 publications in international journals, 44 national publications and 383 international and 473 national presentations. He has also contributed 49 chapters in international books and is the Chief Editor of a Video Atlas of Spine Surgery and the ASSI Textbook on Spinal Infections & Trauma.



Prof. Pamela Habibovic

Applying novel design- and screening tools to advance the field of organ and tissue regeneration

Pamela Habibovic

MERLN Institute for Technology-Inspired Regenerative Medicine, Maastricht University

Department of Instructive Biomaterials Engineering Maastricht, the Netherlands

Email: p.habibovic@maastrichtuniversity.nl

Abstract

Current treatments of damaged organs and tissues that are based on a patient's own material, cells and growth factors are associated with important drawbacks of limited availability, biological instability and high costs. Regenerative strategies based on synthetic biomaterials are becoming increasingly attractive as an alternative to strategies based on tissue, cells or growth factors, because they are relatively inexpensive, off-the-shelf available and adaptable to requirements of individual clinical application. Nevertheless, biomaterials for tissue- and organ regeneration need to be designed in such a way that they exert the desired function in the body, in a spatiotemporally controlled manner. This requires a different set of tools for design of biomaterials and for screening of their interactions with the biological system than is currently used in the field. In this lecture, a number of such tools is discussed, including the application of bioinorganics as synthetic "growth factors", use of micro- and nanotechnology to independently design chemical and structural properties of biomaterials, application of microfluidics to increase throughput of production and complexity of screening of material-cell/tissue interactions and the use of nanomaterials to spatiotemporally control the behavior of functional biomaterials in the body.

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Profile

PROF. PAMELA HABIBOVIC

Pamela Habibovic obtained her PhD degree in 2005 from the University of Twente in the Netherlands. In 2006, she worked as post-doctoral research fellow at Children's Hospital Boston-Harvard Medical School and in 2007 she spent a year as post-doctoral research fellow at McGill University in Montreal, Canada. From 2008 until 2014 she led a research group at the University of Twente, first as assistant and later as associate professor. In 2014, she moved to Maastricht University, where she became Full Professor of Inorganic Biomaterials and where she cofounded MERLN Institute for Technology-Inspired Regenerative Medicine. Currently, she is the Scientific Director of the institute and she chairs the Department of Instructive Biomaterials Engineering. The main focus of her research group is on synthetic bone graft substitutes, bioinorganics, nanomaterials for theranostics in regenerative medicine and high-throughput approaches in biomaterials research. For her research she received prestigious Veni, Vidi, Aspasia and Gravitation grants of the Netherlands Organisation for Scientific Research among other external research funds. Since 2013, she serves as a council member of the European Society for Biomaterials (ESB), and since 2017 she holds the role of the ESB President. Habibovic is an Associate Editor of the RSC journal *Biomaterials Science* and an editorial board member of the journals *Acta Biomaterialia*, *Journal of Materials Science: Materials in Medicine*, *Advanced Biomaterials and Devices in Medicine*, *Regenerative Biomaterials*, *Biomedical Engineering* and *Biomaterials Research*. She has published over 90 peer-review articles on the topic of biomaterials and regenerative medicine. In 2013, she received the Jean Leray Award of the European Society for Biomaterials.

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Prof. BalaVaidhyanathan

Additive Manufacturing of Nanostructured Bioceramic Implants

BalaVaidhyanathan

Department of Materials, Loughborough University, UK

Email: b.vaidhyanathan@lboro.ac.uk

Abstract

The processing of nanocrystalline ceramic powders and suspensions into useful engineering components has been investigated via a series of research projects each focusing on a different stage of the manufacturing route viz., (i) the ability to control the agglomerates present in the powder resulting in the production of a free-flowing and crushable powder for die pressing, (ii) the formation of a low viscosity but high solids content nano suspensions suitable for slip casting, additive manufacturing (AM: 3D printing) and (iii) the use of novel field assisted sintering techniques. This holistic approach helped to transfer the developments achieved in each stage of the manufacturing process to the next and resulted in the ability to form fully dense bioceramic components whilst restricting the grain growth to a minimum. The methodology has been employed to develop various nanostructured zirconia based ceramic components exhibiting vastly superior hydrothermal ageing resistance and mechanical performance suitable for use in biomedical implants (eg., hip/knee prosthesis, finger joints, dental and jaw repairs), surgical tools, petro-chemical valve parts as well as for ballistic armour applications. Significant advantages were noted with AM compared to conventional subtractive manufacturing methods and the 3D printing of hydrothermally immune nanostructured dental implants was considered as one of the six best modern technological developments in materials science by a recent BBC documentary (Materials for the Modern Age: The Secret Story of Stuff). These novel advancements are covered by a series of patents and papers and this talk will provide an overview of some of these developments.

Key Words: additive manufacturing, bioceramic implants, field assisted sintering.

Plenary Lecture

Profile

PROF. BALA VAIDHYANATHAN

Vaidhyanathan is a Professor of Advanced Materials and Processing, current Associate Dean for Enterprise (ADE) of the School of Aeronautical, Automotive, Chemical and Materials Engineering at Loughborough University (LU), Leader of the Advanced Ceramics Research Group, member of the School Senior Management Team (SSMT), member of the advisory team of university's research challenges and Chair of School Student Placement committee. Previously he has been a member of the research staff at the Pennsylvania State University, USA, and a Lead Scientist at General Electric-Global Research Corporation. He specializes in nanostructured functional materials and non-conventional field assisted processing. He has published over 200 peer-reviewed articles, 6 book chapters, holder of 17 patents and has delivered >60 plenary, keynote and invited presentations across the globe. He has held/holds >47 Government/Industry sponsored project grants, worth >£12.2M. Vaidhyanathan has pioneered the development of additive manufacturing of advanced ceramics, energy efficient microwave, hybrid and flash methods for the advanced processing of functional ceramic materials and Loughborough is currently regarded as one of the world leaders in the utilization of these techniques and hosts the largest nanoceramics group in UK. With over 20 years of experience, he is one of the leading exponents in the field of microwave-assisted materials manufacturing, pioneered the development of hybrid two stage sintering methods and was the first to set up an atmosphere controlled, gradient flash sintering facility for the processing of oxide/non-oxide materials and devices. The range of products worked on has been very wide, from traditional to nanostructured materials, for energy, electronic, defense and healthcare applications. LU Materials department is also the home of the Loughborough Materials Characterisation Centre, a specialized facility for state-of-the-art materials characterisation in all length scales from surface to bulk, from microscopic to macroscopic structures and BV's team commands significant analytical expertise on structure-property correlations.

Chief Editor for Advances in Applied Ceramics (published by Taylor & Francis) and Editorial Board member for 4 international materials' journals, Awarded K.P. Abraham Gold Medal for the best doctoral thesis from IISc, Bangalore, 1998., Awarded Edison Innovation Medal by GE, 2006 , Fellow of the Higher Education Academy, UK, 2009. Recipient of 'Glory of India' Award for his contribution to Science, Technology and Education, 2010 Awarded Verulam Medal and Prize for his significant contributions to the field of ceramics by the Institute of Materials, Minerals and Mining (IOM3) in UK, 2015, IOM3's Pfeil Award for the Best Paper in the field of ceramics, 2017. He is a member of American Ceramics Society, European Ceramics Society and Life member of the Indian Ceramics Society, Management Committee member of the Association of Microwave Power Education and Research in Europe (AMPERE), Member of IOM3 Ceramics Science Committee, Defense, Safety and Security Committee, Defense Ceramics Network, UK , Fellow of the Institute of Nanotechnology, Member of the Materials Research Society of USA, Singapore and India. 'Visiting Professor' at two international institutions, Session Chair and Organizing Committee Member for >20 International Materials' Conferences.

KEYNOTE ADDRESS

Keynote Address



Prof. Ashok Kumar

Exosomes functionalised biomaterials: A promising therapeutic tool for diabetic secondary complications

Ashok Kumar

*Department of Biological Sciences and Bioengineering, Indian Institute of Technology Kanpur,
Kanpur, India*

Email: ashokkum@iitk.ac.in

Abstract

Diabetes, a chronic metabolic disease, has shown a dramatic global prevalence in recent decades in both high and low-income countries. The International Diabetes Federation (IDF) has reported that the number of diabetic population will increase from 415 million in 2015 to 642 million by 2040. The major secondary complications associated with diabetes includeneuropathy, nephropathy, retinopathy, and foot ulcers.The current treatment strategies for these secondary complications are still falling short in effective therapeutic and regenerative applications. However, in recent timesadvanced tissue engineering strategieshas emerged as a crucial stepfortheeffective management of diabetes and its complications.Taking cues from the current demands, we havebeen working onmultifaceted approaches based on biomaterials and cell-derived nano-vesicles for efficient regenerative and therapeutic applications. Such combinatorial approaches may promote the sustained release of these nano-vesicles (exosomes) through localisation when compared to the rapid release profile into the systemic circulation. For this, we have explored diabetic foot ulcers (DFU) and diabetic peripheral neuropathy (DPN) - two of the most common long-term complications associated with diabetes. DPN is a major underlying cause in the severe pathologies associated with DFUs, which 15% of the times results in non-traumatic amputation due to impaired healing in chronic wounds.

Keynote Address

Chronic diabetic wounds are associated with persistent inflammation and infections having insufficient nutrient and oxygen supply due to impaired angiogenesis, leading to the inevitable hypoxic environment and improper wound closure. A newer strategy to develop an OxOBand, an exosome laden oxygen releasing antioxidant wound dressing, was utilised for enhanced wound healing and skin regeneration. OxOBand is composed of antioxidant polyurethane (PUAO), as highly porous cryogels with sustained oxygen releasing properties and supplemented with adipose-derived stem cells (ADSCs) exosomes. This dressing attenuated oxidative stress, induced vascularisation, enhanced collagen remodelling, ininfected and non-infected wounds in a diabetic rat model.

Diabetic peripheral neuropathy is also a long-term complication of diabetes, which is the major causative underlying mechanism in non-healing diabetic ulcers and is associated with nerve dysfunction and uncontrolled hyperglycemia. Here, we developed a combinatorial approach utilising exosome-liposome therapy along with electrical stimulation to generate a conductible delivery system. The delivery vehicle was developed by fusing the bone marrow mesenchymal stem cells (BMSC)-derived exosomes with liposomes containing polypyrrole nanoparticles. The fused exosomal system, in conjunction with electrical stimulation, provided a conducive environment of optimal biochemical and electrical cues for the efficient nerve regeneration in DPN rat model.

In future, both of the multifaceted approaches employing the regenerative possibilities of exosomes will be explored for clinical translation as cutting-edge therapies in diabetes secondary complications.

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Keynote Address

Profile

PROF. ASHOK KUMAR

Prof. Kumar received his PhD in Biotechnology in 1994 jointly from Institute of genomics and integrative biology, Delhi and Indian Institute of Technology, Roorkee, India. He has completed two of his postdoctoral research from Nagoya University, Japan and Lund University, Sweden. He then joined as a faculty of Biotechnology in Lund University, Sweden and also worked as a group leader in a Biotechnology company in Sweden. He also worked as a co-coordinator for the Swedish centre for Bioseparation in the area of nano/microparticle separations during 2001-2004. He has served as a visiting professor at Lund University Hospital, Sweden and Miyazaki University, Japan and is currently affiliated with Aalto University, Finland as a visiting professor.

At present, Prof. Kumar is a Rajeeva and Sangeeta Lahri Chair Professor of Bioengineering at the Department of Biological Sciences and Bioengineering, Indian Institute of Technology Kanpur, India. His current research interests are in the area of biomaterials, tissue engineering, regenerative medicine, stem cell research, bioprocess engineering, bioseparations, nanotechnology and environmental biotechnology. He has published around 200 peer-reviewed research papers in International Journals, has written twenty book chapters and has many patents granted and filed in his area of research. He served as the editor of five books on cell separations, biomaterials, nanobiotechnology and biomedical and biotechnological applications. He served as associate editor of Nanoscale Research Letters and is on the editorial board of several other Biological and Biotechnological Journals. He is the executive board member of the Asian Federation of Biotechnology. He also serves on expert committees for Biomaterials and Tissue engineering research and teaching in India and also serve as a committee member of Ministry of Science and Technology, Govt. of India. Some of his significant research achievements in the regenerative medicine have been designing of functional biomaterials and therapeutic approaches for critical defect healing of bone, liver, diabetic wounds, peripheral nerve and developing bioartificial lever support bioreactor using cryogel matrices which are at the pre-clinical and clinical evaluation stages. In the area of bioseparations and bioprocessing, he has developed the technologies and processes like metal affinity precipitation, ATPS for protein and cell separations, monolithic chromatographic approaches for macromolecules and cell separations and disposable polymeric bioreactors for therapeutic protein production and have transferred technology to HLL Lifecare, India. His other research achievements are in the development of stem cell separation technology and leukocyte filtration devices. In the area of environmental biotechnology, he has suitably designed membrane filtration devices for air and water purification. He has active International research collaborations with Finland, Germany, Sweden, UK, USA, Japan, Slovenia and Korea. He has also worked as the co-coordinator for recently completed Indo-US centre for Biomaterials at IITK supported by India-US Science and Technology Forum. With the UK, he has recently conducted India-UK, DST-UKIERI award project and India-UK science bridge project. He is currently carrying out clinical research in skeletal tissue regeneration in collaboration with Lund University Orthopaedic department, Sweden. He is the elected Fellow – Biomaterials and Artificial Organs (FBAO) of the Society of Biomaterials & Artificial Organs of India (SBAOI). He has been awarded the GRO Samsung project award from Korea for health systems research and TATA Innovation Fellowship from DBT, Ministry of Science and Technology, Govt of India for outstanding research contributions.

Keynote Address



Dr. Arvind Sinha

Biomaterials: An ongoing journey from biomimetics to biodegradable alloys

Arvind Sinha

CSIR-National Metallurgical Laboratory, Jamshedpur, India

E.Mail: arvind@nmlindia.org

Abstract

Biomimetics is a well-known concept of abstraction and application of biological principles into human-made technologies in general and materials science and technology, in particular. Self-assembly assisted stringent micro and macro-structural control, manifested by structural materials produced by nature, could be explained on the basis of underlying supramolecular matrix and its specific molecular recognition, leading to controlled nucleation and growth and its self-assembly.

In the latter half of the last decade of 20th century, when the term biomimetics was still a new concept in the field of materials science and engineering, we started our journey with a focus on controlled nucleation and growth of nanoparticles. A natural flow of our journey brought us in the domain of biomimetic bone grafts, ranging from osteo-conductive nano-powders to osteo-inductive 3d-scaffolds. Recognizing the importance of high strength biocompatible metallic alloys for load bearing orthopedic application, our group is now involved in developing high strength and biodegradable (controlled degradation) metallic implants (Mg and Zn based), while addressing some of the well-known challenges, associated with these alloys.

Our journey, in the field of biomaterials became more interesting and productive with the active participation of Indian biomaterials industries. My talk will highlight some of the significant milestones covered by our team during this ongoing journey.

Keynote Address

Profile

DR. ARVIND SINHA

- ✓ Chief Scientist & Head Advanced Materials & Process Division CSIR-National Metallurgical Laboratory, Jamshedpur 831007
- ✓ Professor (Engineering Sciences) Academy of Scientific & Innovative Research (AcSIR) &
- ✓ Chairman, Jharkhand State Chapter of The National Academy of Sciences, India.

Awards & Honors

S. No.	Name of Award/Fellowship etc.	Elected/Honorary Fellow	Awarded by	Year of Award
i	University Gold Medal	Medal	University of Roorkee, now IIT Roorkee	1986
ii	CSIR Young Scientist Award	AWARD	CSIR	1999
iii	MRSI Medal	AWARD	Materials Research Society of India	2005
iv	Altekar Award	AWARD	CSIR-NML	2005
v	CSIR Raman Research Fellowship	AWARD	CSIR	2006
vi	N. P. Gandhi Memorial Fellow	Elected	Department of Metallurgical Engineering, IIT BHU	2011
vii	Sahaj Memorial Lecture Award	AWARD	Indian Ceramic Society	2013
viii	Nijhawan Best Paper Award	AWARD	CSIR-NML	2013
ix	Fellow of The National Academy of Sciences, India	ELECTED	The National Academy of Sciences, India	2011
x	Fellow of Indian Chemical Society	ELECTED	INDIAN CHEMICAL SOCIETY	2019

Keynote Address

Publications, Patents and Technology Transfer etc

Publications in SCI journals	65
National Patents Granted	04
International Patents granted	07
Patents under filing	05
Technology Transferred	04
Products commercialized	03
Ph D/ M Tech Students guided	PhD:2 Awarded, 01 ongoing M Tech 06

Scholarly Achievements

Editorial Boards: Member of Editorial Advisory Board of JMMS, In recent past, has been a Member of Editorial Boards of ISST Journal of Applied Physics (ISSN : 0976-903X) and Journal of Powder Metallurgy & Mining.

Participation and contribution at International Forum: Represented India / CSIR as a delegation member to:

- (i) UK Ministry of Commerce-CII meeting on Nanotechnology in 2007 at **London, UK**
- (ii) Asian Productivity Council Meeting at **Taipei, Republic of China (Taiwan)** in 2008
- (iii) Humboldt-DST joint meeting at **Potsdam, Germany** 2010.

Delivered following lectures on different international platforms:

S. No.	Date	Title of Conference or Institution	Title
1	August 2000	5 th International Conference on Nanostructured Materials, Thoku University, Sendai, Japan (Contributory talk)	Bioinspired ways to synthesize nanomaterials
2	Oct 2003	Department of Physics Purdue University USA (Invited Lecture)	Biomimetics
3	Nov 2004	Bulgarian Academy of Sciences, Sofia, Bulgaria (Invited Lecture Lecture)	Biomimetic Nanocomposites
4	Oct 2006	University of Massachusetts, Dartmouth, USA (Invited Lecture)	Nature Inspired Design of Materials
5	Nov 2006	Brown University, USA (Invited Lecture)	Biomimetic Nanocomposites
6	Nov 2007	Kings College, London, UK , (Invited Lecture)	Bioactive nanocomposites

Keynote Address



Prof. Annabel Braem

Anti-infective strategies for next generation dental implants

Annabel Braem

Department of Materials Engineering in Leuven, Belgium

Email: annabel.braem@kuleuven.be

Abstract

Considering the high prevalence rates and the lack of a current gold-standard treatment, peri-implantitis is rapidly becoming an – if not the most – important clinical challenge in dental implantology. Because of the pivotal role of biofilms, there is a growing interest in the local delivery of antimicrobial agents into the periodontal pocket, i.e. the anatomical cavity between implant and soft tissue formed at the onset of peri-implantitis, to inhibit microbial colonization and biofilm formation at the implant site. Delivery strategies include controlled release from drug-eluting carriers and permanent attachment (immobilization) at the implant surface. Both concepts offer interesting advantages, but practical implementations still need to be improved with respect to mechanical stability of the materials and spatial and temporal control over the drug concentration. We present several approaches addressing the currently experienced needs in implant-based drug delivery which will allow establishing more therapeutically effective peri-implantitis treatments in the future.

Keynote Address

Profile

PROF. ANNABEL BRAEM

Prof. Annabel Braem is an assistant professor at the KU Leuven Department of Materials Engineering in Leuven, Belgium. After graduating magna cum laude as Master of Engineering: Materials Engineering at KU Leuven in July 2007, she joined the KU Leuven Department of Materials Engineering (MTM), first as a PhD student and later as a postdoctoral researcher in the research group of Advanced Ceramics and Powder Metallurgy. She obtained her PhD in Engineering at KU Leuven in September 2012 on the ‘Development of biofunctional porous coatings for bone implants’ for which she also received the 1st prize in the 2014 EPMA Powder Metallurgy Thesis Competition in the Doctorate/PhD category from the European Powder Metallurgy Association. As a postdoctoral researcher, Annabel focused on the development of antibiofilm coatings for implants. In October 2017, Annabel Braem was appointed as an assistant professor in the Biomaterials and Tissue Engineering research group at the KU Leuven Department of Materials Engineering. She has been a visiting researcher/professor at the Friedrich-Alexander-Universität in Erlangen-Nürnberg (Germany) in 2015 and 2018 and at the Institut National des Sciences Appliquées de Lyon (France) in 2019. Her research is situated in the interdisciplinary field of biomaterials research and development at the tangent of engineering and biomedical sciences and focuses on the development of multifunctional tissue-biomaterial interfaces through surface functionalization of implant materials with biologically active molecules, e.g. through controlled release or immobilization techniques. Her research has been published in ~50 international peer-reviewed papers with an h-index of 14, according to ‘Web of Science’ or 18 according to Google Scholar, and >40 international conference contributions. Within the Materials Engineering and Biomedical Engineering educational programmed at KU Leuven, prof. Annabel Braem is teaching several biomaterials related courses.

Keynote Address



Prof. Rohit Srivastava

Affordable Healthcare Technologies in Sensing, Drug Delivery and Therapy

Rohit Srivastava

Department of Biosciences and Bioengineering, IIT Bombay, Powai,

E.Mail: rsrivasta@iitb.ac.in

Profile

PROF. ROHIT SRIVASTAVA

Our lab at IIT Bombay is well recognized for his translation research in the field of Biosensors and affordable Point-of-care diagnostic technologies for rural and maternal healthcare. Our team have *already commercialized four point-of-care diagnostic devices* such as **SYNC**- Bluetooth integrated glucometer for diabetes management; **UChek**- routine urine analysis system; **ToucHb**- non-invasive haemoglobin detection device; **CareMother**- a smart phone-based platform to integrate doctors and pregnant women to screen and identify risk-prone pregnancies for maternal and neonatal healthcare in the rural areas. We have *also clinically validated and transferred numerous healthcare technologies to the companies* such as **SmartsenseTM**- affordable and portable blood electrolyte analyzer with integrated blood plasma centrifuge; **UridsaTM**- a low-cost, portable colourimetric device to diagnose kidney-related disorders; **ElectroFinderTM**- Portable and rapid detection device to sodium and potassium level in critical care patients. We have also *clinically validated several technologies* like **PorFloRTM**- Fluorescence strips and device for detection of orthopedic implant-associated infection such as C-reactive protein (CRP) and interleukin-6 (IL-6); **CholcheckTM**- Affordable LFA-based complete cholesterol panel and detection device; **Insulin Infusion Pump**- Continuous insulin infusion pump, along with hollow silicon microneedle patch and the flexible reservoir for diabetes management. This has been possible by extensive support from BIRAC, DBT, ICMR and DST translational schemes. Our group

Keynote Address

has developed many affordable, novel, biodegradable plasmonic nanoparticles for minimally-invasive cancer theranostic application. The promising preclinical result of the developed technology has encouraged us to take it forward into Phase I clinical trial through a Start-up route. Our group has also indigenously developed economical, novel, resorbable bone screw and drug loaded chitosan sponges for orthopedic applications. We have established active collaborations with various technical, medical institutes along with hospitals, research centers and companies all around India and World. We strongly believe in bringing a positive change in India's underdeveloped healthcare sector via developing affordable healthcare technologies with the collaboration of industries and generating funds via transferring technologies for commercialization. We have mentored 25+ Medtech start-ups in last five years and helped them to secure grants to develop innovative solutions for healthcare applications.

Keynote Address



Prof. B.D. Malhotra

Nanostructured Metal Oxides-Enabled Biosensors for Oral Cancer Detection

Bansi D. Malhotra

Department of Biotechnology, Delhi Technological University,
Delhi, India

E.Mail:bansi.malhotra@gmail.com

Abstract

Nanostructured metal oxides have recently attracted much interest as immobilizing matrices for development of biosensorssince these materials provide desired orientation, better conformation and high biological activity resulting in enhanced sensing characteristicsfor oral cancer detection.[1–5] In this context, nanostructured oxides of metals such as zirconium, yttrium and hafnium have been found to show interesting functional, biocompatible, non-toxic and catalytic properties for oral cancer detection. These materials have been predicted to yield enhanced electron-transfer kinetics and strong adsorption capability and provide suitable microenvironments for the immobilization of oral cancer biomarkerse.ginterleukin- 8 (IL-8), interleukin-6 (IL-6), vascular endothelial growth factor (VEGF) and cytokeratin fragment-21-1(Cyfra-21-1) resulting in enhanced electron transfer and improved characteristics for OC detection.Among the variousbiomarkers, CYFRA-21-1 is a water-soluble proteinaceous biomarker and is a fragment of 40 kD of cytokeratin 19.[2] Thecut-off concentration of CYFRA-21-1 in saliva for normal persons is 3.8 ng mL^{-1} and patients havebeen found to have CYFRA-21-1 concentration as high as 17.46ng mL^{-1} in saliva. I shall talk about the results of some the recent experimentsobtained in our laboratories onnanostructured metal oxides based biosensors for non-invasiveoral cancer detection.[2-4]

Keynote Address

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Keynote Address

Profile

PROF. B D MALHOTRA

Prof. B.D. Malhotra received his PhD from the University of Delhi, Delhi in 1980. He has published 324 papers in refereed international journals (**Citations:21716, h-index: 80**), has filed 12 patents (in India and overseas), and has co-authored text books on ‘Nanomaterials for Biosensors: Fundamentals and Applications’ and ‘Biosensors: Fundamentals and Applications’. He is a recipient of the National Research Development Corporation Award 2005 for invention on ‘Blood Glucose Biochemical Analyzer’ and is a Fellow of the Indian National Science Academy, the National Academy of Sciences, India and an Academician of the Asia Pacific Academy of Materials(APAM).His current research activities include Biosensors, Nanobiomaterials, Bio-fuel cells, Ordered Molecular Assemblies, Conducting Polymers, Langmuir-Blodgett Films, Self-assembled Monolayers, Nano-Biotechnology, Biomedical Engineering and Biomolecular Electronics. Dr Malhotra is currently a DST-SERB(Govt of India) Distinguished Fellow and an Adjunct Professor with the Department of Biotechnology, Delhi Technological University, Delhi, India.

Keynote Address



Prof. P. Padmanabhan

Nano-technological approach for the early detection of Alzheimer's disease

P. Padmanabhan

Lee Kong Chian School of Medicine, Nanyang Technological University (NTU), Singapore

Email: ppadmanabhan@ntu.edu.sg

Profile

PROF. P PADMANABHAN

EXPERIENCE

- ✓ Deputy Director, **Lee Kong Chian School of Medicine, Nanyang Technological University (NTU)**, Singapore (June 2014 to till now)
- ✓ Senior Research Fellow, **Lee Kong Chian School of Medicine, Nanyang Technological University (NTU)**, Singapore (December 2012 to June, 2014)
- ✓ Vice President, **BioPharma Training Institute Pte Ltd**, Singapore (June 2012– November 2012)
- ✓ Director, Bioimaging Centre, **PWG Genetics Pvt. Ltd**, Pre-Clinical CRO, Singapore (June 2011- May 2012)
- ✓ Research Manager, Translational Molecular Imaging Group (TMIG), **Singapore BioImaging Consortium (SBIC)**, **A-STAR** (2007- 2011)
- ✓ Senior Research Fellow, **Singapore BioImaging Consortium (SBIC)**, **A-STAR**, Singapore (2006 – 2007)
- ✓ 2003- 2005 Research Associate, **Stanford Medical School**, USA
- ✓ 2000- 2001 Visiting Scientist, Dept. Microbiology, **Cornell University**, Ithaca, USA

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- ✓ 1996- 2002 Senior Scientist, DRD (Environmental Biotechnology), **NEERI (CSIR)**, Nagpur, INDIA
- ✓ 1993- 1996 Scientist Fellow, DRD (Environmental Biotechnology), **NEERI (CSIR)**, Nagpur, INDIA

Other Positions Held:

- Visiting Professor, Alagappa University, India, 2018 to till now
- Visiting Professor, Sri Ramachandra Medical University, Porur, Chennai, India, 2017-2019
- Adjunct Professor, Vellore Institute of Technology (VIT), Near Katpadi Road, Vellore, Tamil Nadu 632014, India
- Visiting Professor, Bharathidasan University, Tiruchirappalli, Tamilnadu, India, 2013
- Adjunct Fellow, Singapore Eye Research Institute, Singapore: 2008-2011

Editorial Role in Peer Reviewed Journal(s)

- ❖ Academic Editor, **PLoS One**, USA
- ❖ Associate Editor, **American Journal of nuclear Medicine and Molecular imaging**, USA
- ❖ Associate Editor in **Health and Technology** Journal (Springer), Germany
- ❖ Reviewing Editor, **Frontiers in Stem Cell Treatments Journal**, USA
- ❖ Series Editor, **Nanotheranostics**(Springer), Germany
- ❖ Corresponding Editor of ICTMI-2017 proceedings

Reviewer in International Peer Reviewing Journals

International Journal of Nanomedicine, Journal of the Neurological Sciences, Breast Cancer: Targets and Therapy, Reports in Medical Imaging, Research and Reports in Nuclear Medicine, Applied Microbiology and Biotechnology, Journal of Molecular Microbiology and Biotechnology, Water, Air, & Soil Pollution, Molecular Vision, Theranostics, PLoS One, Small, ActaBiomaterialia, ACS Nano

Current Research Interests/Expertise

Cognitive Neuroimaging, Nano Medicine, Multimodal Molecular Imaging (MR, PET, SPECT, MEG and Optical) and Probe Development, Image processing, Microbiology, Animal Science, Regenerative Medicine, Drug Discovery, Primary cell culture (ADMSC, Neural crest stem cells,, Adipose cells, Glia cells) , Cell and Molecular Biology, Viral mediated Gene Delivery and Biomedical optics

Keynote Address



Dr. V. Arulselvan

Brain-Nanotechnology

V. Arulselvan

Department of Neurology, Royal Care Super Speciality Hospital,

Coimbatore, India

Email:arul441@hotmail.com

Profile

DR V ARULSEVAN

Dr.V. Arul Selvan is a consultant at KMCH Speciality Hospital, Coimbatore, Tamilnadu, India

- ✓ Consultant at Walton centre for Neurology in Liverpool which is a premier neurosciences institute in North of England, consultant there for 6 years
- ✓ Conducted several courses, workshops and invited lectures nationally and internationally
- ✓ Supervisor for PhD and M Phil students at University of Liverpool where served as Honorary Lecturer in Neurology

Education

- ❖ MBBS from Thanjavur Medical College in 1990
- ❖ MD General Medicine from MGM Medical College Indore in1993
- ❖ DM Neurology from Institute of Neurology at Madras Medical College in 1996
- ❖ Completed training in Oxford under internationally renowned professors at Radcliffe Infirmary
- ❖ He was also nominated for fellowship by Royal College of Physicians of London and Edinburgh (FRCP) for his outstanding achievement

Keynote Address



Prof. Artemis Stamboulis

Antimicrobial Methodology for Orthopedic Applications

Artemis Stamboulis

University of Birmingham

Birmingham

Profile

PROF. ARTEMIS STAMBOULIS

Artemis obtained a BSc in Chemistry (Biochemistry) from the Kapodistrian University of Athens, an MSc in Polymer Science and Technology from UMIST and a PhD in Polymer Science and Engineering from the National Technical University of Athens in 1997. She then worked in the Department of Materials at Imperial College as a Marie Curie Research Fellow until 2003, when she accepted a position as Lecturer in Nanotechnology in NIBEC, University of Ulster. In 2005, she moved to the University of Birmingham as Birmingham Fellow and since 2012, she is a Senior Lecturer in Biomaterials and Nanomaterials. Artemis' main research interests are in the microstructural characterisation of materials for biomedical applications as well as in multifunctional materials with emphasis in orthopaedic antimicrobial materials. She has published over 70 research papers in international scientific journals. Artemis has an active research group and has supervised successfully to completion around 55 postgraduate students. Artemis teaches Biomaterials at both undergraduate and postgraduate level. She has an interest in education research and has completed two projects on Threshold Concepts in Engineering funded by the Royal Academy of Engineering. Artemis has recently coordinated a 3-year Marie Skłodowska-Curie RISE programme. NEXT-3D was a RISE innovative research staff exchange network that consisted of 4 academic participants and two non-academic participants from Europe and Australia. The research methodology was based on the multidisciplinary and inter-sectorial collaboration among the network participants and focused on three main themes: Materials, Processing and Characterisation to produce multifunctional coatings (devices) for maxillofacial and orthopaedic applications using 3D laser printing and sintering. The network participants acquire expertise in materials science and engineering, chemistry, physics, biology and medicine.

Keynote Address



Prof.P. Ravi Selvaganapathy

Biofabrication Techniques for Tissue Engineering and Cultivated Meat

P. Ravi Selvaganapathy

*Department of Mechanical engineering and the Canada Research Chair in Biomicrofluidics at
McMaster University, Canada*
Email: selvaga@mcmaster.ca

Abstract

The goal of biofabrication is to use cells and extracellular matrices to assemble tissue constructs that could be used as tissue models in drug discovery or as implantable constructs for regenerative medicine. Over the past decade several new methods have been developed. In this talk, I will discuss the recent advances in biofabrication approaches and the particular challenges that needed to be overcome to produce realistic 3D tissue constructs. I also discuss several new biofabrication techniques developed in my laboratory that produce highly dense multicellular tissue constructs that could be used as tissue models for drug discovery or in regenerative medicine. Finally, I show how the same techniques could be used to assemble lab grown meat as an environmentally friendly replacement for animal meat.

Keynote Address

Profile

PROF.P. RAVI SELVAGANAPATHY

Prof. P. Ravi Selvaganapathy is a Professor in mechanical engineering and the Canada Research Chair in Biomicrofluidics at McMaster University, Canada. He obtained his M.S and Ph.D in electrical engineering (2002) from University of Michigan, Ann Arbor. He was a postdoctoral fellow at Sandia National Laboratories from 2003-2004 and joined McMaster University as an Assistant Professor in 2005. His research interests are in the development of microfluidic devices for drug discovery, drug delivery, diagnostics, artificial organs and tissue engineering. He has over 120 journal publications, has written 6 invited book chapters and been issued 8 US patents related to MEMS/microfluidic devices. Some of his research has been featured in scientific media such as Popular Mechanics as well as in mainstream media such as CBC News, and in newspapers across Canada. He also received the Early Researchers Award from the ministry of research and innovation in 2010 and has been named as a Rising Star in Global Health by Grand Challenges Canada in 2012. He has developed several biofabrication methods and grown Canada's first lab grown meat.

Keynote Address



Prof. Nathaniel S. Hwang

Injectable and anti-inflammatory hydrogel for tissue repair

Nathaniel S. Hwang

School of Chemical and Biological Engineering,

Seoul National University, Korea.

E.Mail: nshwang@snu.ac.kr

Abstract

We fabricated anti-inflammatory and adhesive hydrogel by crosslinking tyramine hyaluronic acid (HA_T) and EGCG conjugated hyaluronic acids (HA_E) through two consecutive oxidation reactions in tyramine as well as in EGCG using tyrosinase from *Streptomyces avermitillis* (SA_Ty) [1]. Especially, with strong oxidative nature of EGCG, the HA_E can be quickly crosslinked with HA_T in few seconds to form HA_TE hydrogel. When HA_TE was applied as tissue adhesive into mouse wound closure, and it successfully closed wound and recovered damaged tissue. Additionally, the HA_TE hydrogel resulted in minimal host tissue response and produced minimal inflammatory cytokines when implanted *invivo*, in which the response was comparable to that of the PBS injection group. This demonstrates that polyphenol-based hydrogel might provide a robust platform in the field of both material science and translational medicine.

Keywords: Polyphenol, Tyrosinase, Anti-Inflammation, Adhesive, Tissue sealant

References

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Keynote Address

Profile

PROF. NATHANIEL S. HWANG

Nathaniel S. Hwang is currently a tenured full professor in the School of Chemical and Biological Engineering at Seoul National University, Republic of Korea. Prof. Hwang is a member of Institute for Chemical Processes and BioMAX Institute at Seoul National University. In addition, he also holds an adjunct position in Stem Cell Graduate Program and Interdisciplinary Program in Bioengineering at the Seoul National University. Prof. Hwang received a bachelor degree in Biomedical Engineering from Johns Hopkins University Whiting School of Engineering in 2002. He obtained his Ph.D. in Biomedical Engineering from the Johns Hopkins School of Medicine in 2007 under the guidance of Professor Jennifer Elisseeff. After doctoral studies, he was a visiting scholar at the University of California, San Diego, Department of Bioengineering, and worked with Professor Shyni Varghese. From 2008 through 2011, he worked as a postdoctoral associate in Professor Robert Langer's laboratory at Massachusetts Institute of Technology. In 2011, Dr. Hwang joined the School of Chemical and Biological Engineering at Seoul National University.

Prof. Hwang is currently leading a group of students that work together to develop new biomaterials, study stem cells, and design new technologies for regenerative medicine. In particular, Prof. Hwang's laboratory is working toward the fabrication of bio-synthetic microenvironments conducive to stem cell differentiation by manipulating scaffold properties and incorporating the desired biological signals. In addition, Prof. Hwang's laboratory is developing non-viral strategies for a direct conversion stem cell technology. He has published over 110 research articles and book chapters covering biomaterials and stem cells for musculoskeletal tissue regeneration (h-index >40, citations>5800). Prof. Hwang is an active member of Tissue Engineering and Regenerative Medicine International Society and Korean Society for Biomaterials.

Keynote Address



Prof. P.R. Harikrishna Varma
In Search of Ideal Biomaterials

Harikrishna Varma

Head, Biomedical Technology Wing

SCTIMST, Trivandrum

Email: varma@sctimst.ac.in

Abstract

Over the last fifty years, science of properly understanding the characteristics of ideal materials for medical applications is in the continuous process of evolution and the term '*biocompatibility*' is also redefined over the years by experts . Biocompatibility is initially defined purely as the characteristic of a material and now, we rephrased this as the characteristic of the material - host system. National Institute of Health (NIH),US, defines biomaterials are, "any substance or combination of substances, other than drugs, synthetic or natural in origin, which can be used for any period of time, which augments or replaces partially or totally any tissue, organ or function of the body, in order to maintain or improve the quality of life of the individual. A number of biomaterials based on polymers, ceramics and metals have been developed for specific clinical applications. Over the last ten years, more emphasis is given to make devices or implants based on a combination of biomaterials, cells and functional biomolecules. The host –guest response involving the biomaterials – tissue interactions leading to tissue attachment, remodeling and ultimate resorption are the sought after challenges in the biomaterial development for specific clinical application. The present talk highlights the thoughts, experience and efforts of a scientist in search of ideal materials for specific clinical applications

Keynote Address

Profile

PROF. HARIKRISHNA VARMA

Harikrishna P.R. Varma is the Head of Biomedical Technology Wing of Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum. Ph.D from Regional Research laboratory (CSIR) (now NIIST) Trivandrum in 1993 and Joined in SCTIMST. Engaged in the research and development of various bioactive ceramics and **Technologies of bioceramic based bone implants** developed in the lab had been transferred to four industries. Product currently available in the market under the trade names **B Ostin®, Grabio Glascera, Biograft HABG etc.**

Did post doctoral research at National Industrial Research Institute of Nagoya, Japan during 1997-1998 as an STA fellow. Was a Visiting Fellow at Queen Mary and Westfield College, University of London during 1994. INDO- DAAD fellow at University of Kaiserlautern, Germany and at Technical University of Dresden Germany. Was a senior JSPS fellow at AIST, Nagoya, Japan during 2002. Currently two international collaborative programmes are running with University of Dresden, Germany and Osaka City University, Japan. Published more than 170 research papers in International Journals and have 15 Indian and one Japanese patent with more than 4000 citations and h index of 37. Received the prestigious **MRSI medal** (Materials Research society of India) for the year 2010 and is a **Fellow of both Indian Institute of Ceramics and Society for Biomaterials and Artificial Organs (SBAOI). Dr.Varma was the President of SBAOI (2014-2017)**

Keynote Address



Prof. Santanu Dhara

Design, development and validation of customized Implants using ethically sourced material

Santanudhara

School of Medical Science and Technology, IIT Kharagpur,

E-mail: sdhara@smst.iitkgp.ernet.in

Abstract

Biomaterials and Tissue Engineering Group was formed in the year 2007 in the vision of product development research based on fundamental understanding of cell-materials interaction. We have established fabrication strategies for different platform technologies for dermal wound, cartilage and skeletal tissue healing. We would show preclinical studies and utilization of ethically sourced materials for biomedical applications.

Keynote Address

Profile

PROF. SANTANU DHARA

Position and Employment:

Institution Place	Position	From (Date)	To (date)
I.I.T. Kharagpur	Professor	April, 2018	-
I.I.T. Kharagpur	Associate Professor	13/01/2012	April, 2018
I.I.T. Kharagpur	Assistant Professor	01/06/2007	13/01/2012
DMRL, Hyderabad (DRDO)	Scientist 'C'	07/08/2006	24/05/2007
University of Bristol (UK)	Research Assistant	01/04/2005	31/07/2006
University of Birmingham (UK)	Research Fellow	24/05/2004	31/03/2005

Honors/Awards:

- ✓ Honorary award of Rosalind Membership of London Journal Press (UK) with assigned no. Membership ID#EP29070
- ✓ Cover page image in Materials Today (December 2017) by winning microscopy competition organized by Zeiss
- ✓ Leadership/Scientist Award for TERMIS-AM 2016 Conference by Two students (Mr. K. Kapat and Dr. B. Das) and TERMIS-AM 2017 Dr. P Dadhich
- ✓ Awarded gold medal in the DST-Lockheed Martin India Innovation Growth Programme (IIGP) 2016, a PAN India Innovators' Competition held at Federation House (FICCI), Tansen Marg, New Delhi for 'Simple low-cost processing of metallic foam for diverse applications'
- ✓ BIRAC SRISTI GYTI award at organized at Rastrapati Bhawan, New Delhi in March'2016 for 'a simple cost-effective titanium foam for skeletal tissue reunion'
- ✓ Selected among Top 8 Business plan in the 'Honourable Mention category at TERMIS World Congress 2015held at Boston, USA on 8-11 September 2015
- ✓ Awarded gold medal in the 2015 DST - Lockheed Martin India Innovation Growth Programme (Joint initiative of the DST, FICCI, Lockheed Martin Corporation; Indo-US Science and Technology Forum, Stanford Graduate School of Business and University of Texas)
 - 'Bone grafts designed via biomimetic approach from natural origin materials'
 - 'Development of X – ray visible polymers for non – invasive imaging applications'
- ✓ For best concept note 'Bone graft Designed via Biomimetic Approach from Natural Origin Materials' under 'Health Tech Innovations – 2015' organized by DeitY, SAMEER

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in technical collaboration with NHSRC & ICMR under theme ‘Technology Innovations in Treatment of Disease’ organized on 9th-10th January, 2015

- ✓ BIRAC SRISTI GYTI award 2015 at Rastrapati Bhawan for contribution entitled ‘Development of X-ray visible polymers via in situ iodination–crosslinking for non-invasive real time imaging’ on 8th March 2015
- ✓ BIRAC fellowship for Entrepreneurial learning under Ignite program at University of Cambridge in 2014
- ✓ EPSRC fellowship UK 2004-2006
- ✓ Fast Track Scheme for Young Scientists (FAST) funded by DST, Govt. India (2010)
- ✓ Highlighted in the MRS Bulletin News, 30 [9] 628 (2005) for ‘Synthesis of Nano Crystalline Alumina Using Egg White’
- ✓ Awarded a silver medal for excellent technology-based innovations ‘Protein Coagulation Casting of Ceramics’ at Incubiz (Anveshan III) organized by IIM Ahmedabad in March 2005
- ✓ Selected to present in the student’s session at the Annual Indian Ceramic Society Conferences held at Hyderabad (January 2001) and Jaipur (January 2002), respectively
 - ‘Challenges and opportunities in ceramic manufacturing via gelcasting’
 - ‘Direct casting of ceramic foams–microstructure and processing relationships’
- ✓ Best posters and presentations awards in eight occasions

Member of Organizations:

- Society for Polymer Science, India (life member)
- STERMI (life member)
- SBAOI (life member)
- The American Ceramic Society (2004-2005)
- The Indian Ceramic Society (2001-2003)
- Powder Matrix, UK (2004-2007)
- TERMIS

Keynote Address



Prof. Ipsita Banerjee

Bioengineering pancreatic islet organoids from hPSCs for regenerative therapy and disease modeling applications

Ipsita Banerjee

Chemical and Petroleum Engineering, Bioengineering and McGowan Institute for Regenerative Medicine, University of Pittsburgh

Email: ipb1@pitt.edu

Abstract

Type 1 diabetes results from the auto-immune destruction of insulin secreting cells of the pancreas – the beta cells within Islets of Langerhans. Exogenous supply of insulin is a commonplace procedure in regulating blood glucose levels in diabetic patients. Alternately, cell replacement therapies such as pancreas and islet transplants offer a more permanent solution to maintain blood glycemic control. However cell therapy is restricted by the availability of donor tissue, which can be overcome by deriving insulin producing cells from a regenerative cell source, like pluripotent stem cells (PSCs). With the current advancement of PSC-derived cell therapy from the laboratory to Phase 1 clinical trials, there is an enhanced emphasis on deriving mature and functional islets from hPSCs in a robust and reproducible manner. In parallel to regenerative therapy, there is also a strong emphasis to reproduce disease phenotypes *in vitro*, using microphysiology systems (MPS) models in tissue chip platforms. Once developed and validated, these models will be invaluable platforms for interrogating disease mechanisms as well as supplementing drug discovery and drug testing activities. Appropriate functioning of the MPS models, however, will largely rely upon successful derivation of mature and functional cells/ tissues/ organs from hPSCs.

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Our research focuses on a range of tissue, organ and organoid engineering strategies for deriving pancreatic islet like cells from hPSCs. We have developed cell encapsulation strategies for scalable culture of hPSCs and its subsequent differentiation to islet like clusters. We have introduced systems engineering techniques to identify robust conditions for hPSC propagation. In a collaborative team we have developed biomaterial substrate to synthesize controlled, multicellular organoids from hPSCs resembling pancreatic islets. We are currently developing strategies to induce *in-vitro* microvascular network formation within the stem cell derived islet organoids. This talk will highlight ways in which our laboratory has integrated natural and synthetic materials to engineer the cellular environment to closely mimic the natural islet environment. Our current efforts on developing MPS models for Diabetes will also be discussed.

Keynote Address

Profile

PROF. IPSITA BANERJEE

Ipsita Banerjee is an Associate Professor of Chemical and Petroleum Engineering, Bioengineering and McGowan Institute for Regenerative Medicine at the University of Pittsburgh. Banerjee obtained her PhD degree in Chemical Engineering from Rutgers University with Professor MarianthiIerapetritou. Subsequently she joined Professor Martin Yarmush's Center for Engineering in Medicine (CEM) at Massachusetts General Hospital as a post-doctoral fellow. In 2008, Banerjee joined University of Pittsburgh. Her laboratory has primarily focused on bioengineering of pluripotent stem cells for cell therapy of Diabetes. Banerjee is the recipient of NIH New Innovator Award, ORAU Ralph E. Powe Faculty Award, Faculty Diversity Award from Swanson School of Engineering at the University of Pittsburgh. She was also selected to participate in the NAE Frontiers for Engineering Education Symposium.

Keynote Address



Dr. Subrata Saha

Ethical Challenges in Biomaterials Research & Practice

Subrata Saha

Department of Restorative Dentistry and an Affiliate Instructor in the Department of Oral and Maxillofacial Surgery at the University of Washington

Profile

DR. SUBRATA SAHA

Dr. Subrata Saha is presently an Affiliate Professor in the Department of Restorative Dentistry, and an Affiliate Instructor in the Department of Oral and Maxillofacial Surgery at the University of Washington, Seattle, and a Courtesy Professor in the Department of Biomedical Engineering at the Florida International University in Miami.

He was previously the Director of Musculoskeletal Research and Research Professor in the Department of Orthopaedic Surgery & Rehabilitation Medicine, and the Director of the Biomedical Engineering Program in the School of Graduate Studies at SUNY Downstate Medical Center in Brooklyn, New York (2005-2015). Previously, he was also a faculty member at Alfred University (2001-2005), Clemson University (2001-2005), Loma Linda University (1996-2001), Louisiana State University Medical Center in Shreveport (1979-1991), and Yale University (1973-1979).

Dr. Saha received a BS in Civil Engineering from Calcutta University in 1963, an MS in Engineering Mechanics in 1969 from Tennessee Technological University, and Engineer and PhD degrees in Applied Mechanics from Stanford University in 1972 and 1974, respectively. Dr. Saha has received many awards from professional societies, including Orthopedic Implant Award, Dr. C. P. Sharma Award, Researcher of the Year Award, C. William Hall Research Award in Biomedical Engineering, Award for Faculty Excellence, Research Career Development Award from NIH, and Engineering Achievement Award. He is a Fellow of The Biomedical Engineering Society (BMES), The American Society of Mechanical Engineers (ASME), and the American Institute for Medical and Biological Engineering (AIMBE), Sigma Xi, and New York Academy of Medicine (NYAM).

He has received numerous research grants from federal agencies (NIH and NSF), foundations, and industry. Dr. Saha is the founder of the Southern Biomedical Engineering Conference Series, and the International Conference on Ethical Issues in Biomedical

Keynote Address

Engineering. Dr. Saha has published over 142 papers in journals, 46 book chapters and edited volumes, 398 papers in conference proceedings, and 178 abstracts. His research interests are bone mechanics, biomaterials, orthopedic and dental implants, drug delivery systems, rehabilitation engineering, and bioethics.

Dr. Saha is presently the Editor-in-Chief of the Journal of Long-Term Effects of Medical Implants and Ethics in Biology, Engineering and Medicine: An International Journal. He is an Associate Editor of the International Journal of Medical Implants & Devices and was an Associate Editor of the Annals of Biomedical Engineering, and Trends in Biomaterials and Artificial Organs. He has been a Member of the Editorial Boards of many journals, including Journal of Biomedical Materials Research; Medical Engineering and Physics; Journal of Applied Biomaterials; Medical Design and Material; Biomaterials, Artificial Cells, and Immobilization Biotechnology; Biomaterials, Medical Device and Artificial Organs; Journal of Bioengineering, Biotelemetry and Patient Monitoring; Journal of Basic & Applied Biomedicine and TM Journal.

INVITED TALK

Invited Talk



Prof. J. Venugopal

Nanofibrous structured porous biomaterials scaffolds to mimic native ECM for Regenerative Medicine

J. Venugopal

Industrial Science & Technology, Universiti Malaysia Pahang, Malaysia

Email: venugopal@ump.edu.my

Abstract

Tissue engineering and regenerative medicine is an emerging interdisciplinary field to apply biological and engineering principles to develop biological substitutes to restore, maintain, or improve tissue function. Potential applications of nanotechnology in life sciences research, particularly at the cellular level sets the stage for an exciting role in nanomedicine for the regeneration of tissues. The availability of more durable and better prosthetics and new drug delivery systems are of great scientific interest and give hope for cancer treatment and minimally invasive treatments for heart disease, diabetes and other diseases. Electrospinning is a well-established process capable of producing ultra-fine fibers by electrically charging a suspended droplet of polymer melt or solution. It is an attractive technique for the processing of polymeric biomaterials into porous nanofibrous scaffolds. This technique provides the opportunity to control over thickness and composition of nanofibers along with the porosity of nanofiber meshes using a simple experimental set-up. The diameter of polymer shrinks from micrometers (10-100 μm) to nanometers (10-100 nm) with large surface area. Particularly, remarkable features such as large specific surface area, high porosity and spatial interconnectivity of electrospun nanofibers make them well suited for nutrient transport, cell migration, cell communication and efficient cellular responses for developing artificial organs. Different types of stem cells are considered for cell-based tissue

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engineering approaches, of which bone-marrow-derived mesenchymal stem cells (BM-MSCs), adipose-derived stem cells (ADSCs) and embryonic stem cells (ESCs) are frequently utilized for the advancement of new tissue engineering strategies. These cells are combined with nanotechnology and applied for the regeneration of various tissue systems such as skin, bone, cartilage, heart and nerves. In order to advance the biotechnological and especially biomedical nanotechnology applications of polymer nanofibers from the perspective to commercialized stages, collaborative interdisciplinary researches involving biologist, material scientists, engineers, physiologists, clinicians and surgeons are required to develop functionalized artificial organs in regenerative medicine.

Invited Talk

Profile

PROF. J. VENUGOPAL

Professor Venugopal Jayarama Reddy, working at Faculty of Industrial Science & Technology, Universiti Malaysia Pahang, Malaysia. He has obtained his PhD degree in Neuroendocrinology from The Presidency College, University of Madras, India. Started research career as a Research Associate at the Central Leather Research Institute, Chennai. Subsequently, he worked as an Assistant Professor at the Deccan College of Medical Sciences and Allied Hospitals, Hyderabad. Then went on to complete his Postdoctoral fellowship in the Karolinska Institute, Stockholm, Sweden and then took up a Research Leader Position for Skin tissue engineering at Reliance Life Science, Mumbai, India. Previously worked as a Senior Research Fellow at Nanoscience and Nanotechnology Initiative, National University of Singapore; and this is one of the leading Nanotechnology and Stem Cell Biology for Regenerative Medicine groups in the World. He guided more than 20 graduate and post-graduate students in their research projects leading to their B. Tech, M. Tech and PhD degrees. Additionally, he had trained nearly 50 visiting national and international scientists in the last 12 years. Published 150 articles in high impact factor peer reviewed journals, 12289 citations, h-index 56. Current research focused on nanostructured biomaterials scaffolds to mimic native ECM for tissue engineering in regenerative medicine



Prof. Prakriti Tayalia

Biomaterial-based bioactive dermal patch for wound healing and platform for cancer immunotherapy

Prakriti Tayalia

*Department of Biosciences and Bioengineering,
Indian Institute of Technology Bombay, Mumbai, India,*

*Email: prakriti@iitb.ac.in

Abstract

Our lab has been developing porous hydrogel matrices to deliver genes or bioactive factors for applications in tissue engineering, immunotherapy, immune modulation or drug screening in cancer and autoimmune studies. Recently, we have developed and characterized a dual-layered peelable dermal patch for chronic and acute wound healing. The dermal patch is made up of composite polymers impregnated with natural bioactive factors to impart antibacterial, antioxidant and anti-inflammatory properties for rapid healing of wounds. Top layer of the patch was designed to be less porous hydrophobic layer for prevention of bacterial invasion and moisture loss from skin. Lower layer function releases wound healing factors and provides adequate moisturization. Our lab has also been working on the proof of concept to develop a biomaterial-based platform to provide a low cost and broadly applicable therapy for generation of anti-tumor response without necessitating *ex vivo* programming of patient derived T-cells for various forms of solid tumors. In our approach, cells can be programmed in their native microenvironment using an implantable bioactive scaffold such that the programmed T cells would gain tumor recognizing and killing capabilities thus overcoming the existing barriers of high cost due to *ex vivo* expansion and manipulation of T cells.

Invited Talk

Profile

PROF. PRAKRITI TAYALIA

Prof. Prakriti Tayalia is an Associate Professor in the Department of Biosciences and Bioengineering at IIT Bombay. She received her B.Tech degree in Metallurgical Engineering & Materials Science from IIT Bombay in 1999. She has an M.S. degree in Materials Science from University of Delaware and did her Ph.D in Applied Physics and Bioengineering at Harvard University. She continued to stay at Harvard for her post-doctoral research before moving back to IIT Bombay in October 2011 as an Assistant Professor at IIT Bombay. Apart from her academic experience she has also worked at GE Research. Her research interests lie in creating microfabricated structures and developing material platforms for applications in the field of cellular, tissue engineering and immunotherapy. Her lab has been developing various kinds of material-based systems for replicating and understanding *in vivo* physiological phenomena.

Invited Talk



Dr. Praveen Raj

Science behind surgical cure for diabetes

Praveen Raj

*Dept of Minimal Access Bariatric & Robotic Surgery,
Gem Hospital & Research Centre,
Coimbatore, India*
Email: info@geminstitute.in

Profile

DR. PRAVEEN RAJ

Head

Dept of Minimal Access Bariatric & Robotic Surgery,
Department of Surgical Gastroenterology,
Gem Hospital & Research Centre, Coimbatore, India

President - International Excellence Federation for Bariatric Surgery (India Chapter)

Honorary Secretary - Obesity Surgery Society of India

Convener - Healthcare - Confederation for Indian Industries (Coimbatore)

Executive Member - Healthcare - Confederation for Indian Industries (Tamil Nadu)

Executive Member - Association for Healthcare providers of India (Tamil Nadu Chapter)

Program Committee Member - Asia Pacific Bariatric & Metabolic Surgery Society
Congress - Japan 2018

Only Doctorate in the field Bariatric Surgery in Asia

- **Editor in Chief** - “**Bariatric Surgery Practice Guide**” by Springer, first of its kind from India.
- **International Centre of Excellence (ICE)** in Bariatric Surgery (Surgeon/ Department) by Surgical Review Corporation, USA, 2012
- **Member-International Excellence Federation** (Taiwan)- Only recognized training center and surgeon for Bariatric Surgery

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- **First and Only International Center of Excellence** and International Excellence Federation member in South India.
- **Organising Secretary LAPAROFIT** 2010/2011/2013/2014, 2015 3rd, 4th, 5th, 6th & 7th International Conference & Live workshop on Bariatric & Metabolic Surgery, Which is the most popular conference for Bariatric Surgery in India
- **LAPAROFIT 2010-1**“ Conference in the world to be done completely in High Definition mode from a venue of >500 kms
- **LAPAROFIT 2014** - 1st complete web conference in the world with 20 speakers around the globe & 900 delegates
- **Vocational Excellence Award** - Honoured with “Vocational Excellence Award” the highest honour from Rotary
- **Training Programs** - Course convenor of >10 Bariatric hands on training programs & 8 Webcast programs having trained >200 Surgeons
- **First surgeon** to perform Single Incision Laparoscopic gastric bypass in the country
- **Largest series** of Single Incision laparoscopic gastric bypass performed in the country
- **Live Teleconference** - Performed the 1st LIVE Teleconference on Bariatric surgery in July 2013.

Invited Talk



Prof. Shamik Sen

Targeting the Glycocalyx for Diabetic Wound Healing

Iffat Jahan, Shamik Sen

Department of Biosciences and Bioengineering,

IIT Bombay, Mumbai, India

Email: shamiks@iitb.ac.in

Abstract

Diabetes is a chronic disorder that leads to multiple complications including impaired wound healing. Fibroblasts play a vital role in wound healing process with altered fibroblast function contributing to impaired wound healing in diabetic patients. However, the mechanism underlying altered fibroblasts function is not well understood. To probe this aspect, here we have performed a detailed biophysical characterization of healthy and diabetic dermal fibroblasts. We show that, in comparison to healthy dermal fibroblasts (HDFs), diabetic dermal fibroblasts (DDFs) are more elongated, less contractile, softer, and less motile. Reduced migration rate of diabetic fibroblasts is attributed to larger focal adhesions which are stabilized by a significantly bulkier glycocalyx. Disruption of the glycocalyx not only enhances DDF motility, but also increases cell proliferation and promotes collagen synthesis. Collectively, our results implicate the glycocalyx as a potential therapeutic target for rescuing impaired wound healing in diabetic patients, and needs to be validated in animal models.

Invited Talk

Profile

PROF. SHAMIK SEN

Prof. Shamik Sen is an Associate Professor in the Department of Biosciences and Bioengineering, IIT Bombay, India. Dr. Sen earned a B.E. in Mechanical Engineering (1999) from Jadavpur University, Kolkata, and an M.Tech in Mechanical Engineering (2002) from IIT Kanpur. He then moved on to the University of Pennsylvania in Philadelphia, where he earned a Ph.D. in Mechanical Engineering (2007) in the lab of Prof. Dennis Discher. Subsequently, he completed postdoctoral training at the California Institute for Quantitative Biosciences (QB3), University of California, Berkeley, in the lab of Prof. Sanjay Kumar. Dr. Sen's research group at IIT Bombay studies how physicochemical cues encoded by the extracellular matrix regulates stem cell fate and cancer invasion, and how physical properties of cells are dynamically tuned during these processes. His lab is also involved in extending these fundamental observations for regenerative medicine and tissue engineering applications. Dr. Sen serves on the Editorial Board of *Frontiers in Cell and Developmental Biology* and *J. Biosciences*. He is a recipient of the BRNS Young Investigator Award (2011) and the Swarnajayanti Fellowship from DST (2017).

Invited Talk



Prof. Yashveer Singh

Diphenylalanine-based self-assembled peptide gels for biomaterial-associated infections

Yashveer Singh*

Department of Chemistry, Indian Institute of Technology Ropar,

Rupnagar-140001, Punjab, India

*Corresponding Author E-mail: yash@iitrpr.ac.in

Abstract

Biomaterial-associated infections along with the emergence of multi-drug resistant (MDR) bacterial strains have posed a major threat to controlling the hospital-acquired infections¹. Infections after surgical treatment often result in significant morbidity and mortality. Local delivery of antibacterial agents through implant coatings or degradable scaffolds has been explored to overcome the challenges associated with antibiotic resistance but with limited success¹⁻². Self-assembled peptide gels have generated significant research interest for their antibacterial properties because these gels act by an entirely different mechanism than antibiotics and, therefore, are not likely to cause the development of resistant bacterial strains²⁻⁵. These gels are also likely to provide an ECM-mimicking matrix for the tissue regeneration applications²⁻⁵. The presence of natural peptide backbone makes these gels susceptible to degradation by proteolytic enzymes³ and various strategies have been explored to improve the proteolytic stability and antibacterial properties of peptide gels. In this context, we have reported the development of self-assembled, antibacterial peptide gels from α/γ -hybrid peptides, Boc-D-Phe- γ^4 -L-Phe-PEA and Boc-L-Phe- γ^4 -L-Phe-PEA, which exhibited enhanced proteolytic stabilities and promising broad-spectrum bactericidal activities against *Escherichia coli*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, and *Staphylococcus aureus*. We have also shown that the complexation of these peptides with antibacterial polymer, chitosan, improved their proteolytic stabilities and bactericidal properties⁴. To further improve the gelation properties, proteolytic stability, and antibacterial activities of peptide gels for long-

Invited Talk

term applications, we have developed self-assembled gels from Fmoc-D-Phe-D-Phe-CONH₂ (FF), Fmoc-L-His-D-Phe-D-Phe-CONH₂ (HFF), and Fmoc-L-Arg-D-Phe-D-Phe-CONH₂ (RFF) peptides⁵. The D-amino acids were incorporated to improve the proteolytic stability of gels, whereas a cation amino acid was incorporated to improve their antibacterial properties. All three gels exhibited high proteolytic stabilities but only RFF gels showed potent and sustained antibacterial activities (> 90%) against *E. coli* and *S. aureus* for up to 72 h. Moreover, the gels were not toxic to mammalian cells (L929). The self-assembled peptide gels developed in this work show strong potential in implant-associated infections and wound-healing applications.

Keywords: Antibacterial; Diphenylalanine; Self-assembled; Peptide gels.

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Profile

PROF. YASHVEER SINGH

Associate Professor, Department of Chemistry
Associate Faculty, Center for Biomedical Engineering
Indian Institute of Technology Ropar
Rupnagar-140001, Punjab

Dr. Singh earned his PhD degree at the University of Allahabad and did postdoctoral research at the Indian Institute of Science (Bangalore), Joseph Fourier University (France), and Rutgers University (USA). Prior to joining IIT Ropar, he was an Assistant Research Professor at the Department of Pharmaceutics, Ernest Mario School of Pharmacy, Rutgers University (USA). His research interests are in broad areas of polymeric biomaterials, drug delivery, and tissue engineering. In particular, his group is working on polymer and peptide-based hydrogels/gels for microbicide delivery (to prevent HIV-1 infection in women), chemotherapeutic agent delivery, wound healing, and tissue engineering applications. He has published 40 papers/reviews in peer-reviewed journals, 4 patents, and 4 book chapters. He is an Assistant Editor of the sixth edition of Martin's Physical Pharmacy and Pharmaceutical Sciences, a major textbook for pharmacy schools worldwide.

Invited Talk



Prof. Kaushik Chatterjee

Nanoscale Surface Engineering of Metallic Biomaterials for Orthopedic Applications

Kaushik Chatterjee

Department of Materials Engineering & Centre for Biosystems Science and Engineering

Indian Institute of Science, Bangalore, India

Email: kchatterjee@iisc.ac.in

Abstract

Metallic biomaterials are widely used clinically for the repair of bone tissues. Despite their widespread use, they continue to suffer from limitations such as bacterial infections, limited osseointegration, and fatigue failure. Our group has been working on various strategies for nanoscale surface modification of these materials to address these needs. In one strategy, we have prepared nanopillars inspired by the topography on insect wings. These nanopillars were optimized to impart bactericidal activity through mechanical rupture of the bacterial cells while they support the attachment, growth, and differentiation of stem cells for enhanced osseointegration. In an independent approach, we have been working on surface mechanical attrition treatment (SMAT) to induce nanocrystallization on the surface of metallic biomaterials. SMAT led to enhanced surface hardness, increased fatigue life, and better wear resistance, along with improved cellular response. Taken together, surface modification at the nanoscale can be an effective means of improving the performance of biomedical implants.

Invited Talk

Profile

DR. KAUSHIK CHATTERJEE

Dr. Kaushik Chatterjee received his Ph.D. from Pennsylvania State University, USA after receiving M.S. from University of Virginia, USA and B.E. from Bengal Engineering College, India. He worked as a postdoctoral fellow jointly at the National Institute of Standards and Technology and the National Institutes of Health, USA. He joined the Indian Institute of Science, Bangalore in 2011 where he is currently an Associate Professor in the Department of Materials Engineering and associated with the Centre for Biosystems Science and Engineering. His research group focuses on materials for biomedical applications.

Invited Talk



Prof. Ashutosh Kumar Dubey

Piezobiomaterials: New generation prosthetic orthopedic implants

Ashutosh Kumar Dubey

Department of Ceramic Engineering,

Indian Institute of Technology (BHU), Varanasi, India

Email: akdubey.cer@iitbhu.ac.in

Abstract

The inherent piezoelectric nature of living bone assists in regulating its various metabolic activities such as growth, fracture healing etc. In this perspective, the development of piezoelectric prosthetic implants has attracted significant attention in recent years, which is anticipated to provide better functional performance over the existing implants. Towards this end, the talk will briefly cover the origin of piezoelectricity and other fundamental electrical responses in natural bone. Considering the electrical equivalents of a generalized living cell, the coupling of a cell with external electrical stimulation will be elaborated. Further, the potentiality of recently evolved piezobiomaterials as appealing prospective prosthetic implants will be revealed. Also, the bacterial infection in prosthetic orthopedic implants is one of the critical issues. The talk will be focused on these two aspects by means of combined action of electrostatic as well as dynamic electrical stimulation towards cellular functionality and antibacterial response on piezobiomaterials.

Invited Talk

Profile

DR ASHUTOSH KUMAR DUBEY

Dr. Ashutosh Kumar Dubey is currently an Assistant Professor in the Department of Ceramic Engineering at Indian Institute of Technology (BHU), Varanasi, UP, India. He is also a visiting faculty at Nagoya Institute of Technology, Nagoya, Japan. His research interests include Piezoelectric biomaterials, Piezo electrically toughened materials, Functionally graded materials, Nanoporous bio-ceramics and Analytical computation. His research outcomes have been published in over 50 prestigious journals of international repute including “Biomaterials”. He also has authored a book. As recognition for his research work, he received various prestigious awards/fellowships such as the Young Scientist Award by Indian Science Congress Association (2011-2012) as well as by Indian Ceramic Society (2015), Japan Society for the Promotion of Sciences (JSPS) Fellowship for Foreign Researchers (2012-14) and Ramanujan Fellowship by Department of Science and Technology, Govt. of India (2015-20), MAHE Award (2018) by Society for Biomaterials and Artificial Organs, India.

More details at: <https://www.iitbhu.ac.in/dept/cer/people/akdubeycer>



Prof. Rupak Dua

Novel Approaches to Develop and Evaluate Biomimetics Surfaces on Orthopedic Implants to provide inherent Anti-Bacterial and Enhanced Osseointegration Properties

Rupak Dua

*Department of Chemical Engineering in the School of Engineering and Technology
Hampton University
Email:rupak.dua@hamptonu.edu*

Abstract

Joint replacements, including hip and knee replacements, bone fracture fixation, dental implants, spinal fusion, and other surgical implant procedures, are commonly performed worldwide. They are conducted to alleviate pain and restore normal functioning of affected joints, fractured bones, and lost teeth. Previous studies show consistently that bacterial infection and poor osseointegration are the leading causes of orthopedic and dental implant failure. More recently, a question has been asked: Is there any way of providing inherent properties to these implants inspired by nature that can offer anti-bacterial and enhance bone integration properties. once you have developed these novel surfaces, how they can be initially evaluated without going into costly and complicated animal studies. Answering these questions and addressing them with a process that can be taught, learned, and perfected has been the focus of my lab. In this talk, I will discuss our work on developing biomimetic structures on the metallic implants that kill bacterial cells on contact. Further, I will also discuss the utilities of an ex-vivo organ culture tool that allow evaluating surfaces for long-term bone osseointegration studies as an alternative to animal studies. Overall, our findings demonstrate that the nanostructures generated on an implant surface show significant bactericidal properties. Besides, they can be evaluated using ex-vivo bone culturing bioreactor systems that can serve as an indispensable tool for studies typically conducted in-vivo but without the associated costs and ethical concerns.

Invited Talk

Profile

DR RUPAK DUA

Dr. Rupak Dua obtained his Bachelor's degree in Biomedical Engineering from Sathyabama Institute of Science & Technology, located in Chennai, India. After this, he moved to USA and then earned his Master's and Ph.D. in Biomedical Engineering with a specialization in Tissue Engineering and Biomaterials from Florida International University located in Miami, FL. Dr. Dua worked for two years as a Postdoctoral Fellow at the Institute of Orthopedic Research and Education housed in Texas Medical Center - the world's largest medical center - located in Houston, TX. Before joining Hampton University in the Department of Chemical Engineering within the School of Engineering & Technology in 2018, Dr. Dua worked as an Assistant Professor in the Department of Chemistry at Hampden-Sydney College, where he taught and supervised undergraduates on clinically translated research projects. His current research focuses on improving or finding solutions for the musculoskeletal system disorders that still exist clinically through biomimetics, chemical, and tissue engineering approaches. Dr. Dua's research has been funded by several organizations, including the National Science Foundation (NSF). He has also won several international and national awards based on his research and leadership qualities. Throughout his career, Dr. Dua has also served as an independent reviewer for numerous scientific journals such as the Journal of Biomedical Materials Research: Part B, BMC Musculoskeletal, and the International Journal of Chemical and Industrial Polymers. He is also an editorial board member for the Journal of Biosensors, Biomarkers and Diagnostics. He has been an active leader in promoting STEM fields and has chaired several scientific and ethics sessions at national and international conferences. Dr. Dua has been an active member of many professional societies, including the Biomedical Engineering Society (BMES), Virginia Academy of Science (VAS), American Society for Engineering Education (ASEE), American Institute of Chemical Engineers (AIChE), and Tissue Engineering & Regenerative Medicine International Society (TERMIS).

Invited Talk



Prof. R. Jayakumar

Vasoconstrictor and Coagulation Activator Incorporated Chitosan Hydrogel for Rapid and Effective Hemostasis

M. Nivedhitha Sundaram¹, Ullas Mony¹, Praveen Varma², **R. Jayakumar**^{1*}

¹Centre for Nanosciences and Molecular Medicine, Amrita Vishwa Vidyapeetham, Kochi, India

²Cardiovascular and Thoracic Surgery department, Amrita Institute of Medical Sciences and Research Centre, Amrita Vishwa Vidyapeetham, Kochi, India

*Email: rjayakumar@aims.amrita.edu

Abstract

Chitosan in the form of granules, sponges, solution, hydrogel and scaffolds have been used for hemostatic applications. Chitosan has been reported to take longer duration to stop bleeding in the injured site. Hence our focus is to improve the hemostatic efficiency of chitosan hydrogel (Cs) by incorporating vasoconstrictor-potassium aluminium sulfate(PA) and coagulation activator-calcium chloride (Ca) for rapid bleeding control. Composite (Cs-PA-Ca) hydrogel was prepared by entrapping an optimum concentration of PA and Ca into Cs hydrogel. The prepared Cs-PA-Ca hydrogel was injectable, shear thinning, cyto and hemocompatible. In vitro studies show the ability of Cs-PA-Ca composite hydrogel to form rapid blood clot by accelerating RBC, platelet aggregation and activation of the coagulation cascade by *in vitro*. Further, *in vivo* studies in rat liver and femoral artery model showed the potential of Cs-PA-Ca hydrogel to achieve rapid bleeding control and decreased amount of blood loss compared to commercially available hemostatic agents such as Fibrin sealant and Floseal. This developed hemostatic Cs-PA-Ca hydrogel has potential clinical applications in low pressure bleeding sites such as dental, liver, gastrointestinal, dermal, lung injuries, bleeding from lateral and posterior surface of heart and pelvic trauma.

Invited Talk

Profile

DR. R. JAYAKUMAR

Prof. R. Jayakumar is working at Centre for Nanosciences and Molecular Medicine (ACNSMM), Amrita Vishwa Vidyapeetham, Kochi-682041, India, specializing in the area of Biomaterials for Healthcare Applications. Dr. R. Jayakumar joined ACNSMM in November 2007. He received his Ph.D. in Polymer Chemistry from Anna University, Chennai, India (2002). Dr. Jayakumar's research laboratory at Amrita Centre for Nanosciences and Molecular Medicine is mainly interested in the development of biopolymeric nanofibers, nanogels, nanoparticles, nanocomposite scaffolds and injectable hydrogels for tissue engineering, Drug Delivery and wound dressing applications. He was awarded the **University Postdoctoral Fellowship** from Chonbuk National University (2002-2003), South Korea. In Portugal, he was awarded **FCT Postdoctoral Fellowship** from the Government of Portugal (2003-2005). In addition, he was also awarded the prestigious **JSPS Postdoctoral Fellowship** (2005-2007) from the Japan Society for the Promotion of Science (JSPS), Japan. He has around **250 Journal publications, edited 4 books, 12 book chapters and 12 patents** to his credit. He is also reviewer and editorial board member of many international journals. His publications have been cited more than **16900 times with h-index-66**. He has received the “**Best Paper Award**” from Journal of Materials Science Materials in Medicine (Springer) and IET Nanobiotechnology Journal. He received “**Faculty Researcher Award-2016**” from Indian Chitin and Chitosan Society and “**MRSI Medal-2017**” from Materials Research Society of India. He also received “**India Research Excellence-Citation Awards 2017 (Health & Medical Science area)**” from Clarivate Analytics, Web of Science. He also completed more than **19 funded projects** and **2 are ongoing**. He has research collaborations in USA, Japan, South Korea, Portugal, Iceland, Germany and Taiwan.

Invited Talk



Prof. Khalil El Mabrouk

3D Metallic Porous Structure Coated with Bioactive Glass for Orthopaedic Application

Khalil El Mabrouk, Meriame Bricha, Zakaria Tabia

Euromed University of Fes, Eco-Campus, Meknes Road, Morocco

E-mail: k.elmabrouk@ueuromed.org

Abstract

In a new approach combining Additive Manufacturing with Bioceramics, a metallic 3D porous structure coated with bioactive glass was produced for possible use in orthopaedic implants. This approach aims to combine high mechanical properties of the metallic structure (stress shielding) with enhanced biological activity. 316L stainless steel (316L-SS) lattice structures, based on rhombic dodecahedron unit cell with a relative density of 20%, were designed and fabricated using Selective Laser Melting (SLM). Despite its good mechanical properties, 316L-SS (as many other metals) lacks the biofunctionality required to achieve long-term implantation. To be successfully used as biomaterial, these porous 3D lattice structures were thus coated by 58S bioglass through a simple impregnation method. The use of a silica layer was evaluated as possible pretreatment to improve bioglass adhesion. The coated parts are then assessed by scanning electron microscopy (SEM) coupled with energy dispersive spectrometry (EDS) to qualify the coating. Porous sample parts pretreated with a silica layer presented a denser coating structure when compared with untreated porous metallic structures. In the following round of characterization, parts were immersed in a simulated body fluid to study their ability to grow new bone tissue. Results show the formation of a uniform apatite layer after seven days of immersion, showing the bioregeneration capability. This, combined with the lightweight framework structure provided by 316-SS, will increase the lifetime of this new generation of orthopedic implants.

Keywords: 316L stainless steel; Lattice structure; Selective Laser Melting; Bioactive glass 58S

Invited Talk

Profile

PROF. KHALIL EL MABROUK

Prof. Khalil El Mabrouk, PhD in Chemical Engineering on 2005 at Laval University-Canada; Postdoctoral in both Queen's University-Canada and in Dow Chemical New Jersey-USA for more than one year. 2008-2013 Research Director in Moroccan Foundation for advanced Science Innovation and Research and in the meantime, Director of Technology Platform. Since 2013 Full Professor at Euromed University of Fes-Morocco

Invited Talk



Dr. A. Maya Nandkumar

Nanoparticles and Vaccine delivery

A. Maya Nandkumar

Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum

Email:amaya@sctimst.ac.in

Profile

DR. A. MAYA NANDKUMAR

Head, Department of Microbial Technology. The department is ISO 17025 accredited and offer accredited tests like Sterility test, Bioburden analysis , In vitro genotoxicity analysis- Ames Test and a number of non-accredited tests. Our research focuses on understanding material, cell and microbial interactions and immuno-modulations by bacterial biofilms. We also work on understanding lung biology in diseases specifically chronic infectious diseases. For this we have developed an in vitro three dimensional artificial lung model. We are analysing development of bacterial persistence using this system. The system is also being developed as an in vitro test system for testing pollutants and drugs. We have also developed a rapid UTI diagnostic kit with antibiotic sensitivity which would drastically reduce testing time and help to better health care delivery.

Invited Talk



Dr. Abhijit Chakraborty

Journey of Nanobioceramics in functional and aesthetic Dentistry

Abhijit Chakraborty

Gnidsr& Hospital. Kolkata

Email:abhijitperiodontist@gmail.com

Abstract

Bone is the building block of stomatognathic system. Loss due to various disease process, trauma or developmental disorders is frequent reasons for artificial rehabilitation. Nanobioceramics has become the answer to the highly demanding functional and aesthetic works of modern dentistry .Huge opportunity is lying with the research and development, clinical applications in large scale in different fields of advanced dentistry. Here, an approach has been given to unfold the Nano bioceramic technology to modern world of regenerative dentistry.

Invited Talk

Profile

DR. ABHIJIT CHAKRABORTY

Qualifications: BDS Calcutta University, India Jun. 1992

MDS Calcutta University on Periodontology, in the year 1998

Present attachment: Professor HoD in Gnidsr & Hospital, Kolkata-7000114

Other than professional attachments:

- External examiner M.Tech examination in the department of Electronics and Instrumentation (J.U).
- Recent International Publication IEEECON, 2007. Publication in indexed journal in 2011.
- Conducted courses on Dental implantology and regenerative osseous surgery.
- Nominated as outstanding Dentist of the year in Famdent Excellence award 2013 and 2014 at National Level.
- Awarded as Highly Commended Periodontist of The Year 2013 and 2014 at National Level.

Invited Talk



Dr. Subhadip Bodhak

Functional Biomaterials for Spinal Reconstruction Applications

Subhadip Bodhak

Bioceramics and Coating Division, CSIR-Central Glass and Ceramic Research Institute

E-mail: sbodhak@cgcri.res.in, sbodhak@gmail.com

Abstract

Orthopaedic impairment is considered as the leading cause of social disability in the world. Among orthopaedic impairment low back pain (LBP) is the second leading cause of disability and a common reason for lost work days primarily caused by the degeneration of intervertebral disc (IVD) resulting in the compression of the spinal nerves and adjacent vertebrae. The IVD is confined by the two cartilage endplates and is composed of two distinct structures: a gelatinous nucleus pulposus (NP) center and several surrounding coaxial lamellae that form the inner and outer annulus fibrosus (AF). Degenerative disc disease (DDD) is defined as an “aberrant, cell-mediated response to progressive structural failure”, a structural disorganization of the NP and the AF which leads to a loss of disc height and herniation causing an overall effect on the biomechanics of the spinal column with age. Over 60% of the Indian adult population and an estimated 65% of worldwide population experience low back pain due to the degenerative IVDs at some point in their lives. Associated healthcare costs are in excess of \$100 billion globally. The prevalence of back pain will increase substantially in the coming years due to the ageing demographic. However, despite the prevalence of degenerated disc diseases (DDD) and its enormous socioeconomic impact current treatment options are limited for spinal reconstruction. Conventionally, metallic interbody spinal cages are being used in spinal fusion surgery but inferior osteoconductivity, corrosion, stress shielding effect of metallic spinal cage leads to severe pain and immature implant failure. Hence, in recent years several attempts have been made for developing osteoconductive nonmetallic spinal cage implants which can provide superior implant stabilization and faster spinal fusion. This lecture will present the prospect of developing bioactive polymer-ceramic composites and/or industrially viable plasma sprayed bioactive ceramics coated spinal cage implants which have showed to increase the ability to osseointegrate for potential spinal reconstruction application than conventional metallic spinal cage implants. Furthermore, the importance of regenerative approaches by combining

Invited Talk

biomaterials science and cell therapy that can possibly enable/stimulate the repair of the damaged disc will also be covered in this lecture.

Profile

DR. SUBHADIP BODHAK

Senior Scientist

Ramalingaswami Fellow, Department of Biotechnology

Assistant Professor, Faculty of Engineering Sciences, AcSIR

Bioceramics and Coating Division

CSIR-Central Glass and Ceramic Research Institute

196 Raja SC Mullick Road, Kolkata 700 032.

Tel: + 91-33-23223562, Mobile: + 91-8910902562

E-mail: sbodhak@cgcri.res.in, sbodhak@gmail.com

Webpage:<https://www.cgcri.res.in/research/research-divisions/bioceramics-coating/dr-subhadip-bodhak/#scientist-detal|2>

Google Scholar: <https://scholar.google.co.in/citations?user=qLqdpSsAAAAJ&hl=en>



Dr. AnuyaNisal

Comparative studies of silk fibroin and calcium ceramic in bone void filling

AnuyaNisal

Polymer Science and Engineering Dept. at CSIR-National Chemical Laboratory (NCL)

Email: aa.nisal@ncl.res.in

Abstract

Synthetic bone void fillers are used to fill cavities in the bone and promote bone regeneration. Calcium-based ceramic bone void fillers are the most widely used materials for filling these bone defects, in spite of their limitations and post-operative complications. More recently scaffolds based on silk fibroin have shown promise for applications in bone void filling. Silk Fibroin is a natural protein polymer extracted from the cocoons of *Bombyx mori* silkworms. In this work, we have compared the safety and efficacy of currently used calcium-based ceramic bone void fillers with that of silk fibroin-based fillers using a series of *in vitro* and *in vivo* experiments. We further compared two silk fibroin scaffolds with strikingly different structural attributes. Our results show that all these scaffolds show comparable performance in early stages of differentiation of stem cells into an osteoblastic lineage. However, the scaffolds prepared using silk fibroin perform better in the expression of mid and late stage markers. Furthermore, the mechanical rigidity and pore architecture of silk fibroin scaffolds has a significant influence on performance. This improvement in *invitro* experiments was found to be validated in *in vivo* studies also. Thus, we conclude that the rigidity and pore architecture of scaffolds, in addition to chemical composition, influence the course of cell differentiation and thus influence the bone tissue regeneration.

Invited Talk

Profile

DR. ANUYA NISAL

Dr. Anuya Nisal is a Principal Scientist in the Polymer Science and Engineering Dept. at CSIR-National Chemical Laboratory (NCL). She has completed her Ph.D. in Chemical Engineering from Indian Institute of Technology, Powai and M.S. in Materials Sci. and Engg. from University of Delaware, USA. She leads a group performing cutting edge scientific research in the areas of polymeric biomaterials, additive manufacturing and tissue regeneration. Her research interests include structure-processing-property-performance relationships of natural and synthetic polymers, their blends and their composites. She is also the lead inventor for a technology patent on silk fibroin scaffolds. Based on this technology, she has floated a start-up SerigenMediproductsPvt. Ltd (previously known as BiolMed Innovations), which is now incubated at Venture Center (a technology business incubator in Pune). She is also the recipient of the a Leaders in Innovation fellowship 2020 from Royal Academy of Engineering, UK, INAE Young Entrepreneur Award 2020 and a TIE-BIRAC-WiNER award for Women in Entrepreneurial Research.

Invited Talk



Dr. Mauro Petretta

The 3D Bioprinting Revolution – Expanding the horizons of Biomedical Science

Mauro Petretta

Senior Scientific Advisor at REGENHU

Abstract

The topic of our presentation will include a short intro of bioprinting technologies, followed by a discussion on the key features of this discipline and its field of applications. A brief overview of our technological solutions will follow to provide an understanding of our approach to the biofabrication field. In conclusion, some applications taken from different possible fields of use of our bioprinting technology will be presented to show all the capabilities provided by this technique in the MedTech field.

Invited Talk

Profile

DR. MAURO PETRETTA

Mauro Petretta is the Senior Scientific Advisor at REGENHU and is responsible for the development of scientific applications using our platform. His work focuses on polymeric, composite and functionalized biomaterials, cell-laden hydrogels, and regeneration of hard and soft tissues. He brings years of research experience on tissue engineering and regenerative medicine

Mauro's bio and company description: Mauro Petretta is the Senior Scientific Advisor at REGENHU and is responsible for the development of scientific applications using our platform. His work focuses on polymeric, composite and functionalized biomaterials, cell-laden hydrogels, and regeneration of hard and soft tissues. He brings years of research experience on tissue engineering and regenerative medicine.

REGENHU is a research driven, Swiss MedTech bioprinter pioneer committed to assisting the research and scientific communities by creating and developing state-of-the art bioprinting technologies to revolutionize medicine. Founded in 2007, the dynamic and rapidly expanding company is based in Villaz-St-Pierre, Switzerland, with offices in the United States, and distributors in Asia and Oceania.



Prof. ing. Joseph Buhagiar

A Paradigm Shift: A Low-Wearing Novel Hip Joint Prosthesis

*Donald Dalli^a, Pierre Schembri Wismayer^b, Pierluigi Mollicone^c, **Joseph Buhagiar^{a1}***

^a *Dept of Metallurgy and Materials Engineering, Faculty of Engineering,
University of Malta, Msida,*

^b *Dept of Anatomy, Faculty of Medicine and Surgery, University of Malta, Msida,*

^c *Dept of Mechanical Engineering, Faculty of Engineering, University of Malta, Msida,*

Email: joseph.p.buhagiar@um.edu.mt

Abstract

The metal-on-polyethylene material combination has been the preferred choice amongst orthopaedic surgeons for artificial hip implants ever since its introduction in the clinical market by Sir John Charnley. Nonetheless, further improvements in the tribological performance of the polyethylene components are needed, since the average lifespan of these prostheses range between 15 to 25 years. The natural ankle joint has low rates of osteoarthritis, being 9 to 10-fold lower when compared to those exhibited by hip and knee joints. We have hence developed a unique artificial articulation that is essentially based on cylindrical geometry that is inspired by the ankle joint. The flexible motion of the ball-and-socket is reproduced by using three cylindrical articulations that are aligned orthogonally to each other. It is hypothesized that this articulation design would produce uni-directional sliding motion which would in turn promote molecular orientation hardening in polyethylene. This is done under distributed contact stress conditions with the aim to minimize the volume of wear particles that are liberated. Prototypes of this design were produced out of high-nitrogen stainless steel and polyethylene. A first set of four implants was manufactured with ultrahigh molecular weight polyethylene and a second set was made of Vitamin E-infused highly cross linked polyethylene. The eight implants were wear tested in a hip joint simulator

Invited Talk

according to ISO 14242-1:2014/Amd 1:2018. Gravimetric measurements conducted on the tested specimens demonstrated that these implants had lower wear rates when compared to conventional ball-and-socket implants that were produced out of the same materials and wear tested under the same conditions. The results of the study demonstrated that the reductions in the rate of wear were statistically significant and therefore support the research hypothesis that was tested in this work.

Invited Talk

Profile

PROF. ING. JOSEPH BUHAGIAR

Joseph Buhagiar received his B.Eng (Hons) degree in Mechanical Engineering from the University of Malta in 2003. He joined the Department of Metallurgy and Materials Engineering of the University of Malta as an Assistant Lecturer in 2004 and in 2008 he received a PhD degree in Plasma Surface Engineering and Characterisation of Biomedical Stainless Steels, at the University of Birmingham (UK). Prior to joining the University of Malta he worked as a design engineer with Method Electronics Malta.

Following his PhD studies at the University of Birmingham, he became a University of Malta Lecturer in 2008. He was promoted to senior lecturer in 2013 and associate professor in 2016. He is on the Editorial board of the Journal of Surface Engineering and represents Malta on the Coal and Steel Committee.

In 2013 he was appointed Honorary Consul of the Republic of Colombia with jurisdiction over Malta and in 2018 he was conferred the National Order of Merit of the Republic of Colombia in the grade of Knight. The decoration was bestowed since Prof. Ing. Buhagiar's academic profile was fundamental for the permanent support that he gives to Colombian students in Malta and for the links that he has forged between universities in both countries.

Prof. Ing. Buhagiar's current research interest is in the fields of biomaterials, biodegradation and surface engineering of biomedical materials. He is the project leader of the BioSA project (Biodegradable Iron for Orthopaedic Scaffold applications) and a collaborator in the MALTAHIP project (Development of low-wearing novel hip joint prosthesis for longer lifespan). Both projects have been financed by the Malta Council for Science and Technology through Fusion: The R&I Technology Development Programme.

Invited Talk



Prof. Bharath Raja Guru

Targeting cancer cells for their over expressed receptors using biodegradable nanoparticles for the therapy

Bharath Raja Guru

Department of Biotechnology

*Manipal Institute of Technology, Manipal Academy of Higher Education, Manipal,
Karnataka, India*

Email: bharath.guru@manipal.edu

Abstract

Background

Some of the integrins like $\alpha_v\beta_3$, growth factors like epidermal growth factor receptors (EGFR) and folate receptors are over expressed by particular cancer cells. The cRGD peptide targets $\alpha_v\beta_3$ integrins which are over expressed in some tumor vasculature and tumor cells. A peptide ligand (YHWYGYTPQNVI) specifically targets EGFR, over expressed by epithelial cancer cells. Folic Acid is as a ligand specifically target folate receptors over expressed by glioma cells. These ligands are used as a targeting moiety for effective anticancer drug delivery. Poly (lactide-co-glycolide) (PLGA) a FDA approved biodegradable polymer is used as a drug delivery vehicle for the study.

Method

The goal of the study is to develop polymeric nanoparticles which target $\alpha_v\beta_3$ integrins, folate receptors and EGFR for tumor-targeted drug delivery. PLGA nanoparticles are formulated by loading it with anticancer drug or a fluorescent probe and surface functionalized with the targeting moiety using a unique technique called ‘Interfacial Activity Assisted Surface Functionalization (IAASF)’. Nanoparticles conjugated to a non-targeting peptide sequence were used as controls for all the experiments. Cellular uptake of the particles and cytotoxicity study of the particles on different cell lines were carried out and effectiveness of the targeted nanoparticles is also found out using in vivo study.

Invited Talk

Results

Functionalization of nanoparticles with cRGD peptide increased the cellular uptake of nanoparticles 2–3 folds in 4T1 cell line and this enhancement in uptake was substantially reduced by the presence of excess cRGD molecules. Folic acid on the surface of the nanoparticles uptake will be much higher in C6 and U87 glioma cells compared to control. EGFR targeted nanoparticles were tested for uptake in different malignant human epithelial cell lines like A549 (lung epithelial carcinoma), PANC-1 (pancreatic epithelioid carcinoma) and U-87 (glioblastoma). Targeted nanoparticles resulted in significantly enhanced cellular uptake (2- to 3-fold) compared to control nanoparticles in all the cell lines. The enhancement in cellular uptake was reduced in the presence of excess free peptide, indicating that peptide-conjugated nanoparticles were binding to EGFR specifically. Cytotoxicity studies demonstrated that targeted nanoparticles loaded with paclitaxel were significantly more effective in killing tumor cells than control nanoparticles.

Conclusion

$\alpha_v\beta_3$ integrins targeted, folate receptor targeted and EGFR targeted nanoparticles using the IAASF technique resulted in enhanced tumor cell uptake and efficient in killing the tumor cells compared to without targeted nanoparticles.

Invited Talk

Profile

PROF. BHARATH RAJA GURU

EDUCATION:

Research-Associate Department of Biomedical Engineering, Case Western Reserve University, USA

Post-Doc Studies Department of Pharmaceutics, University of Minnesota, Minneapolis, USA

PhD. Chemical Engineering, Wayne State University, USA

M.Tech. Chemical Engineering, Indian Institute of Technology (IIT), Bombay, India.

B.E. Chemical Engineering, National Institute of Technology, Karnataka, India.

PROFESSIONAL AND RESEARCH EXPERIENCE:

Manipal Institute of Technology (A constituent unit of MAHE), Manipal Jan 2017 – till date, Professor, Department of Biotechnology.

Manipal Institute of Technology, (A constituent unit of MAHE) , Manipal April 2012 – July 2017, Associate Professor, Department of Biotechnology

Collaborative projects: with Professor **Guhan Jayaraman of IIT Madras** – purify and use hyaluronic acid (HA) as drug delivery vehicle. Dr. Jayaraman has expertise in producing HA from different strains. The HA produced will be used for different drug delivery and tissue engineering applications in MIT Manipal.

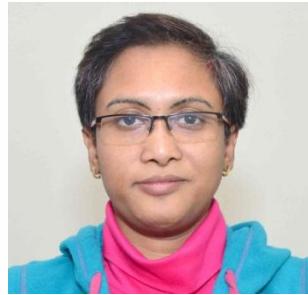
Collaborated with **Dr. Vishnu Prasad Shenoy of Department of Microbiology, KMC Manipal** to analyze the anti-tubercular drug formulated nanoparticles on *Mycobacterium Tuberculosis*.

Collaborated with **Dr. Sulatha Bandary, Professor & Head, Ophthalmology, KMC, Manipal**, to deliver effective doses of drugs to patients after cataract surgery using biodegradable polymers.

Collaborated with **Dr. Sajan George** of '**Department of atomic Physics**' Manipal Academy of Higher Education, Manipal to make microchannel to grow cancer cell lines and check different mechanisms of cancer cells

BOOK CHAPTER

Sriprasad Acharya and **Bharath Raja Guru** 'Optimization of a glucocorticoid encapsulated PLGA nanoparticles for inflammatory diseases' Springer, Singapore.



Dr. Debrupa Lahiri

Bioengineered Smart Trilayer Skin Tissue Substitute for Efficient Deep Wound Healing

Swati Haldar, Partha Roy, Debrupa Lahiri

Tissue Engineering Lab, Centre of Nanotechnology, IIT Roorkee

Email: debrupa.lahiri@gmail.com

Abstract

Skin substitutes for deep wound healing require meticulous designing and fabrication to ensure proper structural and functional regeneration of the tissue. Range of physical and mechanical properties conducive for regeneration of different layers of skin is a prerequisite of an ideal scaffold. However, single or bilayer substitutes, lacking this feature, fail to heal full thickness wound. Complete scar free regeneration of skin is still a big challenge. This study reports fabrication of a trilayer scaffold, from biodegradable polymers that can provide the right ambience for simultaneous regeneration of all the three layers of skin. The scaffold was developed through optimization of different fabrication techniques, namely, casting, electrospinning and lyophilisation, for obtaining a tailored trilayer structure. It has mechanical strength similar to skin layers, can maintain a porosity-gradient and provides microenvironments suitable for simultaneous regeneration of epidermis, dermis and hypodermis. A co-culture model, of keratinocytes and dermal fibroblasts, confirms the efficiency of the scaffold in supporting proliferation and differentiation of different types of cells, into organized tissue. The scaffold showed improved and expedited wound healing *in-vivo*. Taken together, these compelling evidences successfully established the engineered trilayer scaffold as a promising template for skin tissue regeneration in case of deep wound.

Invited Talk

Profile

PROF. DEBRUPA LAHIRI

WORK EXPERIENCE

1. Associate Professor, Department of Metallurgical and Materials Engineering, Indian Institute of Technology (IIT), Roorkee, India, December, 2018 onwards.
2. Assistant Professor, Department of Metallurgical and Materials Engineering, Indian Institute of Technology (IIT), Roorkee, India, December, 2012 – December, 2018.
3. Visiting Assistant Professor, Department of Mechanical and Materials Engineering, Florida International University, Miami, Florida, August, 2012 – December, 2012
4. Post Doctoral Researcher, Department of Mechanical and Materials Engineering, Florida International University, Miami, Florida, August, 2011 – August, 2012.
5. Worked as Scientific Officer D in Nuclear Fuel Complex, Hyderabad, August, 2003 – July, 2007
6. Worked as Visiting Scientist in Nuclear Fuel Complex, Dept. of Atomic Energy, Govt. of India, Hyderabad, India, July, 2001 - July, 2003.
7. Worked as Metallurgist, R&D in Indian Aluminium Co. Ltd. (INDAL), Belur, India, May, 1999 - January, 2001.

CURRENT RESEARCH INTERESTS

- Developing biomaterial based systems (implants/scaffolds) for hard and soft tissue engineering and regeneration – e.g., bone, nerve, skin etc.
- Metal/Ceramic/Polymer Matrix composites for structural applications, bioimplants, temporary scaffolds for tissue engineering etc
- Adhesion strength of biological cells and different nanostructures (carbon nanotube, graphene etc.) with substrate
- Understanding Nanomechanical and Nanotribological behavior of a wide variety of materials – metals, ceramics, diamond, concrete, polymers, composites and other soft materials, 1D/2D nanomaterials, biological materials – by indentation/compression, dynamic mechanical analysis and tribological studies at nano-scale.

Invited Talk



Mr. Suman Bhutoria

3D Bioprinting - Revolutionizing healthcare and medicine

Suman Bhutoria

CEO and founder at Alfatek Systems

Email:sb@alfateksystems.com

Abstract

Our talk will start with an introduction to 3D bio-printing and will provide a basic understanding of 3D bio-printing technologies, which will be easy to understand by new researchers in this field. We will also showcase our low cost, innovative 3D bio-printer, proudly made locally in India, along with a number of customized attachments, and accessories that are helping to bring 3D bio-printing technologies to labs all over India. Finally, we will talk about some applications of 3D bio-printing in India.

Invited Talk

Profile

MR. SUMANT BHUTORIA

Sumant Bhutoria, an alumni from IIT KGP, and IIM Ahmedabad, currently works as CEO and founder at Alfatek Systems, and together with his team, has played an important role in making Alfatek Systems the undisputed market leader in 3D bio-printers in India in the last 5 years. Sumant is a co-author in two journal publications in 3D bio-printing from JMR, Cambridge, UK, and JPMPB, Philadelphia, USA on work jointly done with research groups in India. His masters' thesis at ASU, USA also led to an IEEE paper in VLSI electronics. In his previous corporate avataar, Sumant has worked in the US, Europe, and Singapore in various engineering, management and finance roles. He remains an engineer at heart, and likes to work on innovative projects.

Alfatek Systems is a privately held IIT-IIM alumni venture in 3D printing and rapid prototyping technologies in electronics and mechanics. Our customers include the biggest corporate names - ITC, Tata Steel, L&T, and the biggest R&D institutions - AIIMS, IITs, SCTIMST, etc. We build custom 3D bio-printing machines for use by researchers in 3D printing tissues, and organs. We are also dealers for the most reputed 3D bio-printer companies in the world such as regenHU, Switzerland and Cellink, Sweden. We also offer in-house 3D printing services to clients for new product development. We have completed more than 70 3D printer installations all over India at IITs, CSIR Labs, IISc and AIIMS. Our machines have been cited in more than 7 international journal publications, and we actively collaborate with some of the research teams in India to develop the next breakthroughs in tissue and organ fabrication. Our work has also been featured in CNBC TV, India TV, Times of India, and Dainik Jagran.



Dr. Francis B Fernandez

Engineered Bioceramic Matrices for Sustained Active Factor Delivery

Francis B Fernandez

Division of Bioceramics, Biomedical Technology Wing, SCTIMST

Email: sb@alfateksystems.com

Abstract

Bone tissue regeneration has an ever increasing need worldwide due to the rise in diseases, defects and trauma. Rise in co-morbidities like diabetes and hypertension limit the microcirculation and cause deterioration of bone quality. With a large aging population worldwide there is an emphasis on the development of bone regenerating materials that play multiple roles in achieving therapeutic endpoints.

Engineered bioceramic structures for drug delivery applications are now actively pursued in Bioceramics. Implantable drug delivery systems that are resorbed after expending are ideal for infection acquired via trauma and non-traumatic pathologies. This brings down costs and ancillary complications associated with conventional techniques.

Current efforts concentrate on deploying drugs in controlled delivery format to maximize the therapeutic window. During the course of this work bioceramic spheres with multi-modal pore structures were loaded with antibiotics using a physical process and the elution evaluated over a period of time. This allows for optimized defect packing. Loading parameters were optimized using water loading trials, Drug carrying capacity was optimized by varying process parameters and elution evaluated via spectrophotometric studies. Integrity of eluted drug moiety for over 60 days was evaluated by a controlled microbiology challenge assay. Sustained functional drug release over extended period favours the use of this platform for clinical application

Invited Talk

Profile

DR. FRANCIS B FERNANDEZ

Dr. Francis has a keen interest in material development and electron microscopy. He has published several peer – reviewed papers and is also the winner of the AIT grant with a keen interest in translational application of technology. He is currently exploring the applications of extruded ceramics and ceramic – metal nanoparticles in diagnosis and therapy. Dr. Francis Fernandez, has completed his PhD in Biomedical Technology from Sree Chitra Tirunal Institute for Medical Sciences and Technology and is currently working as Scientist – C, Division of Bioceramics, Biomedical Technology Wing, SCTIMST.



Dr. Aline Miller

Tuneable Peptide Hydrogels for 3D Cell Culture and 3D Bioprinting

Aline Miller

Chief Executive Officer and Co-Founder of Manchester BIOGEL

Email: aline.Miller@manchester.ac.uk

Abstract

Three-dimensional (3D) cell culture systems are attracting increasing attention in drug discovery and tissue engineering due to their clear advantages in providing more physiologically relevant information and more predictive data for *in vivo* tests to facilitate clinical translation. With parallel progress in bio printing technologies we are also seeing an advance in the *in vitro* generation of 3D tissue analogues with complex functional and structural organisation through the precise spatial positioning of multiple materials and cells. Here, we will outline such recent progression, advancement and application in 3D cell culture and bio inks, including the use of synthetic peptide hydrogels that faithfully recapitulate the *in vivo* micro architecture and chemical functionality to generate 3D tissue and disease models, including for example 3D organoids, tumour models and more complex printed tissues. We will also highlight the most pressing challenges, opportunities and future perspectives within this growing field of bio ink development for tissue engineering and regenerative medicine applications.

Invited Talk

Profile

DR. ALINE MILLER

Aline Miller, PhD, is Chief Executive Officer and Co-Founder of Manchester BIOGEL, a company specialising in providing engineered, self-assembling peptide hydrogels for 3D cell culture, 3D bioprinting and incorporation within medical devices. She currently oversees all aspects of the business from product production and development, to marketing and sales, to ensure our customers receive the very best product and service. Aline is also Professor of Biomolecular Engineering in the School of Chemical Engineering at the University of Manchester where she has won several awards, including The Royal Society of Chemistry MacroGroup UK Young Researchers Medal, The Institute of Physics, Polymer Physics Group Young Researchers Lecture Award and the Philip Leverhulme Prize for Engineering for her work on self-assembling peptide materials. In this area she has published over 100 refereed papers, authored 5 patents and has won > £8M from research councils, EU, charities and industry to support her research group.

Company

Manchester BIOGEL is a leader in the design and manufacture of 3D synthetic peptide hydrogels that are redefining cell culture for life science. Our biologically relevant PeptiGels® mimic the cell micro-environment and have tuneable properties to simulate the natural environment of all human tissues. Our PeptiGels® are specifically designed and tailored to overcome the key limitations with current biomaterials for regenerative medical applications. They are 100% ethical, animal free and chemically defined, and are supplied with no batch to batch variability. This gives you the confidence to achieve reliable and consistent results every time, and with the adage of being clinically translatable, you have the potential to deliver life changing therapies.

Invited Talk



Dr. Suresh S Pillai

Evolution and present status of implants in spine surgery

Suresh S Pillai

BMH Spine centre, Baby Memorial Hospital Calicut

Profile

DR. SURESH S PILLAI

Dr Suresh S Pillai, MS, DNB, MNAMS, Mch, FRCS, Fellow (spine surgery)

BMH Spine centre, Baby Memorial Hospital Calicut

- 75 Publication in national and international journals
- Text book chapter on scoliosis
- Recipient of Clinical Research award of ASSI 2020
- Recipient of many humanitarian awards for charitable work
- Authored books about spine in Malayalam
- Former editor of Kerala Journal of orthopedics
- Present editor of Journal of Orthopedic association of south Indian States
- member of many national and international societies
- Active fellow of Scoliosis Research Society
- Around 300 talks on various spine topics, regional, national and international

CONTRIBUTED ABSTRACTS

PRINTABILITY EVALUATION OF HYDROGEL FOR EXTRUSION-BASED 3D BIOPRINTING

Anupama Sekar J1, Shiny Velayudhan and Anil Kumar PR*

Division of Tissue Culture, Department of Applied Biology, Biomedical Technology Wing, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram 695012, Kerala, India

*Corresponding Author E-mail: anilkumarpr@sctimst.ac.in

Abstract

Three dimensional (3D) bioprinting is a promising technology in the field of tissue engineering that aids in biofabrication of tissues for various applications such as *in vitro* disease model, *in vitro* assay system and for clinical transplantation purposes. In extrusion-based 3D bioprinting, cells along with a biomaterial, together termed as bioink is used for building 3D constructs in a layer-by-layer fashion. The biomaterial component would be generally water-based hydrogel system that provides an extracellular matrix environment for the laden cells and facilitates better attachment, growth and proliferation of cells. As an initial step in maintaining the precision of construct during bioprinting, it is essential to evaluate the printability property of bioinks. Printability can be defined as the ability of a material, when subjected to a certain set of printing conditions, to be printed in a way which results in printing outcomes which are desirable for a given application¹. Printability depends primarily upon the rheological properties of the bioink as well as the physical parameters set in bioprinter. In this study, the printability of a gelatin-based hydrogel formulated for bioprinting liver tissue constructs was evaluated. A thorough cytocompatibility evaluation of the hydrogel was done and subsequently the formulation was completed by adding cells. Patterns and designs in 2D and 3D were used to find out the extrudability, filament characterization and shape fidelity in extrusion printing. Single and multilayer evaluation of bioink formulation was qualitatively and quantitatively evaluated. The results suggest that the hydrogel can be precisely deposited with a good spatial, temporal, and volumetric control. The printability was also quantified by image analysis. Maintenance of shape fidelity is essential for the accuracy of the prototype. The multilayered patterns showed good shape fidelity and were reproducible. In addition to the chemical characterization and physical requirements of the bioink, it should also satisfy the biological requirements related to tissue function. Functional analysis of hepatocyte laden constructs satisfies the basic requirement of a bioink to be used for 3D bioprinting liver construct.

Keywords: Three-dimensional bioprinting; bioinks; printability

References

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3D BIOPRINTED OSTEOARTHRITIC *IN VITRO* BIOMIMETIC MODEL AS HIGH-THROUGHPUT ANTI-INFLAMMATORY DRUG SCREENING PLATFORM

Yogendra Pratap Singh¹, Joseph Christakiran Moses¹, Biman B. Mandal^{1,2*}

***1Biomaterial and Tissue Engineering Laboratory, Department of Biosciences and Bioengineering,
Indian Institute of Technology Guwahati, Guwahati – 781039, Assam, India.***

2Centre for Nanotechnology, Indian Institute of Technology Guwahati, Guwahati, Assam, India.

1Email: yogi13160@gmail.com; *Email: biman.mandal@iitg.ac.in

Abstract

Osteoarthritis (OA) represents most common musculoskeletal disease and one of the leading cause of disability worldwide. Currently available OA therapeutics are restricted to reduction of joint pain and inflammation due to lack of biomarkers and less understanding of molecular mechanisms of intricate OA tissue. Towards this, the development of a valid model mimicking OA conditions is essential. Various animal models of OA have been used for many years however, concerns such as differences between the developed model and human OA conditions, longer timeline and higher costs involved along with the ethical issues associated with the killing of animals for primary screening and optimization reasons, necessitates the development and use of an alternative efficient *in vitro* OA model preceding the formal animal trials. *In vitro* OA models make an excellent substitute for animal models due to their ability to satisfy the demand for a reductionist approach to understand the pathophysiology of OA [1]. Additionally, *in vitro* models produce more reproducible data, due to the possibility to tightly control the experimental parameters, along with lower cost and lesser time. Furthermore, they provide a platform for rapid and high throughput screening of emerging new drugs more efficiently and cost-effectively, while reducing, refining and replacing animal trials in agreement with the ‘3Rs’ principle for more ethical research. In this study, osteochondral constructs (consisting of a cartilage phase, bone phase and an interface) were bioprinted using silk-based bioinks [2] and matured. The study consists of 2 main aims: (i) establishing of OA like diseased condition, and (ii) assessing it as a drug testing platform. To establish *in vitro* OA-model and to induce OA-like conditions, we targeted the inflammatory cascade associated with OA pathogenesis. In this regard, we used interleukin-1 β (IL-1 β) and tumor necrosis factor- α (TNF α) two well-known pro-inflammatory cytokines that play crucial roles in the onset as well as the progression of pathogenesis of OA. These inflammatory cytokines induces chronic inflammation and dysregulates remodelling at the interface thus altering the joint haemostasis. Further, the attenuation of the OA damage was studied using celecoxib (CXB) and rhein (RHN) anti-inflammatory drugs. CXB is a selective COX-2 inhibitor of the class of nonsteroidal anti-inflammatory drug (NSAID). It has been widely explored in OA research and treatment. It works by inhibition of the prostaglandin E2 molecule and decreases the inflammation. Similarly, RHN is a crucial IL-1 β inhibitor, which is known to reduce cartilage degradation and enhance synthesis. Herein, we also investigate the relevant pathways involved such as the c-Jun N-terminal kinases (JNK) signaling pathway, p38 mitogen-activated protein kinase (p38MAPK) and nuclear factor- κ B (NF- κ B) signaling mechanisms associated in the inflammatory cascade. Overall, in this study, we aimed to establish an cytokine induced *in vitro* OA-model, subsequently evaluate the treatment effects of anti-inflammatory drugs (CBX and RHN) on attenuation of OA like diseased state by investigating the underlying molecular basis.

HEAT TREATMENT OF ADDITIVELY MANUFACTURED Ti-6Al-4V BONE PLATE FOR ENHANCED BIOMECHANICAL PERFORMANCE

Saurabh Kumar Gupta¹, Nagur Shahidsha¹, Sumit Bahl¹, #, Dhaval Kedaria¹, Sarat

Singamneni², Prasad K.D.V. Yarlagadda³, Satyam Suwas¹, Kaushik Chatterjee^{1*}

¹Department of Materials Engineering, Indian Institute of Science, Bangalore, India

²Department of Mechanical Engineering, Auckland University of Technology, Auckland, New Zealand

³School of Chemistry, Physics and Mechanical Engineering, Science and Engineering Faculty, Queensland University of Technology, Brisbane, Australia

*Corresponding Author E-mail: kchatterjee@iisc.ac.in

Abstract

Selective laser melting (SLM) of Ti-6Al-4V powder was utilized for fabrication of near-net-shape bone plates. SLM produced parts have martensitic microstructure which resulted in poor ductility, thereby limiting the application for components. Cyclic heat-treatment based on repeated heating and cooling below but close to β -transus was applied to bone plates after fabrication. This heat-treatment resulted into transformation of the martensitic microstructure into bimodal microstructure. 3-point bend test and tensile test performed on heat-treated plates have shown large improvement in ductility and the results were comparable to the plate that was manufactured from wrought alloy. Corrosion behavior of plates was assessed in simulated body fluid and results show that the corrosion resistance in as-manufactured, heat-treated and wrought plate samples were similar. Cytocompatibility *in vitro* was assessed using MC3T3-E1 for and results show that heat treated plate samples as cytocompatible as the additively manufactured and wrought plates. These findings demonstrate that biomechanical performance of additively manufactured bone plates can be enhanced by performing heat treatment and comparable to the plate manufactured from the wrought alloy. These results have important implications for the fabrication of patient-specific metallic orthopedic devices using SLM without compromising their biomechanical performance by subjecting them to a tailored heat treatment.

Keyword: Bone plate; Ti-6Al-4V alloy; Selective laser melting; Mechanical properties.

A PHOTOLUMINESCENCE STUDY OF NITROGEN-DOPED CARBON QUANTUM DOTS/HYDROXYAPATITE (NCQDS/HAp) NANOCOMPOSITES

Jeshurun A¹, Md. Irfan¹, P. Baraneedharan², B. M. Reddy^{2*}

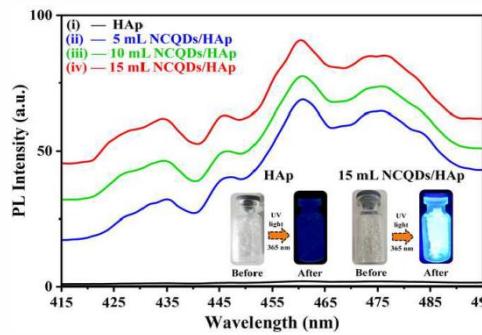
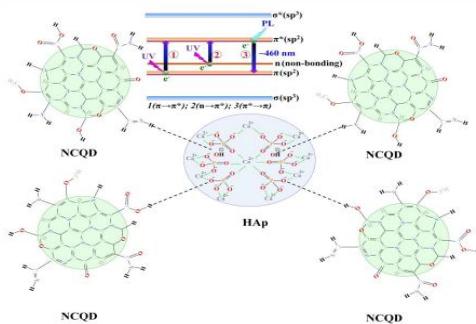
*Department of Materials Science, School of Technology, Central University of Tamilnadu,
Thiruvarur, Tamilnadu, India – 610005.*

Abinnovus Consulting Pvt. Ltd, Tamilnadu, India.

*Corresponding Author E-mail: B. M. Reddy, mrbogala@crimson.ua.edu.

Abstract:

The present study involves the investigation of nitrogen-doped carbon quantum dots (NCQDs) functionalized with hydroxyapatite (HAp) and its photoluminescence under ultraviolet (UV) radiation. The NCQDs were prepared by irradiating a mixture of urea and citric acid in the ratio of 3:1 in a microwave at 750W for approximately 5 min. The wet chemical process was used to synthesize the HAp by reacting 1 mol of calcium nitrate tetrahydrate with 0.6 mol of ammonium dihydrogen phosphate at ~37°C for 15 hrs. under basic conditions(pH < 8). The NCQD/HAp composite was prepared by hydrothermal method. 5 – 15 mL aqueous solution of NCQDs were mixed with 1g of HAp and the mixtures were autoclaved at 100°C for 1 hr. The Sample characterizations were performed using microscopic, spectroscopic and diffraction techniques. The average particle size of the NCQD/HAp composite was observed to be 45 nm. The NCQD/HAp composites showed brighter photoluminescence in comparison to pure HAp.



Keywords: Nitrogen-doped carbon quantum dots (NCQDs); hydroxyapatite (HAp); nanocomposite; photoluminescence.

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MICROWAVE-ASSISTED ONE-STEP SYNTHESIS OF NANO-HYDROXYAPATITE FROM FISH BONES AND MUSSEL SHELLS

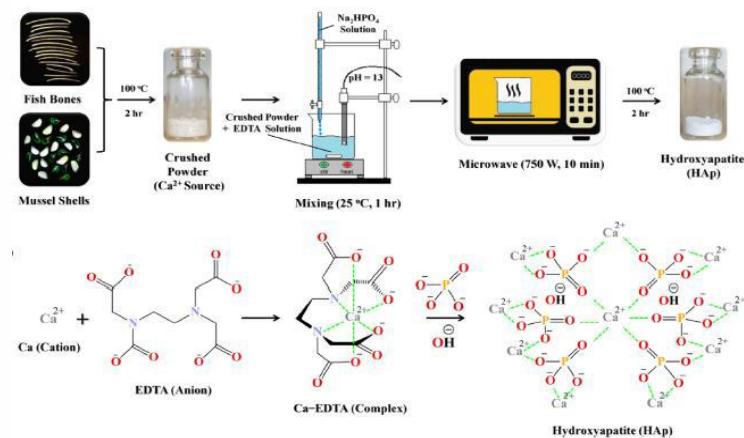
P. S. Suprajaa, Md. Irfan, R. Praveen, B. M. Reddy*.

Department of Materials Science, School of Technology, Central University of Tamilnadu,
Thiruvarur, Tamilnadu, India – 610005.

*Corresponding Author E-mail: B. M. Reddy, mrbogala@crimson.ua.edu.

Abstract:

The present study reveals one-step, rapid and cost-effective preparation of nano-hydroxyapatite (n-HAp) from fish bones and mussel shells via microwave-assisted method. Fish bones and mussel shells facilitate the calcium (Ca) that reacts with ethylenediaminetetraacetic acid (EDTA) to form Ca-EDTA. Microwave irradiation of Ca-EDTA and disodium hydrogen phosphate (Na_2HPO_4) mixture at 750 W for 10 min resulted in HAp or $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$. Samples were analysed using diffraction, spectroscopic, microscopic and thermal techniques. High quality and thermally stable nanocrystals were present in fish bones and mussel shells HAp samples, with average particle size of 265 nm and 108 nm respectively.

**Keywords:** Hydroxyapatite; Fish bone; Mussel shells; Microwave processing.**References**

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PREPARATION OF FORSTERITE-HYDROXYAPATITE COMPOSITES AND ITS BIOMEDICAL APPLICATION

Sherlin Joseph Selvanayagam¹, Senthil Kumar Venkataraman, Naveen Subramaniam Vijayakumar,

*Collin Samuel M, Sasikumar Swamiyappan², **

Department of Chemistry, School of Advanced Sciences, Vellore Institute of Technology,

Vellore-632014, Tamil Nadu, India.

**Corresponding Author E-mail: ssasikumar@vit.ac.in*

Abstract

In this study forsterite (Mg_2SiO_4) ceramic was prepared by implementing sol-gel method using citric acid as a fuel in the stoichiometric ratio and hydroxyapatite ($Ca_{10}(PO_4)_6(OH)_2$) was synthesized by co-precipitation method. The resulting products is calcinated at 9000C for 6 hrs. The phase formation and crystallite size were examined by XRD, FT-IR. In-vitro bioactivity of the Fors-HAp scaffolds were induced in SBF for 9 days at three different intervals. XRD, FT-IR and SEM/EDX characterizations were used for investigation of apatite deposition on the surface of scaffolds.

Keywords: Forsterite; bioactivity; scaffolds; composites.

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INVESTIGATION ON THE BIO-COMPATIBILITY OF AKERMANITE/TIO2 COMPOSITE FOR TISSUE ENGINEERING APPLICATION

Shobana Kothandam1, Senthilkumar Venkataraman, Ravindran Nandhakumar,

*Sasikumar Swamiyappan2, **

Department of Chemistry, School of Advanced Sciences,

Vellore Institute of Technology, Vellore-632014, Tamil Nadu, India.

*Corresponding Author E-mail: ssasikumar@vit.ac.in

Abstract

In this study, pure akermanite was prepared by sol-gel combustion technique using citric acid as fuel by calcinating at 9000C. Since the major drawback of akermanite is its inadequate fracture toughness which disturbed the further application. The akermanite/TiO₂ composite was prepared by conventional soli-state method and the in-vitro bioactivity was investigated on subjecting to the SBF fluid. The deposition of hydroxyapatite on the surface was examined and characterized by XRD, FT-IR and SEM/EDX techniques. The results revealed that the composite showed the apatite deposition after 3 days of immersion and improved mechanical strength.

Keywords: akermanite; bioactivity; composite.

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COMBINED INFLUENCE OF SELECTIVE RARE EARTHS SUBSTITUTIONS (YB³⁺, DY³⁺, TB³⁺, GD³⁺, EU³⁺, ND³⁺) IN ZRO₂ FOR BIOMEDICAL APPLICATIONS

S.Kalaivani¹, S. Kannan^{2,*}

Centre for Nanoscience and Technology, Pondicherry University, Kalapet
Puducherry-605 014, INDIA

*Corresponding Author E-mail: para_kanna@yahoo.com

Abstract

The study probes the impact of collective rare earth (RE³⁺) substitutions in ZrO₂ for biomedical applications. RE³⁺ namely Yb³⁺, Dy³⁺, Tb³⁺, Gd³⁺, Eu³⁺, Nd³⁺ were chosen for the study and three different combinations were attained by altering the substitution level of RE³⁺ in ZrO₂. Structural flexibility alongside optical, mechanical, magnetic, computed tomography (CT), magnetic resonance imaging (MRI) features were explored. Average ionic size and RE³⁺ concentration plays a crucial role in the crystallization behavior of ZrO₂ at elevated temperatures. Collective RE³⁺ substitutions exhibit both up-conversion and down-conversion emission properties under excitation at 793 and 350 nm. Nonetheless, elevated level of RE³⁺ substitution has shown detrimental effect on the mechanical stability of ZrO₂. The existence of Dy³⁺, Tb³⁺, Gd³⁺ and Nd³⁺ reveal paramagnetic response necessary for MR-imaging, while the presence of Dy³⁺ and Yb³⁺ contributes high X-ray absorption coefficient values appropriate for CT imaging. The combined physiognomies of multiple RE³⁺ demonstrate the prospective of the investigated system in multimodal imaging applications.

Keywords: ZrO₂; RE³⁺; Structure; Mechanical; Imaging.

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**STRUCTURAL, MECHANICAL, OPTICAL AND IN VITRO CT IMAGING
POTENTIAL OF YB³⁺ SUBSTITUTED ZIRCONIA TOUGHENED
ALUMINA SYSTEM**

M. Ezhilan, V. Ponnileavan and S. Kannan*

Centre for Nanoscience and Technology,

Pondicherry University, Puducherry-605 014, India

Corresponding Author E-mail : para_kanna@yahoo.com

Abstract

A wide range of ytterbium (Yb³⁺) substitutions in zirconia toughened alumina (ZTA) have been synthesized. The structural, morphological, optical, mechanical and *in vitro* computed tomography (CT) features of the synthesized materials were examined using various characterization techniques. The results deliberated the impact of Yb³⁺ content on the crystal structure, morphological, mechanical, optical, and computed tomography of the resultant ZTA systems. XRD results witnessed the presence of tetragonal ZrO₂ (*t*-ZrO₂) until 20 mol. % of Yb³⁺ while the stabilization of cubic ZrO₂ (*c*-ZrO₂) is witnessed in the range between 20 - 50 mol. % of Yb³⁺ in the ZTA system. Beyond 50 mol. %, Yb³⁺ prefers to react with Al₂O₃ to yield Yb₃Al₅O₁₂. Morphological analysis revealed the existence of two different crystalline phases pertinent to ZrO₂ and Al₂O₃. Indentation results displayed relatively better hardness and Young's modulus data that are consistent with the commercial ZTA implant. Optical properties of Yb³⁺ in ZTA showcases a typical emission behavior; however, the *t*→*c*-ZrO₂ polymorphic transition annulled this characteristic emission. Further, CT imaging verifies the potential of Yb³⁺ substituted ZTA from the experimental results.

Key words: ZTA; Ytterbium; polymorphism; Al₂O₃; imaging; mechanical.

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**STRUCTURAL, MECHANICAL AND IN VITRO ANALYSIS OF
ZRO₂/ZNFE2O₄ MAGNETIC BIOCERAMIC**

Mushtaq Alam.M1, Subina Raveendran2, S.Kannan*

*Center for Nanoscience and Technology, Pondicherry University,Kalapet,
Puducherry-605014,India*

Corresponding Author : para_kanna@yahoo.com

Abstract

The study involves the in situ formation of ZrO₂/ZnFe₂O₄ composites and subsequently the structural, morphological, mechanical and magnetic properties were determined. The crystallization of tetragonal ZrO₂ (*t*-ZrO₂) and ZnFe₂O₄ phases were determined at 900 °C. Based on the Zn²⁺/Fe³⁺ content, the composite system revealed a gradual increment in the phase yield of ZnFe₂O₄. All the systems indicated the presence of monoclinic ZrO₂ (*m*-ZrO₂) along with *t*-ZrO₂ and ZnFe₂O₄ at 900 °C; however, the increment in gradual annealing to 1300 °C revealed a reverse trend of *m*- □ *t*-ZrO₂ transition. Morphological analysis also affirmed the crystallization of ZnFe₂O₄ as a secondary phase in the *t*-ZrO₂ matrix. Mechanical studies accomplished good uniformity in all the investigated compositions despite the variation in phase content of the ZnFe₂O₄ component in the composite system. Magnetization studies unveiled the enhanced magnetic features with respect to the ZnFe₂O₄ component and further the composite systems also displayed better biocompatibility and non-toxicity features from *in vitro* test.

Keywords: ZrO₂; ZnFe₂O₄; Structure; Mechanical; Magnetic.

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EFFECT OF CONCENTRATION GRADIENT AND ELEVATED TEMPERATURES ON PHASE STABILIZATION OF T-ZRO₂/COFE₂O₄ COMPOSITE

Subina Raveendran¹, S. Kannan^{2,}*

*Centre for Nanoscience and Technology, Pondicherry University, Kalapet
Puducherry-605 014, INDIA*

**Corresponding Author E-mail: para_kanna@yahoo.com*

Abstract

The study analyze the combined influence of Zr⁴⁺, Y³⁺, Fe³⁺, and Co²⁺ metal ions in a solution mixture and their potential to yield the desired ZrO₂/CoFe₂O₄ composite that possesses better structural stability at 1300 °C. The role of heat treatment temperatures and concentration gradient of Fe³⁺/Co²⁺ to retain tetragonal ZrO₂ (*t*-ZrO₂) and CoFe₂O₄ structures were highlighted. The incidence of a gradual m→*t*-ZrO₂ transition alongside the enhanced phase yield of CoFe₂O₄ is determined. Despite the invariable presence of 8 mol % of Y₂O₃ in all the investigated systems, the results revealed the inability to establish *t*-ZrO₂ stabilization at 900 and 1100 °C. XPS analysis confirms the oxidation states of iron, yttrium, cobalt, and zirconium in their respective 3+, 3+, 2+, and 4+ in the ZrO₂/CoFe₂O₄ composite. Morphological analysis revealed the presence of distinct grains pertinent to ZrO₂ and CoFe₂O₄ with dense microstructures. The resultant microstructures demonstrated better hardness and Young's modulus values, and a gradual increment in the phase content of CoFe₂O₄ in the composite facilitated ferrimagnetic features. Moreover, the good biocompatibility and non-toxic behavior of the composite system is evident from *in vitro* studies.

Keywords: Structure; Mechanical; Magnetic; Composite.

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BIOCERAMIC DRUG CARRIER FOR OSTEOPOROSIS

R. Abimanyu, A.M. Ballamurugan

Department of Nanoscience & Technology, Bharathiar University

Coimbatore-641 046, Tamil Nadu

Corresponding Author: balamurugan@buc.edu.in

Abstract

Calcium phosphates (CaPs) Bioceramics are the most widely used bone substitutes in bone tissue engineering due to their compositional similarities to bone mineral and excellent biocompatibility. In recent years, CaPs, especially Hydroxyapatite and Tricalcium phosphate, have attracted significant interest in simultaneous use as bone substitute and drug delivery vehicle, adding a new dimension to their application. The advanced synthetic methods and new chemical strategies allow the impregnation of drugs within them or on their functionalized surfaces, the Bioceramics act as local drug delivery systems to treat large bone defects, osteoporotic fractures, bone infections, and bone tumours. The development of new mesoporous nanoceramics, suitable to be used as carriers for drug delivery, has also opened new perspectives for cancer therapy and osteoporosis treatment. In particular, the present work demonstrates the viability of the porous calcium deficient appetite matrices as the carrier for amino acids and drugs to deliver at the targeted defect sites using a stimuli-responsive system

Keywords: Hydroxyapatite, Tricalcium phosphate, osteoporotic fractures

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INFLUENCE OF DY³⁺ OCCUPANCY IN β -CA₃(PO₄)₂/T-ZRO₂ LATTICE IN THE ENRICHMENT OF PHASE STABILITY AND MECHANICAL FEATURES

P. Nandha Kumar and S. Kannan*

Centre for Nanoscience and Technology, Pondicherry University, Puducherry-605014, India

Presenting Author address Centre for Nanoscience and Technology,

Pondicherry University, Puducherry-605014, India

E-mail: nandhabiochem@gmail.com

Abstract

The present study demonstrates the addition of Dy³⁺ in β -Ca₃(PO₄)₂/t-ZrO₂ composite mixtures by the aqueous precipitation method. Effect of Dy³⁺ ions in composite powders which inhibit the phase transition and thermal stability of β -Ca₃(PO₄)₂ and t-ZrO₂ at 1500 °C were studied. The composite powder has been prepared in five assorted compositional proportions to investigate if it is suitable for implant applications. The phase transition and thermal stability of β -Ca₃(PO₄)₂ and t-ZrO₂ were accessed by X-Ray Diffraction, Rietveld Refinement, Infrared, and Raman spectroscopy. The influence of Dy³⁺ delays the phase transition of calcium-deficient apatite to β -Ca₃(PO₄)₂ only at 1300 °C. The Dy³⁺ initially occupy at β -Ca₃(PO₄)₂ lattice site at Ca1, Ca2, and Ca3 sites and when saturation limits exceed in β -Ca₃(PO₄)₂ the Dy³⁺ occupy the ZrO₂ sites. The morphological features display two different pertinent structures of β -Ca₃(PO₄)₂ and ZrO₂ grains. The impact of Dy³⁺ ions is revealed in absorption and emission spectra which shows the sequential enhancement by concentration addition. The magnetic properties reflect paramagnetic behavior due to the upsurge of Dy³⁺ domains. Also, the gradual enhancement in phase content of t-ZrO₂ in the composite mixtures ensured a significant improvement in the resultant mechanical performance.

Keywords: Dy³⁺; β -Ca₃(PO₄)₂; ZrO₂; Composite; Rietveld Refinement

CARBON NANOTUBE REINFORCED CALCIUM DEFICIENT CERAMIC FOR IMPROVED SURFACE MODIFICATION ON LOW COST STAINLESS STEEL IMPLANTS

M. Logesh a and A M Ballamurugana,*

a Department of Nanoscience and Technology, Bharathiar University,

Coimbatore – 641 046, Tamilnadu, INDIA

E-mail: logeshchemistry@gmail.com

Abstract

Calcium phosphate materials are the most promising bioceramic material widely used in the field of orthopedic and dentistry due to their properties closely resembles to the host tissue. Here, macroporous calcium phosphate reinforced MWCNT composites were fabricated and evaluated for its potential usage in tissue engineering applications. To improve the mechanical strength of the calcium phosphate polymorphs, the 1D carbonaceous material of MWCNT was incorporated. Further to improve the stable functionalization on the surface of stainless steel implants ceramic nanocomposites were used as a surface modifier. The required properties were systematically studied according to the latest standards for biomaterials. The developed reinforced composites surface modification meets the recent clinical demands, the porous nature of the coating on the metal surface provides a suitable platform for anchoring bone cells and its proliferation at the orchestrate the fashion.

Keywords: Bioceramic, Mesoporous Calcium Phosphate, MWCNT

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Biocomposites

PREPARATION OF BIODEGRADABLE CHITOSAN / STRONTIUM DOPED MESOPOROUS BIOACTIVE GLASS COMPOSITES FOR SOFT TISSUE ENGINEERING AND DRUG DELIVER APPLICATION

*S. Amudha a, J. Ramana Ramyaa,b S. Narayana Kalkura**

a Crystal Growth Centre, Anna University, Chennai 600025, Tamil Nadu, India.

b National Centre for Nanoscience and Nanotechnology, University of Madras, Guindy Campus, Chennai 600 025, Tamil Nadu, India

**Corresponding author's email id:kalkura@yahoo.com*

Abstract

Chitosan(CS) with mesoporous strontium doped 45S5 bioactive glasses composite have great application potential in soft and hard tissue application. Here in, the first time developed the mesoporous strontium doped bioactive glass/ chitosan filler loaded with cyclophosphamide for bone filling and drug deliver application. All the samples were characterized by XRD, FT-IR, Raman, SEM, TGA, Zeta potential. The phases and their functional groups were confirmed by the X-ray diffraction (XRD) and FTIR and FT-Raman spectroscopy respectively. Materials with negative zeta potential (electronegative surface charge) aid cell proliferation and support the formation of new bone. In addition, biological properties such as hemocompatibility, antimicrobial activity and in vitro bioactivity of composite powders were also studied. The SEM analysis showed the nano spherical shape of chitosan particle mingle with bioactive glass particle. All the composite films are highly hemocompatible. The antimicrobial activity of the bone cement was tested against the culture of *E. coli* to create the considerable zone of inhibition.

Keywords: Chitosan; mesoporous bioglass; bone cement; nano sphere

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Biocomposites

GELATIN- ALGINATE/ MINERAL SUBSTITUTED FHA NANOCOMPOSITE DEPOSITIONS ON TIO2 FOR HARD TISSUE IMPLANT; BIOCHEMICAL STUDIES

Renji Rajendran and V. Raj

*Advanced Materials Research Laboratory, Dept of Chemistry, Periyar University,
Salem, Tamil Nadu, India.*

Corresponding author mail id: alaguraj2@rediffmail.com
Tel: +919790694972

Abstract

Background

Immaculate Ti is considered as a prospective biomedical implant in orthopedics. But its biologically inert behavior limits its applications. So the surface requires ameliorating bioactivity. Bioceramic coating on immaculate Ti enhances the biological and mechanical properties. Here we developed the mineral substituted Fluorapatite (MFHA) with the combination of biopolymer- gelatin - alginate composite coatings on TiO₂. (TiO₂-MFHA/Gel-Alg), for improving the structural and biological properties and minimizing the bacterial adhesion.

Methods

The nanoporous TiO₂ will be fabricated by anodization of titanium and the MFHA – gelatin-alginate composite coatings will be deposited on anodized Ti by electrophoretic deposition. The presence of developed layer by layer coatings was confirmed by XRD, FTIR, SEM and EDX analyses. Also, the mechanical properties, corrosion behavior, antibacterial activity of the layer by layer coating and in vitro bioactivity, cell viability, cell adhesion test were analyzed by appropriate techniques.

Results

The (TiO₂-MFHA/Gel-Alg) bilayer coatings possess good mechanical properties and corrosion studies reveal that these coatings can effectively prevent the corrosion of titanium base metal. Moreover, the fabricated coatings have a great antibacterial efficiency.

Conclusion

The electrophoretic fabrication of bilayer coatings on anodized Titanium (TiO₂-MFHA/Gel-Alg) possess excellent mechanical, antibacterial, corrosion resistance properties and better bioactivity, which is an effective implant material for orthopedic applications.

Key words

Titanium, Fluorapatite, Gelatin, Alginate, Anodization, Corrosion

Biocomposites

SKULL-BASE DEFECT CLOSURE DEVICE BASED ON FLEXIBLE ETHYLENE-VINYL ACETATE COPOLYMER-HYDROXYAPATITE COMPOSITE

Gijo Raj1, Prakash Nair2, Hariharan Venkat Easwer2, Manoj Komath1, Roy Joseph1*

1 Biomedical Technology Wing, Sree Chitra Tirunal Institute for Medical Science and Technology, Trivandrum, Kerala 695012, India.

2 Neurosurgery Department, Hospital Wing, Sree Chitra Tirunal Institute for Medical Science and Technology, Trivandrum, Kerala 695011, India.

*Corresponding Author E-mail: rjoseph@sctimst.ac.in

Abstract

Endoscopic trans-sphenoidal surgeries to remove tumors such as pituitary adenomas are done by making an opening on skull-base. An effective closure of the skull base defect is of paramount importance in preventing cerebrospinal fluid leakage during the recovery period of the patient. Conventionally, such osteodural defects are closed using autologous tissue such as fascia lata or fat harvested from the thigh or the umbilical region. However, these autograft tissues bear the risk of dislodgement due to pressure of cerebrospinal fluid pulsations or transient increases in intracranial pressure induced by cough or sneeze. This work presents a skull base defect closure device, which is tissue-compatible, flexible and bioactive. The device has a petal-like shape with 20mm each side and thickness 500-800 microns. There is a peg shaped projection for holding and bending using the instrument so that it could be passed through trans-sphenoidal route in folded condition. In the final deployment phase, the device has to regain its flat shape and fit to the defect geometry. The device is made up of polymer composite material based on ethylene-vinyl acetate copolymer (EVA) and bioactive fillers like hydroxyl apatite (HAP). The formulation of the composite material is optimized in a Brabender plastograph and the device is fabricated using compression molding. The mechanical properties of the composite material are estimated using UTM under physiological conditions in a liquid bath. Robust mechanical properties of the composite material are attributed to a uniform distribution of the bioactive filler in the EVA polymer matrix as observed from SEM analysis of the cryo-cracked interface of the material. The glass transition temperature, evaluated using DMA, of the composite material increase by 5°C when compared to the unfilled material indicating physical interaction of EVA chains with the hydroxyapatite filler. 2D-Confocal Raman imaging shows the chemical distribution of HAP inside EVA matrix and indicates that no toxic impurities are present during composite preparation. The recovery of the device upon folding is tested by investigating shape memory properties, so as to ensure reliable deployment. The closure device is thin so as to allow custom shaping by the surgeon to fit to the defect geometry. The materials chosen for the device are biocompatible and osteoconductive and hence anticipated to integrate with the host bone at the skull base. The device has sufficient radio-contrast when compared to predicate devices suggested for skull base defect closure. The device offer several advantages in endoscopic transphenoidal skull base repair.

Keywords: Skull-base repair, Trans-sphenoidal surgery, Ethylene-vinyl acetate copolymer, Hydroxyapatite

Biocomposites

TETRAGONAL TO CUBIC PHASE TRANSFORMATION OF ZRO₂ IN ZRO₂-SIO₂ CERAMIC-GLASS COMPOSITE THROUGH DYSPROSIUM SUBSTITUTIONS

S. Vasanthavel *a,b*, Brian Derby *b* and S. Kannan *a**

a Centre for Nanoscience and Technology,

Pondicherry University, Puducherry-605 014, INDIA

bSchool of Materials, University of Manchester Manchester, M13 9PL, UNITED KINGDOM

E-mail: para_kanna@yahoo.com

Abstract

Stabilization of tetragonal zirconia (*t*-ZrO₂) is of specific interest for load bearing bone replacements. Low temperature degradation related failures associated with gradual transformation from *t*-ZrO₂ to *m*-ZrO₂ (monoclinic zirconia) can lead to its early removal from the implant site. Moreover, monitoring the implant performance by non-invasive techniques is an essential task. The magnetic resonance imaging (MRI) contrast ability of dysprosium (Dy³⁺) is well established. To this aim, varied levels of Dy³⁺ additions in the ZrO₂-SiO₂ binary oxide system have been attempted. The results show the essential role of Dy³⁺ in the formation of stable *c*-ZrO₂ (cubic zirconia) phase at higher temperatures. The presence of SiO₂ influenced the *t*-ZrO₂ stabilization whereas Dy³⁺ tends to occupy the ZrO₂ lattice sites to persuade *c*-ZrO₂ transition. MRI tests displayed the commendable contrast ability of Dy³⁺ stabilized ZrO₂-SiO₂ ceramic-glass composite. Nanoindentation results reveal significant enhancement on the mechanical properties.

Keywords: Zirconia; Silica; Dysprosium; Phase stabilization; Mechanical strength.

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Bioglass

RARE EARTH ELEMENT (NB) INCORPORATED BIOGLASS MATRIX FOR IMPROVED OSTEOBLASTS CELL GROWTH

S. Manikandan, A.M. Ballamurugan*

Department of Nanoscience and Technology, Bharathiar University,
Coimbatore, Tamil Nadu, India

*Corresponding author: E-mail: balamurugan@buc.edu.in (A.M.Ballamurugan)

Abstract

Bioactive glasses are the most promising bioceramic material widely used in orthopedic and dental applications due to their superior bioactivity and biocompatibility. To enhance their surface reactivity of bioactive glasses and relevant metallic ions can be substituted into an inorganic glass matrix. The substitution of a trace amount of Niobium ions into bioglass matrix has shown a substantial potential to enhance the bone-forming ability through the proliferation and differentiation of osteoblasts. Niobium ions also refine the calcification there is helps to form a new bone tissue that can promote alkaline phosphates activity of osteoblasts. Within this mind, recently developed composition of bioactive glasses has been synthesized coating was on 316L SS. Electrochemical investigations such as potentiodynamic polarization and electrochemical impedance studies have been Carrey out to evaluate the corrosion resistance of the coated substrates. In vitro biocompatibility studies have also been investigated for results revealed that the developed materials are a promising candidate for hard tissue repair.

Keywords: Bioglass, 316l SS, Corrosion resistance

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TANTALUM DOPED 58S BIOACTIVE GLASS FOR BONE TISSUE ENGINEERING: ASSESSMENT OF BIOACTIVITY AND ANTIBACTERIAL PROPERTIES AND ANTIBACTERIAL PROPERTIES

Zakaria Tabia¹, Sihame Akhtach¹, Meriame Bricha¹, Khalil El Mabrouk^{1,}*

¹Euromed Research Center, Euromed Engineering Faculty, Euromed University of Fes, Eco-Campus, Meknes Road, 30 030, Fes, Morocco;

*Email : z.tabia@ueuromed.org ; *Email : k.elmabrouk@ueuromed.org*

Abstract

Bioactive ceramics have become, throughout the years, a major field of biomaterials research that yielded promising bone substitute candidates such as bioactive glasses. These later can be selectively adjusted to act as multifunctional materials, not only promoting new bone formation but also preventing bacterial invasion after surgery. From a clinical standpoint, experts have always considered bacterial infections as a major challenge for tissue regeneration and repair as they can lead to implant failure and prolonged healing of the bone defect. Pathogens, such as Escherichia coli and Staphylococcus aureus are two of the most prevalent bacteria that cause infections through nosocomial contaminations during surgery. Furthermore, the seriousness of bacteria colonization arises from the ability of these microorganisms to develop resistance against antibiotics. In this sense, multifunctional biomaterials that possess intrinsic anti-infective properties are of utmost importance. In the case of bioactive glasses, multifunctionality can be addressed by doping these materials with therapeutic metallic elements.

A BIOMIMETIC SCAFFOLD FOR LIGAMENT TISSUE ENGINEERING

Sriram M, Smriti Priya & Dhirendra S Katti*

Department of Biological Sciences and Bioengineering,

Indian Institute of Technology Kanpur, Kanpur, India

*Corresponding author: dsk@iitk.ac.in

Abstract

Anterior cruciate ligament (ACL), an intra-articular ligament that connects the femur and tibia is very crucial for knee stability and movement. ACL tear is a common sports injury that compromises knee biomechanics. ACL reconstruction surgery using autografts or synthetic grafts can restore function of the knee. However, donor site morbidity and high failure rate make ACL reconstruction a clinical challenge. Although synthetic grafts circumvent donor-site morbidity, high failure rate associated with conventional synthetic grafts urges development of novel graft-designs that can improve the outcome of reconstruction surgeries. Studies have established that accumulation of irreversible damages in synthetic grafts overtime and poor mechanical properties of tissue that grow on scaffold grafts cause graft failure in long-term. Inadequate mechanical properties of tissues that grow on such scaffolds can be attributed to inappropriate architecture or structure of these tissues. Ligaments have a structure-to-function relationship, that is, they possess a complex yet highly organized ECM to aid their mechanical function. Therefore, functional scaffolds engineered with biomimetic designs that govern ligament-mimetic organized tissue in-growth can be a promising approach in improving the outcomes of ACL reconstruction surgeries. In this regard, in the current study, we designed a biomimetic scaffold that mimics the two major zones of ligament tissues, that is, epiligament and ligament-proper. The biomimetic scaffold comprises of a hydrogel-based scaffold with unidirectionally aligned pores to mimic ligament-proper zone and a micropatterned film fabricated using lithographic methods that covers the hydrogel circumferentially to mimic the epiligament zone. We hypothesized that, cells seeded in this bi-zonal scaffold will organize themselves bi-directionally similar to those in native ligaments, thereby governing an organized ligament mimetic tissue in-growth. The scaffolds were fabricated using silk fibroin/gelatin (SG) composite. Scanning electron microscopy (SEM)-based imaging demonstrated that the fabricated biomimetic scaffold possessed zone-specific architecture. The surface of the scaffolds (SG film) had well-defined micropatterns

running circumferentially around the scaffold while the core of the scaffold (SG hydrogel) possessed longitudinally oriented pores. Additionally, integration of epiligament mimetic SG films to unidirectional SG hydrogels drastically improved their tensile modulus from 355.5 kPa to 942.3 kPa. The mechanical performance of the biomimetic scaffold was also superior to that of unidirectional SG hydrogels under cyclic tensile stress which is essential for an ACL graft. Cell culture studies demonstrated that, both SG film and SG hydrogel were compatible with goat-derived intra-articular ligament fibroblasts (LFs) and goat infrapatellar fatpad-derived mesenchymal stem cells (IFP-MSCs). With the help of F-actin staining and SEM imaging, we observed that LFs cultured in the bi-directional scaffolds organized themselves in a zone-specific manner, that is, the cells on the outer surface were aligned circumferentially and the cells in the core were aligned longitudinally, thereby exhibiting the ligament-mimetic bi-directionality. Further, the SG hydrogel could support the differentiation of IFP-MSCs to fibroblasts when induced with connective tissue growth factor. In conclusion, the developed bi-zonal biomimetic scaffold with superior mechanical and pro-ligamentogenic properties can support ligament-mimetic cell organization, thereby, showing great promise as a graft/scaffold for ligament tissue engineering and ACL reconstruction surgery.

Keywords: Ligament; Biomaterial scaffold; Tissue engineering; Biomimetics.

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A NOVEL BIOMIMETIC NON-SUTURABLE ADHESIVE-PATCH BASED DELIVERY SYSTEM FOR INTERNAL TISSUE

Santosh Gupta¹, Akriti Sharma¹, Rama Shanker Verma^{1}*

*1. Stem Cell and Molecular Biology Laboratory, Bhupat and Jyoti Mehta School of Biosciences,
Department of Biotechnology, Indian Institute of Technology Madras, Chennai, Tamil Nadu, India.*

*Corresponding Author E-mail: vermars@iitm.ac.in

Abstract

Premature mortality in terms of years of life lost because of CVD in India increased by 59%, from 23.2 million (1990) to 37 million (2010). Despite wide heterogeneity in the prevalence of cardiovascular risk factors across different regions, CVD has emerged as the leading cause of death in all parts of India, including poorer states and rural areas. Out of all the CVD related diseases, Myocardium Infarction (MI) accounts for little over 50% of the cases. Incidences of Ischemic heart disease are more in India than any country in the world. Therefore, treatment modality of MI has to emphasize on the innovative and more patient compliance methods with large-scale applicability and cost-effective method is the necessity of the current time (1). The limited regenerative potential of native cardiomyocytes hinders its recovery in myocardial Infarction (2). Stem cells delivery-based systems come across as a therapeutic alternative for regeneration of the infarcted area (3). Currently patch based system are being explored in clinical and preclinical research. However, these patch-based systems require to be sutured on the infarcted area, further creating injury to the already ailing heart (4). Here, we report the development of a two-component based suture-less system consisting of a patch for stem cell delivery that relies on a bioadhesive for implantation. The developed mussels inspired biomimetic bioadhesive system comprises of Catechol-Gelatine and Oxidized chitosan. It promotes wet adhesion and has self-crosslinking capability. The nanofibre patch is fabricated using chitosan. The bioadhesive is applied on heart epicardium and then the patch loaded with stem cells is placed on bioadhesive applied area. Adhesion of the patch on heart is instant upon implantation. Echocardiography confirmed the presence of patch on heart after 7 days of patch implantation. Histological studies showed no inflammatory or toxic effect on heart tissue. Trans-well studies confirmed the migration of stem cell from the bioadhesive. This is imperative as post patch implantation; stem cells should be able to migrate to the infarct area. The bioadhesive showed no toxic effect on stem cells as assessed by viability and cytotoxicity studies. Our innovation can be applied on MI patients requiring therapeutic delivery to heart. This adhesive-patch based system can be applied on heart with key-hole surgery, without the need of performing open heart surgery, and most importantly, it does not need to be sutured upon implantation. Therefore, this technology can be very useful to the ever-increasing number of MI patients in India and across the world.

Keywords: Biomimetic, Non-Suturable Platform, Delivery System, Internal Tissue.

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DEVELOPING LEAD-FREE COMPOSITE MATERIALS FOR RADIATION SHIELDING APPLICATION IN THE MEDICAL INDUSTRY

*Digvijay Yadav¹, Mimangsha Sarma¹, Shannon Torcato¹, Shubhankar Shanware¹,
Suya Prem Anand², R. Sivakumar³*

¹ School of Electronics and Engineering (SENSE), Vellore Institute of Technology, Vellore, India

*²Centre of Biomaterials Cellular and Molecular Theranostics,
Vellore Institute of Technology, Vellore, India*

*³Department of Sensor and Biomedical Technology (SENSE),
Vellore Institute of Technology, Vellore-632014, India
suyaprime@yahoo.co.in² rsivakumar@vit.ac.in³*

Abstract

The paper reviews and analyses contemporary simulation software to test the behaviour of the lead-free apron for radiation shielding in the biomedical application. The challenging task is to extend the duration of wearing an apron, reduce the weight, and increase the comfort level for physicians. The lead-free composite material is used as an apron due to the excellent properties such as mass attenuation coefficients, effectiveness against gamma radiation, flexibility and light-weight, and certain other parameters like K-edge absorption. The present study discusses different simulation software used to assess the properties of the shielding material against the radiation effects. In advance conditions, the promising directions are outlined for future research.

Keywords: Software, Simulation, Apron, Composite Material, Radiation, Photon Energy

INTEGRATION OF RANDOM FOREST APPROACH WITH DEEP LEARNING TECHNIQUE TO PREDICT THE GENE TYPE (STREPTOMYCES, PAENIBACILLUS AND BACILLUS) BASED ON THE CONSERVED REGIONS IN 16S RIBOSOME RNA SEQUENCES

M.Meharunnisa¹, M.Sornam^{2,*}

Department of Computer Science, University of Madras, Guindy Campus, Chennai, India

*Corresponding author - madasamy.sornam@gmail.com

Abstract

The taxonomical classification of prokaryotic living beings dependent on morphological contrasts is difficult. A ribosomal RNA (rRNA) arrangement has numerous polymorphic regions that can serve as a hereditary reserve to reveal the hereditary foundation of prokaryotes. The 16S rRNA is a ribosomal RNA vital for the synthesis of every single prokaryotic protein. The internal structure of 16S rRNA quality is made out of conserved and hypervariable regions. The conserved region is shared by all the microorganisms (genes or species), and the variable region have various levels of distinction among the various microscopic organisms, with the particularity of the class or species. Conservation score is a score given to each nucleotide in a multiple sequence alignment to identify how conserved the nucleotide is. Entropy based measure is adopted to calculate the conservation score of the nucleotide. In this study, three genes are taken for consideration namely Streptomyces, Paenibacillus and Bacillus with the conservation score of greater than 50% is taken resulted in 1867 nucleotide sequences and 1443 features. Here, the bases A, T, C, G are taken as feature vectors. The main idea of this study is to reduce the feature vectors using a deep learning feature reduction technique such as Auto encoders. The reduced features are trained using the ensemble machine learning technique called random forest, which basically works on majority voting method. The result outcomes show that auto encoders perform well and hold all the data of the original dataset. The accuracy of 100% is achieved with less components using auto encoders with ensemble learning technique. The statistical significance test of Wilcoxon signed rank test is performed to validate the model which shows high significance to integrating random forest with auto encoders. This technique can be used to identify the conserved regions of 16S rRNA nucleotides with higher precision.

Keywords: Auto encoders; Deep Learning; Random Forest; 16S rRNA;

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REGENERATING NERVES ON ELECTRICALLY CONDUCTIVE SCAFFOLD

Ekta Srivastava¹, Ashok Kumar^{1,2}*

*¹Department of Biological Sciences and Bioengineering;
Indian Institute of Technology Kanpur, Kanpur-208016, UP, India,
²Centre for Environmental Sciences and Engineering,
Indian Institute of Technology Kanpur, Kanpur-208016, UP, India,*

**Email:ashokkum@iitk.ac.in*

Abstract

Injury to central nervous system (CNS) has always been a challenge for scientists across the globe, echoing the intrinsic inability of neurons in CNS to regenerate and hostile niche at the lesion site. Despite arduous efforts, no therapy till date could make its place into clinics. Present scenario suggests an interdisciplinary approach might assist in tackling the issue. Working in the domain of nerve engineering, our lab has previously demonstrated the significance of electrical and topographical cues in regenerating peripheral nerve, which ignited us to surmise that an electrically conductive biocompatible scaffold might augment nerve regeneration and functional recovery in CNS after injury. We successfully fabricated chitosan gelatin sheets using electro spinning, which were further crosslinked to obtain desired degradation rate. Graphene was further added to induce electrical conductivity in sheets and quantified using cyclic voltammetry. Biocompatibility of conductive electrospun scaffold was analysed by culturing neuroblastoma cell lines and scanning electron microscopy (SEM) micrographs depict the intended internetwork among cells. These results prompted us to conclude that the fabricated conductive electrospun substrate depicts prominent potential to regenerate damaged nerve.

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DEVELOPMENT OF SELF-HEALING INTERPENETRATING HYDROGEL BASED 3D PRINTED SCAFFOLDS FOR MENISCUS REGENERATION

Akriti Sharma¹, Santosh Gupta¹, Rama Shanker Verma^{1*}

¹ Stem Cell and Molecular Biology Laboratory, Department of Biotechnology,

Institute of Technology Madras, Chennai 600036, Tamil Nadu, India.

E-mail: akriti.sharma764@gmail.com

Abstract

Meniscal injuries, one of the most common knee injuries, lead to development of osteoarthritis in about 50% of patients causing immobile lifestyle and decreased quality of life [1]. This necessitates the development of biocompatible tissue engineered constructs that aid in restoring meniscus functionality [2]. Therefore, we developed a 3D printed poly lactic acid (PLA) structure chemically conjugated to a self-healing interpenetrating hydrogel system that enhances chondrogenic differentiation of human umbilical cord derived mesenchymal stem cells (hMSC). Mechanical properties of the printed scaffold supported its load bearing capacity critical for treatment of a load bearing tissue. The hydrogel system was constituted using a combination of natural polymers which not only contributed to the pro chondrogenicity of the hydrogel, but possessed self-healing behavior essential to maintain hydrogel structure under load bearing conditions. The hydrogel system was characterized for its physicochemical properties like swelling behavior, degradation kinetics, rheological characteristic and microstructural architecture. The hydrogel and PLA scaffold were found to be biocompatible when analyzed for in-vitro cytotoxicity using hMSC. The hydrogel system showed changes in hMSC morphology in 3D conditions over a period of 28 days. In-vitro differentiation studies showed high expression of chondrocyte specific genes. Further, in-vivo biocompatibility and improved cartilage function was confirmed by heterotopic implantation of designed cell laden constructs in rats. Therefore, this study provides a novel tissue engineering based potential treatment alternative for regenerative repair of meniscal tissue.

Keywords: 3D printing, self-healing hydrogel, meniscus, tissue regeneration

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INVITRO STUDIES OF METAL DOPED NANO BIOCERAMIC IN SBF SOLUTION

K. Aruna¹, V. Deepalakshmi² and T.M. Sridhar^{1*}

¹Department of Analytical Chemistry, University of Madras,

Guindy Campus, Chennai 600 025.

²Department of Chemistry, Guru Nanak College, Chennai 600 042

Email: *tmsridhar23@gmail.com

Abstract

Hydroxyapatite is the main component of mineral bone. nHAP is not only bioactive but also osteoconductive, hypoallergenic and non-immunogenic. More recently, nHAP composites are used in clinical orthopedics for spacing or filling bone defects. The advantages of nHAP include lack of immuno-reaction and absence of postoperative morphological change or volume decrease. However, stoichiometric nHAP is contemplate to be osteoconductive but not osteoinductive. Besides, its use is finite because of its high in vivo solubility and poor mechanical strength. Propitiously, these flaw could be made up for by ionic doping. As calcium and strontium share the properties of group 2A elements, strontium can replace calcium in hydroxyapatite, and hence in bone, without much difficulty. The stable strontium is non-toxic even when it is administered in large doses in our body for prolonged periods. Strontium doped Hydroxyapatite (Sr-doped nHAP) has been synthesized using a precipitation method. In present work n-HAP and 1,3,5 % Sr doped n-HAP was synthesized through wet chemical precipitation method. The powders obtained were characterized by FTIR to determine the presence of functional groups and DLS to find its particle size. The pellets of the synthesized samples were prepared and its optical image was observed. Invitro studies of the pellets were carried out in SBF for 21 days. Weight of the samples was noted before immersion in SBF. Weight gain in the sample was noted after immersion in SBF for 21 days. Immersed samples optical image was also observed to identify apatite growth.

Keywords: HAP; Strontium, SBF.

SELF-CONTRACTING AND STIFFENING HYDROGEL PROMOTES CARTILAGE REGENERATION

Aman Mahajan¹, Akhilesh Singh², Dipak Datta² and Dhirendra S. Katti^{1,*}

¹*Department of Biological Sciences and Bioengineering,*

²*Indian Institute of Technology-Kanpur, Kanpur-208016, Uttar Pradesh, India*

²*Cancer Biology Division, CSIR-Central Drug Research Institute,*

Lucknow- 226031, Uttar Pradesh, India

1Email: amanmah@iitk.ac.in; *Email: dsk@iitk.ac.in

Abstract

Injectable hydrogels are preferred scaffolding materials for articular cartilage regeneration. Although, stiffer hydrogels may seem desirable for regeneration of load bearing articular cartilage tissue, the increased stiffness is known to downregulate chondrogenesis of encapsulated cells. Therefore, developing stiff and resilient injectable hydrogels that can mechanically support load-bearing joints while enabling chondrogenic differentiation of stem cells is a major challenge in the field of cartilage tissue engineering.

INVITRO ANALYSIS OF GRAPHENE INCORPORATED CALCIUM PHOSPHATE FOR BONE REGENERATION

M. Sundara Ganeasan¹, K. Jayasree¹, B. Anandhan², D. Prabhu³, T. M. Sridhar^{1*}

¹Department of Analytical Chemistry, University of Madras, Guindy Campus, Chennai-25.

²Department of Genetics, University of Madras, IBMS Campus, Chennai-113.

³Department of Microbiology, University of Madras, IBMS Campus, Chennai-113.

Email: *tmsridhar23@gmail.com

Abstract

Nowadays the bone related defects such as bone cyst, fibrous dysplasia and dental implants etc requires perfect restoration and regeneration by using Autogenous bone graft. As they provide tissue compatibility, osteoconduction, osteoinduction, and osteogenesis. Inspite of these advantages, they have limitations towards bone substitutes because of poor biodegradation, Immune rejection etc. Calcium phosphates has been used as scaffolds because of their structure and composition which is similar to that of bone β -Tricalcium phosphate (β -TCP) is a promising material because of its bioactivity, biocompatibility, ease of sterilization, and extended shelf life. β -TCP can build a resorbable interlocking chain in the defect site to faster bone healing. Graphene based materials finds a great interest on various fields especially in bone regeneration and drug delivery. Graphene oxide (GO), prepared by oxidation of graphite, is a two-dimensional carbon-based nanomaterial with many hydrophilic functional groups. The aim is to prepare a β -Tricalcium Phosphate-Graphene Oxide composite which could enhance the mechanical property of the β -TCP and favours significant increase in bone formation. The prepared composite has been evaluated by using FTIR, XRD while its invitro calcifications studies by immersing in Stimulated Body Fluid (SBF) for a span of 14 days and degradation behavior in Tris-HCL Buffer for 7 days. The significant weight change and pH change has been monitored continuously.

Key words: GO, TCP, Invitro Studies, SBF.

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EVALUATION OF n-Zn DOPED n-HAp/n- β TCP POLYMER COMPOSITE FOR BONE TISSUE ENGINEERING

K. Kala¹, V. Balasubramani², K.M. Veerabadran³, K. Amala¹, T. M. Sridhar^{2*}

¹Department of Biotechnology, St. Peter's University, Avadi, Chennai- 600054

²Department of Analytical Chemistry, University of Madras, Guindy Campus, Chennai – 600025

³ Dept. of Chemistry, MIT campus, Anna University, Chennai-600025

*Corresponding Author- tmsridhar23@gmail.com

Abstract

Bioactive nano hydroxyapatite and bioresorbable nano β -Tricalcium phosphate can be used as composite form for synthesis of bone scaffold and used to replace the damaged bone. Incorporation of ions such as Zinc shows the stimulatory effects on bone formation. This type of synthetic polymeric scaffold possesses the unique properties and have good biocompatibility when used for the bone replacement. Reports confirms that Osteogenesis of osteoblasts can be accelerated by n-Zn ion. Since, n-Zn ion can increase the alkaline phosphatase (ALP) activity and DNA content of the bone cells. The current study focusing on the synthesis of composites such as n-HAp/n- β TCP through wet chemical precipitation method using the polymers poly ethylene glycol (PEG). This composite has been compared with the n-Zn doped n-HAp/n- β TCP as n-Zn have an ionic radius of about 0.075nm, it can easily take up by substitution in the apatite structure in biologically active n-HAp. The evaluation of n-Zn doped composite such as n-Zn n-HAp/n- β TCP/PEG was done by analysing its structure through XRD and FESEM and determining its biocompatibility using biochemical parameters such as alkaline phosphatase assay (ALP), cytotoxicity assay (MTT), antioxidant property (DPPH) and antimicrobial study. Osteoblast cell line MG63 was chosen for the evaluation study. This report helps to conclude that the n-Zn doped composites n-HAp/n- β TCP/PEG has good biological property. The antibacterial property is found to be good against the common bone affecting bacteria *Staphylococcus aureus*. The DPPH study conclude that the n-Zn doped composite have good interaction with cell surrounding and have the ability to encapsulate the free radical which is undesirable and response for the cancerous cell development. Hence, the doped composite in scaffold preparation can be used as an effective material for both normal patients and good to use in cancerous patient.

Key words: n-Zn n-HAp/n- β TCP/PEG, MTT, DPPH, ALP.

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PRE-CLINICAL EFFICACY STUDY OF AN ARTIFICIAL SKIN SUBSTITUTE IN A SECOND DEGREE SWINE BURN INJURY MODEL

Amit Khurana^{1,2*}, Anil Kumar Banothu², Kala Kumar Bharani², Veena Kou¹

¹*Centre for Biomedical Engineering (CBME),*

Indian Institute of Technology (IIT), Delhi-110016, India.

²*Department of Veterinary Pharmacology and Toxicology,*

College of Veterinary Science, PVNRTVU, Rajendranagar, Hyderabad, Telangana, India.

*Corresponding Author E-mail: ak3.khurana@gmail.com

Abstract

Burn induced injuries are complex and may pose serious threat to health due to various clinical difficulties in evaluation and therapeutics. Burn injuries may range from superficial injury to epidermis to deep burn wounds with heavy skin necrosis rendering the lives of patients in grave danger. Furthermore, over half of skin wounds become infected, which is a major limiting factor for recovery, especially after severe burns. Burn injuries not only leave scar on the injury site leaving the skin disfigured but often lead to prolonged psychological stress, lifelong disabilities and high rate of mortality. In a global epidemiological study of 2017 it was reported that there were 8991468 new fire, heat and hot substance injuries with 120632 deaths. The current study was carried out to study the efficacy of a bio-inspired bi-layered polymeric hybrid artificial skin substitute. The radiation sterilized optimized foam based gelatin/hyaluronic acid/chondroitin sulphate (G-HA-CS) porous nanofibrous scaffold was studied for efficacy in a swine second degree burn injury model. The results were compared to the marketed artificial skin substitute Integra™.

SILK HYDROGEL FUNCTIONALIZED WITH HUMAN DECELLULARIZED WHARTON'S JELLY MATRIX AS A MINIMALLY INVASIVE INJECTABLE HYDROGEL FOR NUCLEUS PULPOSUS TISSUE ENGINEERING

Bibhas K. Bhunia1, Souradeep Dey2, Ashutosh Bandyopadhyay1 and Biman B. Mandal1,2,*

1*Biomaterial and Tissue Engineering Laboratory, Department of Biosciences and Bioengineering,
Indian Institute of Technology Guwahati, Guwahati – 781 039, India*

2*Centre for Nanotechnology, Indian Institute of Technology Guwahati, Guwahati – 781 039, India*

*Author for correspondence: biman.mandal@iitg.ac.in, mandal.biman@gmail.com

Abstract

Low back pain (LBP) is becoming a leading cause of disability nowadays, affecting ~80 % of adults worldwide and imposes a severe socio-economic burden on society and family. The intervertebral disc (IVD) bonds two adjacent vertebrae and acts as a shock absorber transmitting and distributing the spinal column's load. IVD consists of two anatomically distinct parts; the multilamellar fibrocartilaginous annulus fibrosus (AF) confining a central highly hydrophilic proteoglycan and collagen-rich gelatinous nucleus pulposus (NP). In a healthy IVD, the NP maintains the hydrostatic pressure inside the disc and distributes the loads to the surrounding AF tissue. It is believed that the early stages of degeneration mainly start from the NP; hence restoration of it may be an ideal step towards IDD treatment.

PRE-CLINICAL EVALUATION OF A ACCELLULAR BIO-POLYMERIC BASED ARTIFICIAL SKIN FOR SECOND DEGREE BURN WOUNDS AND TRAUMA CARE – ITS SAFETY AND EFFICACY STUDIES

Thanusha A. VI,2., Veena Koul1,2,*

1Centre for Biomedical Engineering, Indian Institute of Technology Delhi, India

2Biomedical Engineering Unit, All India Institute of Medical Sciences, New Delhi, India

Email: veenak_iitd@yahoo.com

Abstract

Development of artificial skin or skin substitute from biopolymers will ease the requirements for donor skin autograft and plays an effective role in the treatment of 2nd degree burn wounds. In the present work, an artificial skin was fabricated using gelatin, chondroitin-6-sulfate and hyaluronic acid which is porous, scalable and effective in treating the partial thickness second degree burn wounds. The novelty of the research work lies in the process of fabrication of the artificial skin with one side porous and other side nonporous by performing controlled crosslinking, an effective role in releasing the components in a precise fashion into the medium and also maintains the scaffold structure intact in providing clues for the healing of burn wounds. The porous scaffold was crosslinked using EDC and sterilized at 2.5M rad gamma sterilization and characterized physico-chemically I.e., morphology, tensile strength, Attenuated total reflection Fourier transform infrared analysis (ATR-FTIR), Differential Scanning Calorimetry (DSC) and Thermogravimetric analysis (TGA). Later the fabricated artificial skin was evaluated by means of biocompatibility via Skin sensitization test, Acute systemic toxicity test, Implantation study, Intracutaneous reactivity test, In vitro cytotoxicity test and Bacterial reverse mutation test by *E. coli* using ISO-10993-11 medical device rules and standards and showed the developed artificial skin is safe to use without any toxic effects. In vivo-efficacy of the artificial skin was evaluated on Wistar rats in 7,14,21 and 28 days for the treatment of partial-thickness second degree burn wounds. Wound contraction assay, Hematological analysis, wound healing markers like hydroxyproline, hexosamine, IL-1 α , TNF- α and C3a and histopathology studies on Wistar rats proved that the developed artificial skin effectively helped in healing of second degree burn wounds in 28 days compared with sham and commercially available skin substitute like Integra®. The acquired result demonstrated that the artificial skin has a potential for clinical settings in second degree burn wounds treatment 2

Keywords: Artificial skin; Biocompatibility; ISO-10993 Standards; Second-degree burn wounds;

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PERIOSTEUM MIMICKING TISSUE ENGINEERED COMPOSITE FOR TREATING PERIOSTEUM DAMAGE IN CRITICAL-SIZED BONE DEFECTS

Sneha Gupta¹, Arun Kumar Teotia¹, Parvaiz Shiekh¹, Irfan Qayoom¹, Ashok Kumar^{1,2,3,*}

1Department of Biological Science and Bioengineering; 2Centre for Environmental Sciences and Engineering and 3Centre for Nanosciences, Indian Institute of Technology Kanpur,

Kanpur-208016, UP, India

*E-mail: ashokkum@iitk.ac.in

Abstract

Periosteum is the outer membranous envelope of the bone that nourishes the cortical bone and acts as a reservoir of osteoprogenitor cells. It plays an indispensable role in bone regeneration and defect healing. Periosteal damage mainly occurs as a result of traumatic injuries, infections or for surgical assistance in bone surgeries. The loss of which often leads to high incidence of delayed bone union or non-unions compounded with severe pain exposing the bone to the risk of second fracture. Although cell sheet engineering, autologous transplantation, intestine sub-mucosa etc. have been used as a periosteal substitute, yet problem in the exogenous cell survival, risk of viral infections etc. limits their efficacy in clinical translation. Therefore bioengineered functional periosteal substitute poses promising strategy to overcome the above limitation leading to enhanced periosteal regeneration augmenting the bone healing. Herein we have developed a periosteum structure mimicking double layered membrane, which consists of oxygen releasing electro-spun ascorbic acid containing polyurethane on a collagen membrane. These scaffolds are elastic in nature with oxygen releasing ability. The scaffold supported the survival of periosteal cells in an in-vitro reactive oxygen species induced model and were able to recruit cells in wound scratch model. The periosteal regeneration was observed when the scaffold was used along with the functionalized composite bone substitute in a rat tibial uni-cortical drill model (5.9 x 3.2 x 1.50 mm³) accounting to extensive periosteal stripping, as confirmed by expression of periosteum specific markers like periostin and neuronal regulation related protein. Moreover we also observed a significant improvement in bone formation as compared to the control group validated through micro computed tomography (micro-CT) and histological analysis. Hence, our study demonstrate the fabrication and development of periosteal mimicking scaffold with favourable application for periosteal reconstructive applications further mimicking natural bone formation.

Keywords: Periosteum, Antioxidant, Periostin, Electrospraying

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EFFECT OF FUEL/OXIDANT RATIO ON THE COMBUSTION SYNTHESIS OF MONTICELLITE AND ITS BIOMEDICAL APPLICATIONS

*Naveen subramaniam Vijayakumari¹, Senthilkumar Venkataraman, Ravindran Nandhakumar,
Sasikumar Swamiyappan^{2,*}*

*Department of Chemistry, School of Advanced Sciences, Vellore Institute of Technology, Vellore-
632014, Tamil Nadu, India.*

*Corresponding Author E-mail: ssasikumar@vit.ac.in

Abstract

The current work focuses with monticellite (CaMgSiO_4) prepared by utilizing the combustion assisted sol-gel technique using citric acid as fuel with heat treatment of 1200°C for 6hrs. The effect of fuel/oxidant ratio on crystallite size, phase evolution and in-vitro bioactivity of monticellite were investigated. Invitro bioactivity of the materials were examined by immersing the scaffolds in SBF fluid. The evolution of apatite layer on the scaffold's surface were characterized and affirmed using XRD, FT-IR and SEM-EDX techniques. The results divulged that the monticellite obtained from citric acid showed good bioactive behavior on exposing it to body fluid.

Keywords: Monticellite; bioactivity; scaffolds; apatite.

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COMBINED CA₂₊ AND PO₄³⁻ ADDITIONS IN ALUMINA ZIRCONIA COMPOSITE FOR ORTHOPEDIC APPLICATIONS: STRUCTURAL, MECHANICAL AND BIO-MINERALIZATION ANALYSISV. Ponnilavan¹, S. Kannan^{2*}*Centre for Nanoscience and Technology,**Pondicherry University, Puducherry-605 014, INDIA*

Corresponding Author E-mail : para_kanna@yahoo.com

Abstract

The impact of Ca₂₊ and PO₄³⁻ additions on structural, mechanical and biominerization features of alumina zirconia composite (AZC) for orthopedic applications is presented. In situ sol-gel synthetic approach was used for the powder synthesis. A different amount of Ca₂₊ and PO₄³⁻ were added to the equimolar concentrations of Al³⁺ and Zr⁴⁺ precursors to obtain five different AZC compositions. Phase behavior and functional group analysis of the synthesized materials were determined using X-ray diffraction and FT-IR spectroscopy. *In vitro* apatite forming ability of the resultant materials were determined through immersion tests in simulated body fluid (SBF). XRD results witnessed the unique crystallization of tetragonal zirconia (*t*-ZrO₂) at 1100 °C while Ca₂₊, PO₄³⁻ and Al₂O₃ retained their amorphous state in the system. Further heat treatment induced the crystallization of \square -Al₂O₃ at 1200 °C, which enforced *t*- \square *m*-ZrO₂ transformation while Ca₂₊ and PO₄³⁻ still retained their amorphous state. The immersion tests in SBF solution validated the enhanced bio-mineralization activity of AZC due to Ca₂₊ and PO₄³⁻ additions. The results from the indentation tests demonstrated good uniformity in the elastic modulus and hardness data of the investigated specimens. Further, *in vitro* cell culture tests ascertained the bioactivity of all the AZC compositions.

Key words: Biominerization; Zirconia; Alumina; Calcium; Phosphate.**References**

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BIOENGINEERED APATITIC NANOCARBON COMPOSITE 3D POROUS SCAFFOLDS FOR HARD TISSUE MENDING

M. Ramadas and A. M. Ballamurugan*

Department of Nanoscience and Technology, Bharathiar University,

Coimbatore, Tamil Nadu, Pin: 641 046, India, Fax: +91 4422 2425706.

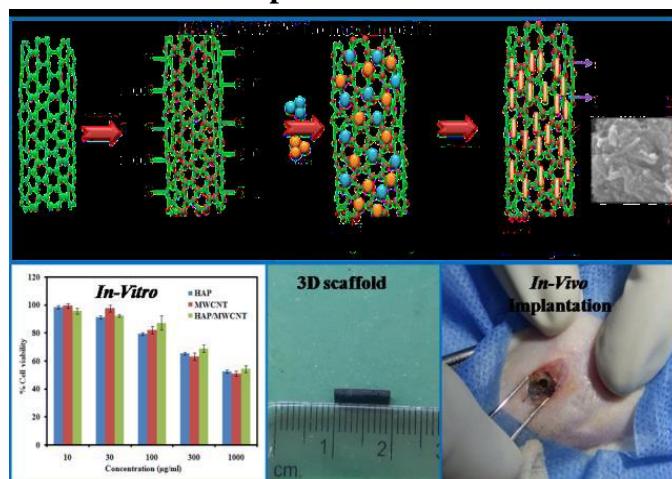
*Corresponding Author E-mail:-balamurugan@buc.edu.in; Phone: +91 9443871751

Abstract

The three-dimensional HAP/f-CNT nanocomposite scaffolds for hard tissue mending were developed. For the engineering of the 3D scaffolds f-CNT based apatite nanocomposite was synthesized by hydrothermal technique, the designing of the scaffolds were made by adapting a suitable casting formulation. Further, the developed sacrificial templates were tested for its biocompatibility and strength by using suitable analytical tools. The *in vitro* MG63 cell line studies were conducted to obtain the growth rate of cells. The *in vivo* studies were conducted in country rabbits as animal models as per the ethical guidelines and standard surgical procedure. The obtained results from the above mentioned tests reveals that the developed scaffolds are suitable for tissue engineering applications.

Keywords: Carbon nanotube; Hydroxyapatite; Scaffold; Biocompatibility.

Graphical abstract



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MATRIX DEPENDENT CHIRAL ORIENTATION OF UMBILICAL CORD DERIVED MESENCHYMAL STEM CELLS

Ankita Das¹, Shreya Adhikary¹, Amit Roy Chowdhury^{1,2}, Ananya Barui^{1*}

¹Centre for Healthcare Science and Technology, IEST, Shibpur

²Department of Aerospace and Applied Mechanics, IEST, Shibpur

* E-mail: ananya.pariksha@gmail.com

Abstract

Stem cell chirality is an essential attribute observed during tissue regeneration and organogenesis. Cell orientation being one of the major contributing parameter defining chirality, it can be manipulated with the help of biophysical cues. Despite remarkable progress in tissue engineering, development of cellular chirality in stem cells has been largely unexplored. In this study, we demonstrate the role of matrix stiffness on chirality of cultured umbilical cord derived mesenchymal stem cells (MSC). Our observation was that MSC acquired higher chirality or asymmetry when cultured on PCL matrices of different stiffness. Apart from cell orientation, different parameters like actin fiber orientation, aspect ratio and intensity of polarized proteins (Par) were also investigated. The results show significant ($p<0.05$) difference in average orientation angle, cellular aspect ratio, the intensity of actin and Par proteins in MSC cultured on 2% and 10% PCL matrices. Gaussian SVM was applied to classify cells cultured on these matrices with an accuracy of 91.34%. The present study aims to interrelate and quantify cellular chirality with matrix properties using an image based quantitative approach.

Keywords: Umbilical cord derived mesenchymal stem cells, Matrix stiffness, Cell orientation, Polarity proteins

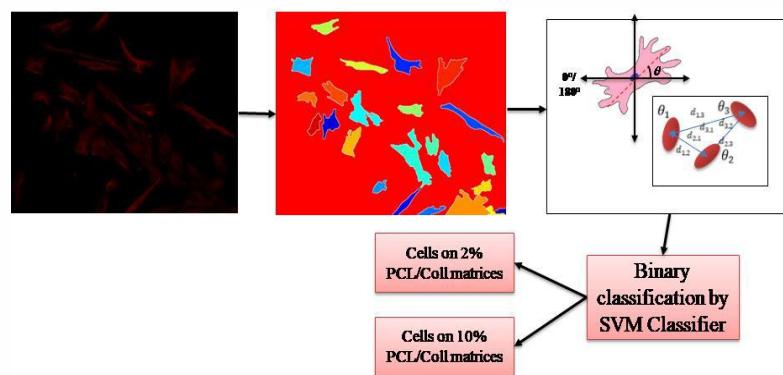


Figure represents an overall workflow of the quantification method applied in our study. Fluorescence image was processed and cell orientation angle was estimated along with other parameters related to cellular chirality and finally classified on the basis of matrix stiffness.

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FERULIC ACID INCORPORATED ALGINATE DIALDEHYDE-GELATIN HYDROGEL: A POTENTIAL WOUND HEALING MATERIAL

Anjali S.1, Rajaleskshmi Resmi2, Ramakrishna Perumal Saravana2,

Roy Joseph2 and Mini Saraswathy1*

1Department of Biochemistry, University of Kerala, Kariavattom,

Thiruvananthapuram- 695581, Kerala, India

2Division of Polymeric Medical Devices, Biomedical Technology Wing, Sree Chitra Tirunal

Institute for Medical Sciences and Technology, Trivandrum, Kerala, India

*Corresponding Author E-mail: minisarswathy@gmail.com

Abstract

Wound healing is a dynamic and complicated process and to happen it effectively, it requires an appropriate biological environment. An ideal wound dressing must act as a protective barrier over the wound area and shall facilitate the healing process. Among the currently available wound dressing materials hydrogels have prime importance. This is because they have the ability to provide a moist environment at the wound area, to act as a barrier from infections, the ability to absorb wound exudates, etc. which in turn facilitate tissue regeneration and the wound healing process. The present work aimed to study the influence of ferulic acid (FA), a phytochemical, in wound healing when it was incorporated in a hydrogel matrix. FA is a natural antioxidant found in fruits and vegetables and it was incorporated in a hydrogel made of Alginic acid (ADA) and Gelatin (G). FA incorporated film was investigated for its physicochemical and biological properties. A peak at 1273cm^{-1} , observed in Raman spectra, that belongs to -OH group of FA, indicated the incorporation of FA in the hydrogel. Surface morphology of the lyophilized hydrogel films, observed under Scanning electron microscopy, indicated the dispersion of FA into the ADA-Gelatin hydrogel. The water absorption studies of FA incorporated hydrogel showed that the hydrogel swelled to an extend $345\pm20\%$. The water vapour transmission rate of hydrogel film was $1170\pm78 \text{ g/m}^2/\text{day}$, which was appropriate for moderately exuding wounds. The FA incorporation did not improve the mechanical properties of ADA-Gelatin hydrogel. The films had tensile strength and elongation at break $61\pm4 \text{ MPa}$ and $52\pm8\%$, respectively, when it was tested dry. The tensile strength and elongation at break dropped to $1.37\pm0.09 \text{ MPa}$ and $505\pm3\%$, respectively, when it was tested in wet condition. Cytocompatibility evaluation of the hydrogel films were carried out with L929 fibroblast cells. The presence of FA in the hydrogel film promoted the proliferation and migration of the cells. In vitro scratch wound assay, observed under inverted phase contrast microscope, and showed a significant increase in wound closure rate. In view of its acceptable water absorption capacity, mechanical properties, water vapour transmission rate and biocompatibility, the FA incorporated ADA-G hydrogel could be considered as a potential candidate for wound healing applications.

Keywords: Phytochemical; Ferulic acid; Alginic acid-Gelatin hydrogel; Wound healing.

**INVESTIGATING THE STRUCTURAL, BIOCOMPATIBILITY AND
MAGNETIC RESONANCE IMAGING CHARACTERISTICS OF
GADOLINIUM SUBSTITUTED STRONTIUM PHOSPHOSILICATE
FOR ORTHOPAEDIC APPLICATIONS**

Chetan¹ and U. Vijayalakshmi^{1*}

1 Department of Chemistry, School of Advanced Sciences,

Vellore Institute of Technology, Vellore, Tamil Nadu, India

*1Email: chetan@vit.ac.in; *Email: vijayalakshmi.u@vit.ac.in*

Abstract

Bone defects and related ailments have long been addressed by use of synthetic substituents as a part of tissue regeneration process. Mostly Calcium phosphate ceramics have been deployed as bioactive substitutes, fillers, cements, etc but complex demands of bone regeneration has led to researchers search new substitutes for the same. Strontium phosphosilicate is one such apatite that trumps contemporary HAP with presence of Strontium and Silica in its native structure. Needless to say, presence of both these components has long been investigated in bone tissue regeneration studies and time and again has provided evidence of positive stimulation in bone growth and remodelling process. The ability of Strontium to mimic Calcium in metabolic pathway and bind to sites designated for Calcium rules out the necessity of Calcium phosphate-based ceramics. Moreover, the presence of calcium at damage site in form of degradation products favours the use of Strontium phosphosilicate.

BIOENGINEERED LIVER MODEL EXHIBITING METABOLIC HETEROGENEITY RECAPITULATING NATIVE-LIKE ZONATION

G. Janani¹, Biman B. Mandal^{1,2,*}

¹Department of Biosciences and Bioengineering, Indian Institute of Technology Guwahati, Guwahati-781039, Assam-India,

²Centre for Nanotechnology, Indian Institute of Technology Guwahati, Guwahati-781039, Assam-India,

1Email:janani1892@gmail.com; *Email: biman.mandal@iitg.ac.in

Abstract

Acute or fulminant hepatic failure (FHF) is a severe life-threatening clinical condition, where liver functions and self-regenerative ability deteriorate, affecting one-third of the total world population with an 80% mortality rate worldwide. Orthotopic Liver Transplant, a standard therapy for FHF, is limited due to organ shortage, immunosuppressant, and secondary complications, thus resulting in 50 million deaths annually, as stated by World Health Organization. Alternative therapies like artificial liver support systems, bioartificial liver (BAL), cell transplantation, and tissue engineering are under investigation to aid in liver regeneration by convalescing the damaged liver. Three-dimensional (3D) *in vitro* functional hepatocyte constructs that emphasize the microenvironmental niche, cell-cell interactions, and cell-matrix interactions of native liver deliver a potential platform for advancements in the cellular components of Bioartificial liver (BAL), cell transplantation, implantable constructs, and *in vitro* models for high-throughput drug screening platform. Liver zonation, a distinct metabolic gradient of hepatocytes, is often not wholly focused while designing and fabricating an *in vitro* liver system. A unique microenvironment with regulated mechanical stability supporting varied cell-matrix interaction is crucial to accomplish native liver zonation. Aiming to develop an *in vitro* liver model system resembling liver zonation, for the first time, we have shown that perfusion bioreactor culture of functionalized silk scaffolds with lineage-specific liver extracellular matrix (ECM) could mimic the oxygen gradient and facilitate metabolic heterogeneity in hepatocytes. In this context, a three-dimensional porous liver ECM blend silk scaffolds were fabricated by blending liver ECM with silk fibroin (*Bombyx mori* and *Antheraea assamensis*) at different ratios.

NANOCOMPOSITE- BASED CONDUCTING ARTIFICIAL NERVE CONDUIT FOR PERIPHERAL NERVE REGENERATION

Mamatha M. Pillai^{1†}, Shadi Houshyar², G. Sathish Kumar³, Rajiv Padhye²,
Amitava Bhattacharyya^{3*}

¹ *Tissue Engineering Laboratory, PSG Institute of Advanced Studies, Coimbatore, India*

[†] *Present address: Department of Biosciences and Bioengineering, IIT Bombay, India*

² *Centre for Materials Innovation and Future Fashion, College of Design and Social Context, RMIT University, Victoria, Australia*

³ *Functional, Innovative and Smart Textiles, PSG Institute of Advanced Studies, Coimbatore 641004,*

1Email: mmpillai1@gmail.com; *Email: amitbha1912@gmail.com

Abstract

Peripheral nerve injury is a challenging issue which has complications such as neurotmesis and axonotmesis which leads to complete degeneration of the damaged nerve. Annually around 25 lakhs damaged peripheral nerve repair surgery occurs in the US alone. Conventionally used treatment methods are replacing the damaged nerve tissue using an autograft or a nerve conduit. The availability of autografts is limited in number and also reported to be associated with complications such as immune suppression and sensory loss. Even though nerve conduits are commercially available, the main limitations are that they do not possess any haptotaxis, chemotaxis, contact guidance, conductivity, insufficient neurotrophic support and the functional repair can attain within a critical limit of 15mm. To address these limitations in this study have developed a biodegradable and conducting artificial nerve conduit (ANC) for the regeneration of a gap upto 2 cm. In this study we have developed artificial nerve conduit with an inner core and outer wall. Three different inner core structures we have developed to understand the structural effects on nerve tissue regeneration. The structures developed were knitted (KS), twisted (TS) and braided (BS). For this, raw silk threads were purchased from local dealers, Mettupalayam, Tamilnadu India. These silk threads were subjected to degumming using 0.5% sodium bicarbonate to remove the sericin. Finally, single threads of silk fibroin (SF) was then subjected to coating with poly caprolactone (PCL)- carbon nanofibers (CNF) nanocomposite using an in house-built setup. Three different concentrations of CNF were used for coating such as 5%, 7.5% and 10% (Figure 1). The outer wall structure was developed using SF-polyvinyl alcohol (PVA) film. The concentration of SF-PVA was optimized in our previous study. Briefly, *Bombyx mori* cocoon was subjected to degumming and dissolved in Ajisawa's reagent. Followed by dialysis and concentration of the SF protein. Further 3:1 SF:PVA was used to develop films using pour plate method (Figure 1). The physical and biological characterization of inner core and outer wall was performed.

CHARACTERIZATION AND MECHANICAL EVALUATION OF SF/SILICA/PVA LAYER BY LAYER NANOFIBERS FOR THE ENHANCEMENT OF BONE REGENERATION

M. Rama¹, T. M. Sridhar², Dr. U. Vijayalakshmi^{1*}

¹Department of Chemistry, School of Advanced Sciences, VIT, Vellore – 632 014.

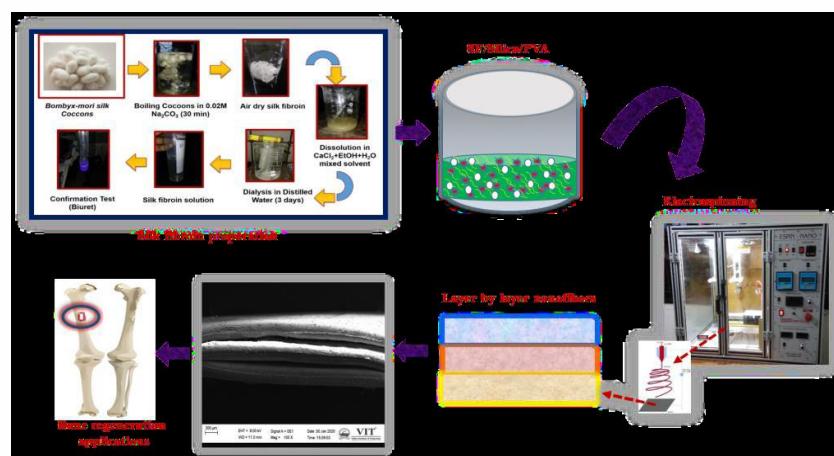
²Department of Analytical Chemistry, University of Madras, Chennai 600025.

E-mail: vijayalakshmi.u@vit.ac.in and lakesminat@yahoo.com

Abstract

Bone tissue engineering focused on designing regenerative nanofibrous scaffolds to provide a natural extracellular matrix (ECM) microenvironment including the incorporation of cell proliferation, biodegradation, swelling ratio, and bioactivity. Even the mechanical properties and orientation of the nanofibers may affect the scaffold performance. Here, we report the fabrication of Silk fibroin/Silica/PVA based layered hybrid nanofibers and the characterization of nanofibers using SEM, XRD, FTIR. Besides, Cell proliferation on osteoblast-like cell lines (MG-63) proved cytocompatibility, and the deposition of an apatite layer on nanofibers in simulated body fluid (SBF) was evaluated. The superior mechanical strength and higher biominerilization of SF/silica/PVA engineered layered nanofibers suggested the osteogenic and biocompatible which may be useful for the enhancement of bone regeneration of large bone defects.

Keywords: Silk fibroin; Layer by layer nanofiber; Electrospinning; Bone regeneration.



Graphical abstract

DEEP CONVOLUTIONAL NEURAL NETWORK FOR SKIN LESION DETECTION WITH HOG AND GLCM FEATURES

Anisha Thangakani S 1, M.Sornam 2,* Muthusubash Kavitha3

Research Scholar1, Department of computer science, University of Madras, Chennai-25

Professor*, Department of computer science, University of Madras, Chennai-25

Graduate School of advanced Science and Engineering3, Hiroshima University, Japan

E-mail: anishakani014@gmail.com1, madasamy.sornam@gmail.com2,*,

Kavitha@hiroshima-u.ac.jp3

corresponding author*

Abstract

Lesion relates to the unnatural growth of tissues in which skin lesions are most common. It may have two types: benign and malignant. Malignant tumours have the highest death rate compared to benign tumours due to their major metastases. Metastasis is nothing but the capacity to enter distant organs. There are a variety of diagnostic features to differentiate both. The most popular approach is the histological approach through which the impacted tissues are taken and examined underneath a microscope. As it is an invasive technique and the chances of spreading to other natural underlying structures, other diagnostic approaches have come into play. This work is one of them, which is a non-invasive technique and is detected by a computer vision algorithm. To determine where such a lesion is malignant or benign, the extraction feature utilizes a mixture of both the directed gradient histogram (HOG) and the Gray scale Level Co-occurrence Matrix (GLCM) functions. Which are applied to the Convolutional neural network. CNN obtained an average accuracy of 98.32 per cent on a dataset of 4100 images, which is greater than the existing method.

Keywords: Skin lesion; HOG; GLCM; CNN Classification.

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EXTRACELLULAR VESICLES MEDIATED REGENERATION OF THE ARTICULAR CARTILAGE

Aman Nikhill¹, Ashok Kumar^{1, 2,3*}

¹Department of Biological Sciences and Bioengineering, Indian Institute of Technology Kanpur, Kanpur-208016, UP, India;

²Centre for Environmental Sciences and Engineering, Indian Institute of Technology Kanpur, Kanpur-208016, UP, India;

³Centre for Nanosciences, Indian Institute of Technology Kanpur, Kanpur-208016, UP, India

*Email: ashokkum@iitk.ac.in

Abstract

Load bearing joints contain a specialized articular cartilage which have the capacity to distribute the loads efficiently to the underlying subchondral bone. But injury in the cartilage fails to heal due to its avascular, aneural and alymphatic nature of tissue. Full length defects which reach the underlying bone, termed osteochondral defects affect both cartilage and bone and disrupt the efficient loading of joints. It causes joint locking, grinding and severe pain leading to immobility. Many cells-based approaches have been clinically tested for treatment of cartilage defects. But cell therapy is prone to limitations of immune response, phenotypic drift, requirement of stringent storage conditions and clinical regulatory hurdles. Cell free therapy has attracted research interest because it can overcome the shortcomings of cell therapy. One of the key mediators under cell free therapy includes extracellular vesicles (EVs). These play important role in cell to cell communication by acting as information carriers in the form of RNA, miRNA, proteins etc. In case of articular cartilage these EVs are found in the chondrocytes, synovial fluid and chondro-progenitor cells present in the synovial joint cavity. Recent studies have highlighted the role of such vesicles in regeneration of different tissues. In case of articular cartilage, these vesicles have shown to drive differentiation of stem cells.

Also, studies have shown cell factory derived bioactive molecules with cryogel scaffold to enhance repair of cartilage in rabbit. Although in clinics, several treatments are present which include non-steroidal anti-inflammatory drugs (NSAIDs), mosaicplasty, total knee replacement (TKR). But these treatments suffer from tissue availability (autograft), immune response (allograft) and revision surgery in TKR. Hence, regenerative techniques pave an efficient alternative way for repair of cartilage.

In this work, goat articular chondrocytes have been isolated and further characterized. These cells were then checked for their biocompatibility and proliferation on different scaffolds fabricated using cryogelation technology which offer pore size of 40µm. Further, extracellular vesicles were obtained from these chondrocytes using ultra centrifugation and ultra-filtration technique and were characterized using differential light scattering (DLS), scanning electron microscopy (SEM), atomic force microscopy (AFM). These isolated vesicles were of average size range 60nm and have zeta potential of -11.2mV. Such cell free therapies are promising and crucial for efficient cartilage regeneration.

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EFFECT OF FUEL ON COMBUSTION DERIVED MERWINITE

Collin Samuel M1, Naveen Subramaniam, Senthilkumar Venkataraman, Subashree Praharaj,
Sasikumar Swamiyappan^{2,*}

*Department of Chemistry, School of Advanced Sciences,
Vellore Institute of Technology, Vellore-632014, Tamil Nadu, India.*

*Corresponding Author E-mail: ssasikumar@vit.ac.in

Abstract

The extant work deals with merwinite ($\text{Ca}_3\text{Mg}(\text{SiO}_2)_2$) been prepared using three types of fuel namely, glycine, urea and citric acid. The solution combustion assisted powders were heat treated at 900°C for 6hrs. The effect of type of fuel used for synthesis was studied using XRD that revealed the crystallite size to be in the range of 32nm to 44nm. Invitro bioactivity of the materials were done for 9 days by immersing the scaffolds in SBF. SEM-EDX investigation of the scaffolds after 9 days and XRD analysis in an interval of 3 days confirm the nucleation of hydroxyapatite (HAp) on the scaffold surface. The results revealed that merwinite obtained from glycine, urea and citric acid showed good bioactive nature in SBF solution.

Keywords: Merwinite; bioactivity; Hydroxyapatite(HAp).

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NOVEL BIO-FABRICATION MODELLING APPROACH FROM MARINE SOURCES: SYNTHESIS, CHARACTERIZATION AND ITS COMPOSITE FORMULATIONS

Gunarajulu Renganathan¹, Dheivanai R¹, Kalyani Durai¹, Suguna Lakshmi Madurai^{2*}

¹Branch of Biomedical Engineering, Anna University, Chennai, TN, India

²Polymer science and Technology Division, CSIR-Central Leather Research Institute, Chennai, TN, India

*Corresponding Author: msugunalakshmimadurai@gmail.com

Abstract

Hydroxyapatite, a bone mineral was extracted from different seashell species by hydrothermal method and investigated by SEM-EDX, FTIR, TGA, DSC, XRD and EPR analysis. Amongst, the seashell *Dallarca subrostata* was chosen for composite preparation by incorporating chitosan and silver nanoparticles which could be used as fillers and films for wound healing applications. Silver ions doped HA were examined using EPR for better biocompatibility. These findings further aim to create a patient specific implant using 3D modelling. It paves the way for the potential applications as pre-operative surgical planning procedure and better point of health care. Further the biominerals extracted would act as a source for fabrication of designs and thereafter 3D modelling for investigation. It also rectifies tissue engineering challenges faced so far.

Keywords: Hydroxyapatite, Sea shells, composite scaffold, Bone tissue engineering

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INVESTIGATING EXOSOMES AS A POTENTIAL BIOMATERIAL FOR BONE REGENERATION

Sasmita Samal^{1, 2}, Mamoni Dash^{1*}

¹Therapeutic Biomaterials Team, Institute of Life Sciences, Bhubaneswar- 751023, Odisha, India

²School of Biotechnology, Kalinga Institute of Industrial Technology, Bhubaneswar- 751024, Odisha, India

1Email: sasmitasamal19@gmail.com; *Email: mamoni.dash@ils.res.in

Abstract

A normal bone possesses a balanced remodeling sequence: first, osteoclasts resorb bone (osteoclastogenesis), and then osteoblasts form bone at the same site (osteogenesis)¹. During sequential events in a tissue, intracellular communication is an important phenomenon. Exosomes (30-200nm) are one such nano-communicator which is gaining importance due to their ability to transfer vital information such as specific proteins, mRNA, and miRNA to target cells. Exosomes released from osteoblasts tend to stimulate osteogenesis via RANKL-RANK mediated pathway, thereby promoting bone regeneration². However, the existing challenge of getting a proper isolation technique in the translational research field has led to our first set of the objective of developing a proper methodology to isolate good amount of pure exosomes from three bone lineage cell lines (i.e. MC3T3-E1, RAW264.7, and K7M2- pCI Neo) using different techniques. A comparison of the different isolation methods in terms of yield, purity, speed, etc is depicted. In the subsequent part of the work, a strategy to enhance the therapeutic potential of exosomes is attempted. Native exosomes often are unable to achieve the therapeutic target and hence need surface modification or encapsulation to get the desired dosage with minimal amount. Biodegradable scaffolds have immensely contributed to this above-mentioned idea³. We are developing such polymeric scaffolds that resemble the native extracellular matrix (ECM), and upon appropriate encapsulation-strategy enhance osteogenesis. The biocompatibility and exosome encapsulation ability of these scaffolds have been examined. Further discussion will be done on the expression of osteogenic genes (Col-1, RUNX2, VEGF, and ALP) in these constructs.

Keywords: Exosomes, bone regeneration, biomaterials.

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ZINC DECORATED HYDROXYAPATITE GRAPHENE OXIDE COMPOSITE FOR BONE REGENERATION

C.Vanitha¹, M. Sundara Ganeasan², M. Kaviya², T. M. Sridhar^{2*}, M.R. Kuppusamy^{1*}

1 Dept. of Chemistry, R.V. Govt. Arts College, Chengalpattu-603001.

2 Dept. of Analytical Chemistry, University of Madras, Guindy Campus, Chennai-600025

*Corresponding Author- tmsridhar23@gmail.com, rksamyrvg@gmail.com.

Abstract

In recent years, the bone disorder diseases are becoming very common in which hydroxyapatite (HAp) has been a promising material for the bone regeneration and repairing hard tissues. Doping with different metal ions can improve the mechanical and physiochemical properties of the hydroxyapatite. Among the different metal ions, Zinc plays a major role in the human body in which 30% of the total composition accounts in the bone tissues. Even though metal doped hydroxyapatite has many advantages, certain properties like low tensile strength; low mechanical strength etc limits its use in biomedical applications. Graphene Oxide (GO) has been a promising material in diverse applications. By the incorporations of graphene oxide along with metal doped hydroxyapatite made as a composite makes it a biocompatible material for biomaterial applications. The pure and metal doped hydroxyapatite has been synthesized by wet chemical precipitation method and graphene oxide has been prepared by using modified Hummers method. FTIR studies identify the functional groups present in the prepared composite. The immersion studies and degradation studies has been carried out for a period of 14 and 7 days respectively.

Key Words: Hydroxyapatite, Graphene oxide, Zinc, Immersion studies.

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SELECTIVITY ENHANCED DOPAMINE ELECTROCHEMICAL DETECTION ON RF MAGNETRON SPUTTERED TiO₂/SS THIN FILM

Amir H1, Ponpandian Nagamony2, and Viswanathan Chinnuswamy1,2*

aDepartment of Nanoscience and Technology, Bharathiar University,

Coimbatore 641046, Tamil Nadu, India

*E-mail address: viswanathan@buc.edu.in (C. Viswanathan)

Abstract

Dopamine (DA) is a distinguished member of catecholamine family, which plays central role among other brain neurotransmitters. This substance is released by neurons and participates in regulating human body functions and transmitting messages to target cell(s). Anomalous levels of this critical organic compound, due to its flawed biosynthesis and metabolic transformation in human body, can cause several severe diseases such as Huntington's, Parkinson's and Alzheimer's diseases, as well as schizophrenia, which require continuous medical observations. Only in 2010, more than 36 million people worldwide were suffering from dementia, expected to reach 115 million by 2050, which costs about one percent of world's gross domestic product. Therefore, unsurprisingly, many efforts have been focused toward the study of causes and treatments of these diseases. Of those efforts, measurement of DA has special place in either prevention or treatment of above-mentioned diseases. Here, we proposed a novel nanostructured electrochemical sensor based on TiO₂ for DA detection. Therefore, herein, we developed Titanium oxide (TiO₂) thin films possessing average thickness of 208 nm were deposited onto Stainless Steel (SS) substrates by a radio frequency magnetron sputtering (RFMS) technique at room temperature. X-ray diffraction (XRD) patterns of the TiO₂ thin film revealed Rutile Phase structure. Scanning electron microscopy (SEM) showed the existence of aggregated crystallites with spherical-shaped grains and compactly packed grains distributed over the film surface. The RFMS TiO₂/SS thin film electrodes resulted in Dopamine (DA) electrochemical detection at 0.1 V in pH 7 phosphate buffer solution with high sensitivity, stability, reproducibility and repeatability are achieved in this film. Significant selectivity for DA detection from the other closely related biological analytes was achieved for this film. The DA sensing was obtained resulted in appreciable sensitivity of 0.00123 $\mu\text{A} \cdot \mu\text{M}^{-1}$ for the linear range of 10–100 μM and a lowest detection limit value (LOD) of 32 nM.

AIE SCHIFF'S BASE USED AS A PROBE FOR SELECTIVE DETECTION OF HG(II) BY FLUOROMETRY AND TOXIC AND BIO-CAPABILITY IN *C. ELEGANS*

K. Ramki, and P. Sakthivel*

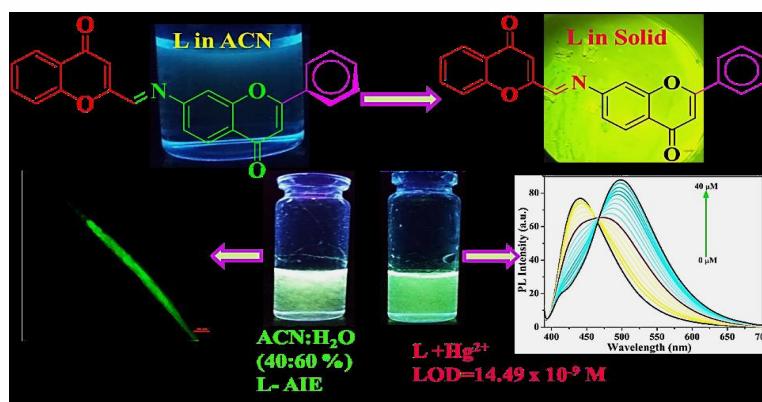
Department of Nanoscience and Technology, Bharathiar University,

Coimbatore-641 046, Tamil Nadu, India.

*Corresponding author: E-mail addresses: polysathi@gmail.com

Abstract

A new Aggregation Induced Emission (AIEgen chromone) based Schiff-base ligand (**L**) as a turn on AIEgen ratiometric chemosensor for Hg(II) metal ions based on AIE induced with chelation induced fluorescence probe (CHEF) is designed and synthesized. Eventhough, there occurs the presence of interfering metal ions the probe **L** have good selectivity and high sensitivity in the detection of Hg(II) metal ions. The detection limit of **L** towards Hg(II) ion probe is nearly 14.49×10^{-9} M. Additionally, the ratiometric emission intensity of **L-Hg(II)** complex at 498 nm to increase 1-fold from free L ligand in the presence of 1 eq. of Hg(II) metal ion, which is credited to CHEF with inhibition of PET phenomenon and isomerization process (-C=N) at the excited state. The probe **L** turn on ratiometric fluorescence response to Hg(II) is fast with good recovery (RSD=2.25). The **L** ligand applied to fluorescent image in living nematode (*Nemathelminthes*) worm, age synchronized young stage-L4 *C. elegans* is exposed to **L** ligand (100 μ M) mixed with medium for 24h. After treatment, *C. elegans* were obtained without any damage in anatomy and also free ligand **L** apply for bio-imaging in nematode worm with no toxic and good bio-capability. Therefore, **L** AIEgen could be applied for monitoring Hg(II) in environmental systems and bio-capability analysis with Hg(II) sensing in animals.



Graphical Abstract

Keywords: Aggregation Induced Emission, bio-capability, nematode, Schiff-base

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CDS MODIFIED GLASSY CARBON ELECTRODE AS AN ELECTROCHEMICAL NONENZYAMATIC OXALIC ACID SENSOR

R. Murugan, A. Rebekah, J. A. Allen, C. Viswanathan, N. Ponpandian*

Department of Nanoscience and Technology, Bharathiar University,

Coimbatore 641046, India

Email:murugangopal986@gmail.com

Abstract

Higher levels of oxalic acid (OA) in the food product leads to digestive problems and urinary tract infections which requires an efficient tool to sense the level accurately. The present work demonstrates the fabrication of CdS nanoparticles attained by hydrothermal process. The prepared CdS nanoparticles were characterized by using X-ray diffraction (XRD), Field emission scanning electron microscopy (FESEM) and Energy-dispersive X-ray spectroscopy. The electrocatalytic activity of OA on CdS nanoparticles modified GCE was investigated using cyclic voltammetry (CV) and amperometry techniques. The modified GCE showed good response towards oxalic acid. Amperometry study showed a linear relationship to the OA concentration of 50 – 900 μM in 0.1 M PBS (pH7). Moreover, CdS/GCE exhibited very good selectivity towards oxalic acid compared with other analyzes like glucose, urea, ascorbic acid and gallic acid.

AN ENVIRONMENT-FRIENDLY ROUTE TO EXPLORE THE CARBON QUANTUM DOTS DERIVED FROM CURRY BERRIES (MURRAYAKOENIGII L) AS A FLUORESCENT BIOSENSOR FOR DETECTING THE THIAMINE

M. Preethi¹, C. Viswanathan², N. Ponpandian^{1*}.

*Department of Nanoscience and Technology,
Bharathiar University, Coimbatore- 641046, India.*

*Corresponding Author: ponpandian@buc.edu.in; Tel.: +91-422-2428421

Abstract

Recently, carbon quantum dots (CQDs) in bio/analytic research are an exciting fluorescence method due to its unique characteristics. Here we report a direct organic and relatively cheap process for fluorescent CQDs was developed for selective thiamine (vitamin B1) detection through ultrasonication treatment of the green plant, curryberries(Murrayakoenigii) for the first time with our knowledge. The functional group of the CQDs, their morphology, and their photoluminescence properties were explored. In this framework, owing to the existence of thiamine arising from the non-fluorescent combination between CQDs and thiamine, the fluorescent CQDs were quenched. Under certain conditions, the fluorescent intensity was gradually decreased with the concentration of thiamine in the different concentrations of 0-0.40 μ M, as well as the limit of detection, which was 0.04 μ M, which shows that the synthesized CQDs can be used effectively as a vitamin B1 sensor.

Keywords: Green extraction of CQDs; Curryberries; Ultrasonication technique; Detection of Thiamine.

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PALLADIUM NANOPARTICLES DECORATED NI-MOF COMPOSITE AS AN ELECTROCHEMICAL PLATFORM FOR THE SELECTIVE DETECTION OF DOPAMINE

K.V. Kavya, Dhanaprabhu Pattappan, Stella Vargheese, Yuvaraj Haldorai*

Department of Nanoscience and Technology, Bharathiar University,
Coimbatore 641046, Tamilnadu, India

*Corresponding Author Email: yuvaraj@buc.edu.in; Ph: +91-422-2428430

Abstract

Neurotransmitter dopamine (DA) belongs to the catecholamine family plays an important role in the mammalian central nervous system. Even small changes in DA concentration in the brain causes several diseases. Therefore, it is important to monitor the DA concentration in biological systems. In the current study, we successfully prepared an electrochemical sensor using palladium nanoparticles decorated nickel-based metal-organic framework Pd@Ni-MOF composite for the detection of DA. The electrochemical sensing performance of the Pd@Ni-MOF composite was characterized by cyclic voltammetry (CV) and amperometry. The CV analysis proved that the glassy carbon electrode modified with the Pd@Ni-MOF composite showed good electrocatalytic activity toward DA oxidation. The amperometric response of the composite electrode showed a linear DA concentration range of 1 - 500 μ M with a detection limit of 10 nM. The modified electrode had high sensitivity, excellent reproducibility, and good selectivity. The sensor showed good recoveries (98-101.5%) of DA in the real urine samples.

Keywords: Metal-organic framework; Palladium, Dopamine; Electrochemical sensor

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FUZZY LOGIC AND CONVOLUTIONAL NEURAL NETWORK TO IDENTIFY THE TOMATO DISEASES

L.Vijayalakshmi 1, Dr. M.Sornam2*

Department of Computer Science1, University of Madras1, Guindy1, Chennai1, India1

Department of Computer Science2, University of Madras2, Guindy2, Chennai2, India2

*Corresponding Author E-mail: madasamy.sornam@gmail.com

Abstract

In our society one of the major problems in agriculture sector is plants diseases. The common plant diseases can be caused by various factors such as viruses, bacteria, fungus etc. Normally Most of the farmers are unaware of such diseases. So, the detection of various diseases of plants is very essential to prevent the damages. In this research work aimed to classify and detect the plant's diseases automatically for particularly for the tomato plant disease. To classify the tomato disease in plants, the Resnet CNN model has been used in this work. The segmentation is done for tomato and its leaves using fuzzy c-means clustering algorithm. The Convolutional Neural Network architecture is used to manipulate the raw input images which are used to predict the type of tomato diseases. As the result, few diseases that usually occur in tomato plants such as Late blight, Gray spot and bacterial canker are detected. Using proposed method an accuracy of 97.01% achieved which is much better than other state of art methods.

Keywords: Fuzzy c-means clustering, Image processing, Convolutional neural network.

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COLORIMETRIC DETERMINATION OF HYDROGEN PEROXIDE BY WS₂ NANOSHEETS/RGO NANOCOMPOSITE – AS A PEROXIDASE MIMIC

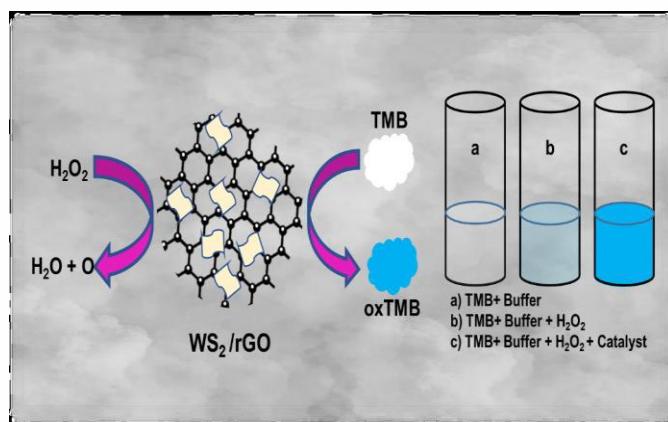
S. Keerthana, A. Rajapriya, C. Viswanathan and N. Ponpandian*

Department of Nanoscience and Technology, Bharathiar University, Coimbatore-641 046, India

*E-mail: ponpandian@buc.edu.in

Abstract

Hydrogen peroxide used in biological, pharmaceutical, clinical, food, chemical, and environmental processes became an interesting subject for research. For that, hydrothermal process was used to prepare the WS₂ on rGO sheets for peroxide mimic sensing. The structural and morphological studies were performed by using XRD, Raman and FESEM analysis. The catalytic activity was examined by using 3, 3',5,5'tetramethylbenzidine (TMB) as a substrate. The catalytic oxidation of TMB and reduction of H₂O₂ occurs simultaneously which examined using UV- Visible spectroscopic analysis. The results confirm that WS₂/rGO displayed peroxidase-like activity and catalyzed the oxidation of TMB in the presence of H₂O₂. This results in the formation of a blue colored product with an absorption maximum at 652 nm and this can readily be detected with bare eyes. The effects of experimental parameters including pH and concentration of TMB on catalytic activity of WS₂/rGO were investigated. The increase of absorbance induced by the catalytic effect of WS₂/rGO offers accurate detection of H₂O₂ in the range of 0.01 – 100 mM. Kinetics of catalytic behavior of the nanocomposites were studied by the Michaelis-Menten constant.



Keywords: WS₂/rGO; Peroxidase; Colorimetric; Hydrogen peroxide.

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SYNTHESIS AND CHARACTERIZATION OF N,N-DIMETHYLCURCUMINOID BASED BIOSENSOR FOR THE DETECTION OF BENZOIC ACID

N. Sudha¹, Dr.R.Surendran²

¹Department of Physics, University College of Engineering Tindivanam, Anna University, Chennai.

²Department of Physics, University College of Engineering Nagercoil, Anna University, Chennai.

sudhaucet@gmail.com

Abstract

Benzoic acid is a well-known preservative that has been used in many food products. It has an antimicrobial property that inhibits yeast growth and prevents bacterial growth. Although benzoic acid prevents or delays nutritional losses due to enzymatic, microbiological or ingredient's chemical conversion of foods during its shelf life, the usage of benzoic acid as a preservative has a permitted level [1]. The normal permitted level of benzoic acid in food products is 1g/kg [2]. Maximum concentrations reported for this preservative added to food products for preservation purposes is in the range of 2g/kg of food product [3]. Thus, the detection and determination of benzoic acid is significant for consumer food production as well as quality assurance. Cases of asthma, urticaria, anaphylactic shock or rhinitis, have been reported following dermal, oral, or inhalation exposure to this preservative.

The benzoic acid is ready to form a salt or interact with electron rich amine. The N,N-dimethyl unit is the right choice to make the interaction with benzoic acid. The curcuminoids are a well-known fluorophore which have an excellent emission property. Based on the collective ideas, we have introduced the N,N-dimethyl unit in the curcuminoid and the benzoic acid detection was tested. A plausible mechanism was proposed using DFT calculations by comparing the various interacted models.

Fig.1: Pictorial representation of N,N-dimethylcurcuminoid based biosensor

Keywords – Benzoic acid, Inhibition,Biosensor,

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POLYCAPROLACTONE MICROSPHERE ENCAPSULATED EXOSOMES: A THERAPEUTIC AGENT FOR CLOT LYSIS

Ankita Das¹ and Ashok Kumar^{1,2,3,*}

a Department of Biological Science and Bioengineering, Indian Institute of Technology Kanpur, Kanpur, UP, India;

b Centre for Environmental Sciences and Engineering, Indian Institute of Technology Kanpur, Kanpur, UP, India;

c Centre for Nanosciences, Indian Institute of Technology Kanpur, Kanpur, UP, India

*E-mail: ashokkum@iitk.ac.in

Abstract

Among cardiovascular diseases, atherosclerosis leads to maximum number of deaths worldwide. Arterial smooth muscle cell proliferation, coupled with continuous influx and propagation of monocytes and macrophages, converts fatty streaks to more advanced lesions and ultimately to a fibrous plaque that will protrude into the arterial lumen. Rupture of fibrous plaque finally leads to thrombus formation and occlusion of the vessel. Systemic injections of streptokinase and urokinase are administered as first line defence for clot dissolution in clinical practice. These are tissue plasminogen activators (tPA) which induce enzymatic activation of plasminogen to plasmin that cleaves fibrin molecules in blood clots. However, it has side effects including bleeding and bruising at injection site, blurred vision, fast heart rate, bleeding from nose and gums, among others. Hence, it should be used with caution with other medications that alter platelet function and increase risk of bleeding. Exosomes are a type of extracellular vesicles (EV), which are membrane-based structures. They are originated from endosomes with a smaller size, ranging from 40 to 100 nm and often referred to as “nanosphere” with a bi-layered membrane. The EVs serve as vehicles to carry different types of cellular cargo—such as lipids, proteins, receptors and effector molecules to the recipient cells. Some typical types of molecules wrapped in exosomes include heat shock proteins and chaperones and proteins involved in trafficking and membrane fusion including annexins. There is an interaction between hsp90 α and tPA, that together with annexin II, activates plasmin. Annexin II has an established role in aggressive tumours and binds both tPA and plasminogen thereby enhancing the conversion of plasminogen to active plasmin. Herein, we have isolated exosomes from an invasive cancer cell line (fibrosarcoma) HT1080 and characterized their size, morphology, protein and lipid content. The exosomes have an average diameter of ~60nm and cup-shaped morphology, as observed by Dynamic Light Scattering, Scanning Electron Microscopy and Atomic Force Microscopy. Blood clot lysis experiments have also shown that the exosomes are effective in lysing blood clots. Furthermore, for better retention of these biomolecules at the required site, PCL microspheres have been fabricated for their encapsulation. Microparticle preparation has been characterized by Fourier Transform Infrared Spectroscopy and Scanning Electron Microscopy results show that these particles have an average diameter of 315 μ m, which is sufficient for encapsulation of the exosomes. Thus it can be concluded that these exosomes and PCL microspheres can serve to be a potential combination for blood clot lysis in atherosclerosis.

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BIOCERAMIC 3D POROUS SCAFFOLDS DERIVED FROM APATITE'S FOR BONE DEFECT REPAIR

A. Marimuthu and A. M. Ballamurugan*

Department of Nanoscience and Technology, Bharathiar University, Coimbatore- 641 046

*Corresponding author: E-mail: balamurugan@buc.edu.in (A. M. Ballamurugan)

Abstract

The biologically relevant ions substituted bioceramic are widely used in biomedical applications in recent years due to their biocompatible features of the human parts. The biphasic calcium phosphate, consisting of hydroxyapatite (HAP) and β -tricalcium phosphate (β -TCP) ($\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$ & $\beta\text{-Ca}_3(\text{PO}_4)_2$), belong to the ceramics family has received more attention because of its chemical similarity perfectly matches to the natural human bone and dentistry. The arrangement of different ions in the Ca/P crystal structure allows one to dope with metal ions, while alter the properties. In this present work, synthesized different mole percentage of Ni^{+2} ion-doped BCP was used for the fabrication of porous bioceramic scaffolds by foam replication technique. The developed 3D porous scaffolds were studied with suitable physicochemical techniques such as FTIR, XRD, and FESEM. The fabricated 3D porous scaffolds were subjected to simulated body fluid to evaluate the apatite formation. The obtained results conclude that the prepared material is suitable for clinical needs.

Keywords: Bioceramic, Hydroxyapatite, CDBCP, and Scaffolds

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A NOVEL BIOMIMETIC NON-SUTURABLE PATCH FOR STEM CELL DELIVERY FOR CARDIAC REGENERATION

Vineeta Sharma¹, Amit Manhas², Santosh Gupta¹, Kumarvelu Jagavelu² and Rama Shanker Verma^{1*}

¹Department of Biotechnology, Jyoti and Bhupat Mehta School of Biosciences, Indian Institute of Technology Madras, Chennai, Tamil Nadu, India.

²Department of Pharmacology, CSIR-CDRI, Lucknow, Uttar Pradesh, India

Abstract

The resident cardiac stem cells having limited regenerative potential hinder myocardial infarction recovery. As an alternative therapeutic intervention, stem cells have been used for myocardial infarction regeneration (1). Many patch-based cell delivery systems are being explored in clinical and preclinical research. These patches, however, require suturing to the infarcted area, causing further injury to the ailing heart (2). Here, we report the development of bioadhesive based non-suturable patches for delivery of stem cells with native decellularized cardiac ECM matrix “cardiogel” (3). The mussels inspired bioadhesive system comprise of gelatin catechol and partial oxidized chitosan. The bioadhesive developed has self-crosslinking capability and promotes wet adhesion. The nano-fiber patch is fabricated using chitosan. The patch loaded with stem cells encapsulated in cardiogel is applied to the infarct area using bioadhesive. The adhesion of the patch is instant after implantation. Echocardiography, followed by mouse sacrifice, confirmed the presence of patch on heart after 3- and 21-days post MI. Histological section showed no toxic effect on heart tissue. Its observed *invitro*, cardiogel, promotes cell proliferation, adhesion and migration while aiding cardiomyogenic differentiation. *In vivo* experiment showed that group containing cardiogel encapsulated stem cells showed significant rescue in infarct area compared to MI.

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HUMAN WHARTON'S JELLY-SILK COMPOSITE GRAFTS FOR SMALL-DIAMETER VASCULAR TISSUE ENGINEERING APPLICATIONS

Prerak Gupta^{1#}, Gaurab Ranjan Chaudhuri³, G. Janani¹, Manoj Agarwala⁴, Debaki Ghosh⁵, Samit K. Nandi⁵, Biman B. Mandal^{1,2*}

¹Department of Biosciences and Bioengineering, Indian Institute of Technology Guwahati, Guwahati-781039, Assam, India,

²Centre for Nanotechnology, Indian Institute of Technology Guwahati, Guwahati-781039, Assam, India,

³Department of Plastic Surgery, R. G. Kar Medical College and Hospital, Kolkata-700004, West Bengal, India

⁴GNRC Institute of Medical Sciences, Guwahati-781039, Assam, India

⁵Department of Veterinary Surgery and Radiology, West Bengal University of Animal and Fishery Sciences, Kolkata-700037, West Bengal, India,

#Email: prerakgupta@gmail.com; *Email: biman.mandal@iitg.ac.in

Abstract

Success of a tissue-engineered vascular graft relies on choosing the optimal combination of scaffold, cells, and microenvironment (bioactive molecules, growth factors, etc.). In the last decade, researchers have realized that developing a vascular graft seeded with patient-specific vascular cells, requiring a long-term maturation, is a time-consuming process and reduces their chances of clinical availability. Mesenchymal stem cells (MSCs) seeded in the vascular graft modulate the immune response in a paracrine fashion by releasing monocyte chemoattractant protein-1 (MCP-1), which aids in graft remodeling. Further investigation corroborated that loading of MCP-1 onto the vascular scaffold was nearly as effective as cell seeding. Hence, research impetus in vascular tissue engineering is lately witnessing a lateral shift towards cell-free grafts. The goal is to reduce the clinical testing time and make the grafts readily available for the patients in need. From a translational perspective, cell-free grafts are expected to follow a shorter path than cell-seeded grafts, which could expedite their clinical translation. Acellular vascular grafts (biological decellularized vessels and engineered polymeric grafts) have shown promising outcomes in animal models and human clinical trials. The human umbilical cord is a medical waste and available in large quantities. Extracellular matrix (ECM) derived from human Wharton's jelly is a rich source of structural proteins and peptide growth factors. Considering the presence of MSCs in the human Wharton's jelly (WJ) matrix, we surmised that the secreted factors would be preserved in the matrix, which could play a crucial role in endothelialization, host cell recruitment, and constructive vascular graft remodeling. Aiming towards creating cell-free, viable tissue-engineered vascular grafts (TEVGs), we hypothesized that functionalizing the vascular scaffolds with decellularized human Wharton's Jelly (dWJ) matrix could potentially enact them with clinical feasibility. We functionalized bi-layered silk scaffolds with dWJ matrix and investigated the *in vivo* graft performance in rabbit jugular vein as an interposition grafting model.

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EFFECTS OF PORE STRUCTURE AND CELL CULTURE APPROACH ON IN VITRO CELLULAR RESPONSE TO BIOCERAMIC SAMPLES

Athira RK^{1,2}, Gayathry G², Anil Kumar PR¹, Manoj Komath^{2,*}, Naresh Kasoju^{1,*}

1 Division of Tissue Culture, Department of Applied Biology, Biomedical Technology Wing, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram, Kerala, India

2 Division of Bioceramics, Department of Biomaterials Science and Technology, Biomedical Technology Wing, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram, Kerala, India

*Corresponding author e-mail: manoj@sctimst.ac.in (MK), naresh.kasoju@sctimst.ac.in (NK)

Abstract

Bone tissue engineering typically involves design and development of a biocompatible and bioresorbable scaffold followed by seeding of bone cells and subsequent maturation *in vitro*. Owing to its biomimetic properties, bioceramics are the most widely explored biomaterials for bone tissue engineering applications. However, apart from the composition, the scaffold should also mimic the structural features of the native extracellular matrix. In particular, the scaffold should have suitable architecture and offer certain level of porosity to allow cellular infiltration, angiogenesis, nutrient exchange and thereby to have successful integration with host tissue. While the material properties influence the overall cell response, the *in vitro* cell culture process would also equally affect the subsequent cell response. In particular, the cell seeding as well as the mode of culture would influence the cell seeding density and the depth of cellular infiltration within the scaffold. In this study, we have explored the effect of the material's structural features and the cell culture approach on the cellular response to bioceramic scaffolds in the context of bone tissue engineering. Briefly, bioceramic scaffolds having a random porous structure vs. an aligned porous structure were considered to understand the effect of pore architecture on cell response. On the other hand, the effect of culture conditions was explored by following three different cell seeding approaches (viz. standard well, confined well and direct drop seeding) and by following two modes of culture conditions (viz. static and dynamic). In all the cases, human osteosarcoma cells (HOS) were seeded on the bioceramic samples, subsequently the cellular response was analyzed qualitatively by following scanning electron microscopy and quantitatively by following alamar blue assay. Our results indicate that the cellular infiltration was end to end in the aligned porous bioceramic samples, whereas, the cells were limited to the surface in case of the random porous scaffold. As for the cell seeding, the direct drop seeding approach was relatively better as compared to the standard well or confined well based seeding, and in terms of culture mode, the dynamic culture mode was relatively better as compared to the static mode of culture. To conclude, both the material properties as well as the culture conditions influence the cellular response to bioceramic samples *in vitro*.

Keywords: bone tissue engineering; cell culture; seeding approach; dynamic culture

MULTIOBJECTIVE OPTIMIZATION OF SURGICAL MESH

Arnob Dutta^{1*}, S. Kanagaraj²

Mechanical Engineering, Indian Institute of Technology Guwahati, Amingaon, Guwahati, India

*Corresponding Author E-mail: attadrnob@gmail.com

Abstract

Meshes find use for hernia repair and urogynecological support inside the human body. These possess a number of properties that affect the support they provide to the intestinal wall or the prolapsed organ as well as their biocompatibility. However, the interrelationships between these properties have not been explored in a comprehensive manner to guide the design of meshes. In this paper, a meta-analysis is offered of three significant properties of a surgical mesh, namely porosity, knot type and material stiffness, to find their interrelationships. These properties are then mapped on a decimal scale for use as variables for a multiobjective optimization equation, with mechanical support performance and biocompatibility as the two quantities to be maximized. A pareto front of non-dominated solutions is obtained after running a Genetic Algorithm, in which scaled optimal values of the properties are obtained. It is found that the less-quantified property, knot type, adopts many values in the Pareto front, while the properties of stiffness and porosity crowd values around a single number each in the scale corresponding to the knot type. This demonstrates that makers can vary the knot type across a range of values while tweaking the other two in a small range to obtain the best meshes, this process being directly integrable with computer aided design. The algorithm can also function as a predictive evaluation tool for the performance of any developed mesh. In future work, more property parameters as well as objectives can be added to further improve the accuracy of the model and its predictive ability.

Keywords: mesh; optimization; meta-analysis; modelling.

HUMAN DENTAL PULP STEM CELLS PROMOTE PRESSURE WOUND HEALING IN DIABETIC RATS

Kuldeep Pawar¹, Shivani Desai^{1*}, Avinash Sanap², Avinash Kharat², Ramesh Bhonde³

¹ Department of Pharmacology; Dr. D. Y. Patio Institute of Pharmaceutical Sciences and Research, Pimpri, Pune-411018, Maharashtra, India,

² Regenerative Medicine Laboratory; Dr. D. Y. Patio Vidyapeeth, Pimpri, Pune-411018, Maharashtra, India,

³ Research; Dr. D. Y. Patio Vidyapeeth, Pimpri, Pune-411018, Maharashtra, India

1Email: shivani.desai@dypvp.edu.in, desai.shivani28@gmail.com;

*Email:desai.shivani28@gmail.com

Abstract

Diabetes mellitus is a fast-growing disorder worldwide and unhealing foot ulcers occurring in diabetic patients causes them to undergo leg amputation. Various treatments are employed to salvage the ulcerated limb but with the loss of limbs in maximum cases. To improve the quality of life in diabetic patients suffering from foot ulcers, we need to find a better alternative to improve their condition. With the advances in cell therapy, stem cells are coming across as a promising therapy. Human dental pulp stem cells (hDPSCs), a type of mesenchymal stem cells possessing self-renewing properties, can be obtained from the dental tissues and are multipotent. hDPSCs are proven to play important roles in various bioprocesses such as immune responses, inflammation, antimicrobial activities, and osteogenesis process. Our study aimed to understand the effect of hDPSCs in recovering diabetic wounds in a pressure wound animal model.

A diabetic animal model was established by using streptozotocin as diabetes inducing agent in male Wistar rats. This was followed by creating standard wounds on the paw of the diabetic rats. These animals were grouped into three categories (each of 6 animals), viz., disease control group, single dose hDPSCs, and multiple dose hDPSCs. After the total study period of 28 days, the results were analysed for wound size reduction and re-epithelialization of the wounded tissues. We also analysed the anti-microbial activity. SPSS was used for analyzing the data.

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Commercialisation of Biomaterials

DUAL CELL SEEDING COMPATIBLE CELL CULTURE INSERT: AN INNOVATIVE DEVICE FOR TISSUE ENGINEERING, TISSUE STORAGE AND TISSUE SHIPPING

Jimna M Ameer¹, Ramesh Babu V², Sabareeswaran A³, Anil Kumar PR¹, Naresh Kasoju^{1,*}

¹ Division of Tissue Culture, Department of Applied Biology, Biomedical Technology Wing, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram, Kerala, India

² Division of Precision Fabrication, Department of Medical Devices Engineering, Biomedical Technology Wing, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram 695012, Kerala, India

³ Division of Experimental Pathology, Department of Applied Biology, Biomedical Technology Wing, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram 695012, Kerala, India

*Email: naresh.kasoju@scitimst.ac.in

Abstract

Engineering human tissues *in vitro* is undoubtedly a fascinating field of modern medicine. Typically, the conventional tissue engineering approach employs a combination of biomaterial scaffolds, cells of interest and bioactive molecules, wherein, the cells of interest are seeded and cultured over a porous scaffold in presence of bioactive molecules in order to fabricate a three dimensional (3D) tissue. Although the history of tissue engineering dates back to early 1990's, mimicking the native tissue histology in the engineered tissues is still a challenge. *In vivo*, a well-organized 3D tissue is formed through a process of morphogenesis involving various cell types. Whereas in the tissue engineering, only one type of cell was typically used; perhaps, this could be the reason why the 3D tissue formation *in vitro* was sub-optimal. In order to mimic the native tissue morphogenesis, it is important to switch towards co-cultured tissue systems. Previously, several co-culture models were reported to be useful in unravelling several physiological and pathological phenomena. For instance, Olumi et al., co-cultured LNCaP prostate cancer cells with normal human prostatic fibroblasts and found that the fibroblasts suppressed the apoptotic pathway in prostate cells and thus enhanced the frequency of tumor formation. In another report, Bale et al. co-cultured hepatocytes, Kupffer cells, sinusoidal endothelial cells and stellate cells and found enhanced viability, functionality and liver functionality in the co-cultured system as compared to the mono-culture system. Realizing the importance of co-culture systems, several researchers reported such co-culture model systems by seeding multiple cell types with the help of cell culture inserts. However, these inserts typically come with a pre-fixed scaffold and does not allow dual cell seeding. While engineering tissues that mimic the native tissue histology and function is one big challenge, keeping them off-the-shelf and shipping them from manufacturing site to the clinics is another massive bottleneck. These storage and shipping aspects significantly affect the commercial viability of the technology. The research into the storage and shipping aspect of tissue engineered products has picked up quite late. Currently, only a handful of reports are found on this aspect, majorly on the preservative formulations for long term storage. But an insert that offer versatile features for engineering co-cultured tissues, followed by ability to stack up and aid in smooth storage and shipping is the need of the hour.

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SYNTHESIS AND CHARACTERIZATION OF LADDER LIKE SILOXANE METHACRYLATE PRE-POLYMERS FOR HARD TISSUE RESTORATIVE APPLICATIONS

Bridget Jeyatha W.1, Willi Paul2, PampadyKandathil Philipose Lizymol1

1. Division of Dental Products, Department of Biomaterial Science and Technology, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Poojappura, Thiruvananthapuram, India.

2. Central Analytical Facility, Biomedical Technology Wing, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram, India

Email:lizymol@sctimst.ac.in

Abstract

Tooth is a hard bio-mineralized tissue performing the role of mechanical mastication and providing facial structural integrity. Trauma, infection, fracture and worn out of tooth demanded restorations. These restorations replace the lost tooth functionally and aesthetically. Generally, dental composite comprised of Bisphenol glycidyl methacrylate BisGMA / Urethane Dimethacrylate/ epoxy as resin matrix. However the problems of post- polymerization shrinkage induce a gap between the interface of tooth and the restoratives. This leads to micro leakage, thermal sensitivity, secondary caries and finally failure of the restorative and even tooth loss. This insisted the need of need of non-cytotoxic low polymerization shrinkage resin. Siloxane methacrylates are emerging class II hybrids with organic methacrylate portions and inorganic siloxane backbone. These fashioned materials are curable, flexible, transparent and with good mechanical properties¹. It can be simply synthesized by a single pot methodology in which the inorganic components are covalently bonded with the organic components to form a three dimensional rigid network². Although reported applications are of electrical, optical and coating, herein we report the simple synthesis, characterization and evaluation for dental applications. A pre-polymeric resin (LSM) of siloxane methacrylate was synthesized by modified sol gel method using the precursor 3- trimethoxysilylpropyl methacrylate (3-TMSPM). Alkali catalyst favoured the formation of polycondensed inorganic siloxane network with Mn 28,000. Using spectroscopic techniques, Si-O-Si skeleton, number of siloxane units, complete condensation of the precursor and the intactness of the organic moiety was studied. Transmission electron microscopy confirmed the ladder morphology of the pre-polymers. Record of T₅ at 400 °C and more than 50% residue (900 °C) proved the thermal stability of the polymer. Cured composites of LSM resin and silanated quartz exhibited the depth of cure of 1.41 + 0.08 mm and low linear polymerization shrinkage of 1.08 + 0.08. Diametral tensile strength and compressive strength analysis revealed the applicability of the LSM resin for dental applications. Direct contact, MTT assay and cell adhesion study proved the non-cytotoxic and cytocompatibility of the cured LSM resin. Thus this study described the simple synthesis, characterization and versatility of the LSM resin for hard tissue restorative applications.

Keywords: dental resin, siloxane methacrylate, sol gel method

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ANTICARIOGENIC PROPERTIES AND CYTOTOXICITY OF NOVEL TRIPHALA-MEDIATED NANO-ZINC OXIDE VARNISH

Manali Deb Barma¹, Srinivasan Raj Samuel²

Department of Public Health Dentistry, Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences, NO 162 PH Road, Velappanchavadi, Chennai, Tamil Nadu, 600077

*Corresponding Author E-mail: samuelrajsrinivasan@gmail.com

Abstract

Zinc is a potent antimicrobial against cariogenic bacteria and effective anti-plaque agent. The present study investigated the efficacy zinc oxide nanoparticles (ZnO-NP) varnish to inhibit *S. mutans* growth, biofilm, acid production, and its antioxidant potential and cytotoxicity.

Design: Green synthesized ZnO-NP were characterized using ultraviolet-visible spectroscopy, x-ray diffraction spectroscopy, and transmission electron microscopy. Secondary metabolites were assessed using fourier transform infrared spectroscopy. Antioxidant potential was ascertained using 2,2-diphenyl-2-picrylhydrazyl hydrate (DDPH) assay and cytotoxicity of synthesized nanoparticles was evaluated on human liver cancer (HepG2) and human embryonic kidney 293 (HEK-293T) cell lines. **Results:** Synthesized ZnO-NP showed excellent antimicrobial properties against *S. mutans* as the Minimum inhibitory, bactericidal concentration was 0.53 µg/ml, and 1.3 µg/ml respectively. ZnO-NP at 0.1 mg/µl concentration had the greatest zone of inhibition (24 mm), followed by 0.05 mg/µl (23 mm) and ampicillin (21 mm). Further, 0.1 mg/µl ZnO-NP varnish inhibited 90% of *S. mutans* biofilms and reduced 24 h acid production closest to that of baseline and it also exhibited antioxidant capacity in a dose dependent manner (94% inhibition-100 µg/ml). Biocompatibility of ZnO-NP varnish was evaluated on HepG2 and HEK-293T cell lines; and the highest concentration of 0.1mg/µl ZnO-NP used caused very low cytotoxicity to HepG2 cells and was non-cytotoxic to HEK-293T cells. **Conclusions:** ZnO-NP varnish is highly effective in inhibiting *S. mutans* and holds great potential as an effective anticaries agent, which is relatively safe for biological applications.

Keywords: Nano-Zinc Oxide, *Streptococcus mutans*, antibiofilm, Dental Caries, varnish

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SOY PROTEIN ISOLATE MEMBRANE FOR GUIDED TISSUE REGENERATION

C.V.Saranya, P.P.Lizymol*

*Division of Dental Products, Biomedical Technology Wing, SCTIMST, Poojappura,
Thiruvananthapuram 695012, India*

Email: lizymol@rediffmail.com, saranyacv16@gmail.com

Abstract

Periodontitis is an inflammatory disease that disturbs the structure and functioning of the periodontium and causes damage to the periodontal tissues and eventually tooth loss. Periodontal diseases are truly a ‘silent’ worldwide massive disease burden and socio-economic effects because untreated periodontitis will lead to other disease like cardiovascular diseases. Guided tissue regeneration (GTR) and guided bone regeneration (GBR) are the advanced treatment strategies for periodontitis. These GTR membranes can prevent the ingrowth of epithelial and fibroblast cells into the alveolar bone region and enhance the regeneration of alveolar bone. Collagen is the material mostly used for the preparation of GTR membranes. But there is a chance of disease transmission from animal derived materials. Here, we prepared a membrane with soy protein isolate (SPI), which is extracted from soybean seeds. SPI is characterized by UV spectroscopy, Fourier-transform infrared spectroscopy (FT IR) and Dynamic light scattering (DLS) analysis. Membranes were formulated from the blend of SPI and polyvinyl alcohol (PVA) in different concentrations by solvent casting. FT IR analysis confirmed the presence of bioactive components in the SPI and SPI-PVA blend membrane. SPI-PVA blend membranes satisfied essential mechanical strength needed for a periodontal GTR membrane and also have sufficient suture pullout strength to withstand the pressure exerted during suturing. Membranes showed favourable physicochemical properties including, enough porosity, suitable pore size, good swelling and hydrophilicity. High percentage of degradation during gravimetric weight loss indicated the biodegradability of the developed membrane and *in vitro* cyto-compatibility studies proved the cyto-compatible nature of SPI-PVA membranes. Altogether, our data indicate that SPI-PVA membrane can be a favourable option for periodontal therapy as a GTR membrane.

Keywords: Periodontitis, Soy protein isolate, PVA, periodontal regeneration

GENDER IDENTIFICATION USING PANORAMIC DENTAL IMAGES WITH DEEP CONVOLUTIONAL NEURAL NETWORKS

L.Nithya¹, Dr. M.Sornam^{2*}, Dr. Ashwin.K.S³

Department of Computer Science¹, University of Madras, Guindy¹, Chennai¹, India¹

Department of Computer Science², University of Madras, Guindy², Chennai², India²

Department of Orthodontics³, Dr MGR Educational and Research Institute³, Maduravoyal³,
Chennai³, India³

*Corresponding Author E-mail: madasamy.sornam@gmail.com

Abstract

The process of gender identification using dental features is done in dental biometrics. Dental biometrics is useful when there is an occurrence of massive calamity. In this study, a new method is proposed for gender evaluation using panoramic dental X-ray images. The proposed method performs binary classification on the panoramic X-ray images, with the help of the trained sequential deep convolutional neural networks. The data collection for this study was done as a real time data collection from the hospital. The architecture of the proposed method was able to prove that the model was able to achieve a higher amount of accuracy than the previously established methods. Using this approach, the model achieved an optimal accuracy of 96.15%.

Keywords: gender estimation; panoramic images; binary classification; image processing

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EFFECT OF COPOLYMERIZING ANTIMICROBIAL MONOMERS ON MECHANICAL PROPERTIES OF PMMA HEAT CURE DENTURE BASE RESIN

Rao S1, Jayaprakash2, Kishore Ginjupalli2, Nandish B.T*

1,2,* Department of Dental Materials, Yenepoya Dental college, Yenepoya (Deemed to be University) Mangalore, India

2 Department of Dental Materials, Manipal College of Dental Sciences, Manipal Academy of Higher Education, Manipal-576104, Karnataka, India

*Corresponding Author E-mail: nandi_bt@yahoo.co.uk

Abstract

Background of the study: In dentistry, Polymethyl methacrylate (PMMA) heat cure denture base material is extensively used for fabricating complete and removable partial dentures. *Candida albicans* species can colonize on the denture base prosthesis forms a biofilm, and develops an oral infection called denture stomatitis (DS). High prevalence of DS in complete denture wearers may lead to serious health complications, especially in elderly and immunocompromised patients. To address in concern, various antifungal additives have been incorporated into PMMA denture base materials.[1] However, such materials show reduced antifungal activity over a period of time as some of the antifungal additive leach out. Recently, efforts are being made to copolymerize antifungal materials to PMMA resin for long lasting antifungal activity.[2] However, effect of these copolymerizing antimicrobial monomers on the mechanical properties of conventional PMMA resin is not been evaluated.

Aim: To investigate the Flexural strength (FS) and impact strength (IS) of PMMA resin modified by copolymerizing with DHMAI and DDMAI monomers.

Methodology: Antifungal monomers such as DHMAI (1, 2 and 5 µg/mL) or DDMAI (5, 10, and 20 µg/mL) were added to monomer of conventional heat activate PMMA denture base resin and the specimens were prepared using compression molding technique. Specimens prepared without antifungal monomers were considered as control group.

Flexural strength was measured by using three-point bending test. Specimens of 65 x 10 x 2.5mm were stressed at 5mm/min in universal testing machine (UTM) until failure (n=20). Flexural strength was calculated using the formula $3PL/2bd^2$ and is expressed in MPa.

Impact strength was measured by using Izod-impact tester. Specimens of 65 x 12 x 3.2mm with a central notch were held vertically and hit by a swinging pendulum at a velocity of 3.4m/s. The energy required to fracture the specimens during the test, in joules, is considered as impact strength (n=10).

Results: PMMA denture base resins copolymerized with DHMAI monomer at 5µg/mL showed 122.86 ± 9.63 MPa flexural strength, which is significantly higher than control group (97.4 ± 9.63 MPa). The flexural strength of PMMA copolymerized with DDMAI monomer showed higher flexural strength though the improvement was not statistically significant. However, copolymerization of these antifungal monomers reduced impact strength.

Conclusions: The results of the present study indicate that copolymerization of antifungal monomers with PMMA heat activated dental base resins improved flexural strength significantly but reduced the impact strength.

Keywords: Denture stomatitis; *C. albicans*; antimicrobial monomer; PMMA denture base resin.

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CHITOSAN GRAFTED FE-DOPED WO_3 DECORATED WITH GOLD NANOPARTICLES FOR STIMULI-RESPONSIVE DRUG DELIVERY SYSTEMS

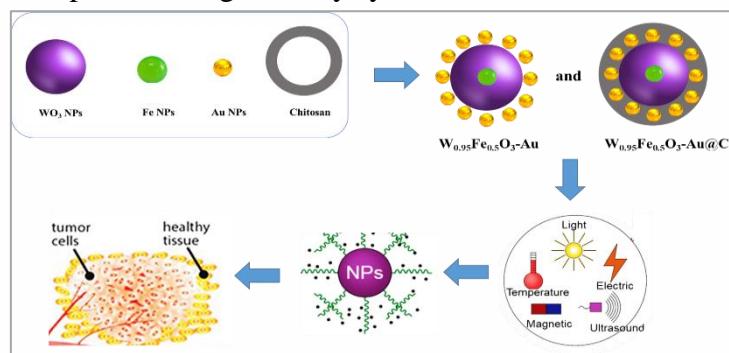
R. Rajalakshmi, S. Sivaselvam, and N. Ponpandian

*Department of Nanoscience and Technology,
Bharathiar University, Coimbatore 641046, India.*

Abstract

Stimuli-responsive drug delivery systems (DDS) appear as a promising approach to control and targeted drug delivery. When these DDS are administered, the drug release is activated and then modulated through some action or external input and facilitated by the energy supplied externally. Herein, we report the possibility of developing a novel degradable chitosan-based nanocarrier which is composited with Fe doped WO_3 decorated with Au nanoparticles to investigate the loading and controllable release properties in human osteosarcoma MG-63 cells. The transition-metal oxide nanoparticle WO_3 proves to be an interesting candidate for drug delivery system owing to their advanced surface functionality chemistries and excellent electro-optical properties. Iron nanoparticles outperform in magnetic properties, lower toxicity and biocompatible features. Colloidal gold nanoparticles (AuNPs) are of interest as they are non-toxic carriers and their hydrophilicity can be tailored. Chitosan serves as a biocompatible polymer dissolving easily in lower pH values enhancing the stability of the drug being carried. This study describes a facile one-step method to synthesize chemically modified stable WO_3 modified by doping 5 mol% of magnetic Fe(Iron) nanoparticles and decorated with colloidal gold nanoparticles ($\text{W}_{0.95}\text{Fe}_{0.5}\text{O}_3\text{-Au}$). The complex was further composited with chitosan ($\text{W}_{0.95}\text{Fe}_{0.5}\text{O}_3\text{-Au@C}$) as a drug targeting vector to deliver cisplatin to MG-63 cancer cells. The nanoparticles were loaded in a PBS buffer under different pH conditions and its drug releasing time was calculated. Compared with $\text{W}_{0.95}\text{Fe}_{0.5}\text{O}_3\text{-Au}$, $\text{W}_{0.95}\text{Fe}_{0.5}\text{O}_3\text{-Au@C}$ was found to be more effective in vitro toxicity assay as the drug release percentage reached 82% within 24 hours at pH 7.2. These results indicate that $\text{W}_{0.95}\text{Fe}_{0.5}\text{O}_3\text{-Au@C}$ is a potential drug carrier for effective targeting of cancer therapy.

Keywords: Stimuli-responsive drug delivery system, WO_3 , cancer cells, chitosan.



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DRUG CROSS-LINKED GELATIN COATED MAGNETIC NANOPARTICLES FOR HYPERTHERMIC THERAPY

Amy Sarah Benjamin [1], Arunai Nambi Raj N[1,2] Sunita Nayak*[2,3]

[1]Department of Physics, School of Advanced Sciences, VIT University, Vellore -632014

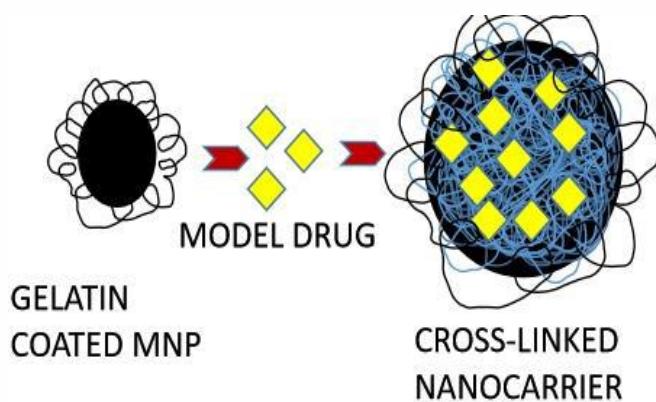
[2] Centre for Biomaterials, Cellular and Molecular Theranostics (CBCMT), VIT University, Vellore

[3] School of BioSciences and Technology(SBST), VIT University, Vellore - 632014

*Corresponding author E-mail: sunita013@gmail.com

Abstract

One of the most attracted fields of nanotechnology research in the last few years has been iron oxide nanoparticles due to their interesting properties like physicochemical, easy functionalization, stability, low toxicity and biological fate creating an emphasis on applications like nano-material based catalysis, biomedicine, magnetic targeting, MRI, environmental remediation, magnetic-separation and cancer therapy. The easy and varied methods of synthesis followed by conjugation with substantial polymers, affinity ligands, antibodies, targeting factors for drug delivery has been studied extensively. Drug design using natural polymers also shows significant results in biomedical applications. This study is aimed to fabricate gelatin-coated iron oxide magnetic nanoparticles through a slightly modified co-precipitation method. Gelatin coated Magnetic nanoparticles was prepared by a slightly modified co-precipitation method where Gelatin was dissolved in millipore water and the ferrous salts were added to it followed by the base solution added drop wise until the pH reached 11. The model drug Doxorubicin was then adsorbed on to the polymer coated magnetic particle and cross linked. Coated polymer and the model cancer drug was cross-linked using Genepin. The nano-carriers were characterized by evaluating the Zeta potential, VSM, Hyperthermia and X-ray diffraction. To investigate the morphology of the MNPs, Scanning Electron Microscopy (SEM) was used. Functional and elemental group was evaluated by FTIR and EDX respectively. The drug loading efficiency and drug release kinetics was studied whereas, the toxicity result of MNPs was assessed by MTT assay along with its hyperthermic reaction. The result displays that the functionalized MNPs are in the non-toxic range with an increased temperature in a short time thus making it a potential candidate for application in anti-cancer treatment using Hyperthermia.



Keywords: Doxorubicin, Genepin, Hyperthermia, Magnetic nanoparticles(MNPs).

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ELEMENTAL CONTENT & TURBIDITY MEASUREMENT IN NEBIVOLOL HYDROCHLORIDE FORMULATION

Tauseef Shaikh¹, Dr.S. Sasikumar²

*Department of Chemistry, School of Advanced Sciences
Vellore Institute of Technology, Vellore 632 014, Tamil Nadu, India
shaikhtauseef.ahamad2010@vit.ac.in*

Abstract

In pharmaceuticals, turbidity measurement is an important tool that defines the presence of suspended particles in a liquid medium which impart to the drug solubility. Elevated level of elemental content may contribute impurities that lead to drug degradation. The present study was aimed to define a level of turbidity and elemental content in solid dispersion and pharmaceutical formulation. Solid dispersion 1 and 2 (SD1 & SD2) prepared with the drug: plasdone: tartaric acid and dug: gelatin respectively. Nebivolol Hydrochloride was employed as an investigational drug. Sodium and Magnesium content were identified in pure drug, SD1 & SD2, in an oral- immediate-release drug delivery system (prepared with SD1 & SD2) in the form of Tablet formulation (F1 & F2 respectively). Sodium was identified in all samples and found within a specified range. Pure drug & SD1 were identified Magnesium free while presence was observed in SD2, F1 & F2 with an allowable specification.

Keywords: Nebivolol Hydrochloride, Solid dispersion, Turbidity, Elemental Content

SURFACE MODIFICATIONS OF EXTRACELLULAR VESICLES FOR ENHANCED UPTAKE IN LIVER INJURY CONDITIONS: A POST-PRODUCTION TARGETED DELIVERY APPROACH

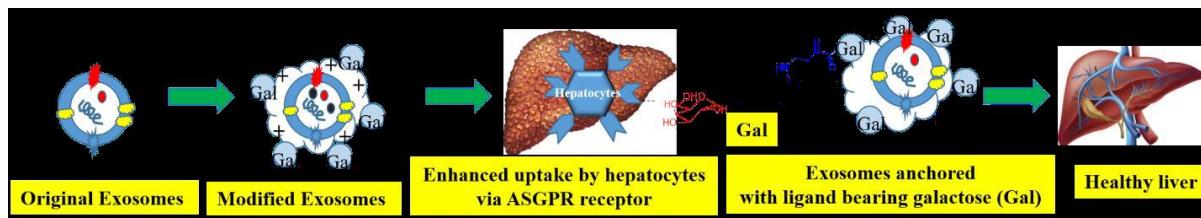
Purva Gupta¹, Abhay Prasad¹, Ashok Kumar^{1, 2, 3,*}

¹ Department of Biological Sciences and Bioengineering; ²Centre for Nanoscience; ³Centre for Environmental Sciences and Engineering, Indian Institute of Technology Kanpur, Kanpur-208016, UP, India

*Email: ashokkum@iitk.ac.in

Abstract

Liver is the first to receive 25% of the total nutrient rich blood supply from the digestive tract containing food toxins, drugs, xenobiotics, etc. It has an innate ability to regenerate when concurred with insults from toxic metabolites. Most forms of liver injury involve hepatocytes as either their primary or secondary target. Thus, hepatocellular death is the leading cause for compromised regeneration, when subjected to repetitive insults. Liver transplantation is deemed the only existing successful treatment for liver failure. The unavailability of liver donors, intricacies of surgical procedures, their expenses and the post-surgery complications have led to the development of alternative strategies to mitigate the conditions of liver failure. The fields of stem cell engineering and nanoparticle-based drug delivery are gaining significance as minimally-invasive interventions to mend the hepatocyte cell death and liver regeneration. Paracrine signalling via the mesenchymal stromal cell (MSC) secretome is recently recognized as a critical factor in mediating recovery from liver injury. Exosomes- small, nanometer-sized extracellular vesicles found in the MSC secretome, are reported to be involved in intercellular communication and play a significant role in alleviation of liver disease. However, the systemic introduction of exosomes is followed by their uptake and consequent degradation by macrophages and proteolytic enzymes, leading to a drastic loss in their therapeutic effect. The objective is to improve the site-specific bioavailability of exosomes via non-covalent surface modification to target the asialoglycoprotein (ASGPR) receptor specific to hepatocytes, to enhance the therapeutic index. Here, we have modified the negatively charged exosomes with a positively charged polyethylenimine (PEI), functionalized with galactosylated bovine serum albumin (gBSA) or lactobionic acid (LA). Two different modification approaches were used to synthesize an ASGPR specific polymer: a) Use of PEI conjugated with gBSA (gBSA-PEI), and b) Use of PEI with LA (PEI-LA) to conjugate with exosomes. The results indicate the successful interaction between exosome and functionalized polymer yielding a ~300nm sized modified exosome with 20mV zeta potential. In future, intracellular trafficking studies will be done to check the enhanced uptake of modified exosomes by liver cells.



Graphical Abstract: Surface-modification of MSC-derived exosomes for targeted liver therapy

Keywords: Exosomes; Mesenchymal stromal cells; Liver failure; Targeted delivery.

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A NANOPARTICLE-BASED COMBINATION THERAPY FOR BREAST CANCER VIA DOWNREGULATION OF WNT SIGNALLING

Garima Lohiya¹, Dhirendra S. Katti^{2,*}

Department of Biological Sciences and Bioengineering, Indian Institute of Technology Kanpur,
Kanpur-208016, Uttar Pradesh, India

¹ E-mail: glohiya@iitk.ac.in; ² E-mail: dsk@iitk.ac.in

Abstract

According to WHO estimations, breast cancer accounts for the highest incidence and mortality rates among women both globally as well as in India. Triple negative breast cancer (TNBC), that accounts for 10-20% of all the breast cancer cases, is the most aggressive and metastatic subtype of breast cancer with very poor prognosis. Moreover, TNBC lacks any targeted therapy and chemotherapy is the mainstay treatment for metastatic TNBC cases. However, chemotherapy is associated with serious shortcomings such as non-specificity and poor biodistribution that may lead to several side-effects and systemic toxicities. Further, cancer cells can develop resistance against chemotherapeutic agents leading to failure of the treatment and tumor relapse. It has been found that cell signalling pathways are dysregulated in cancer which imparts enhanced proliferation, migration, invasion and chemoresistance to cancer cells and are implicated in poor clinical outcomes. Therefore, targeting these dysregulated pathways can make cancer cells chemo-sensitive and less oncogenic. When treated with anti-cancer drugs, such chemo-sensitive cells with decreased oncogenic potential are expected to show a better therapeutic outcome. Hence, a combinatorial approach of targeting dysregulated signaling pathways along with using chemotherapeutic drugs may be an efficient approach to improve the therapeutic outcome of the breast cancer patients. Wnt signalling is one such dysregulated pathway in breast cancer, wherein upregulated Wnt signalling has been shown to be associated with tumorigenesis, metastasis and chemoresistance of cancer cells leading to a poor clinical outcome. Therefore, in this work, we aimed to develop a combination therapy based on a non-conventional agent Niclosamide (Nic), a Wnt signalling inhibitor along with doxorubicin (Dox), a first-line treatment for TNBC.

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A BIOACTIVE CERAMIC AS A CARRIER OF ANTIBIOTICS FOR ORTHOPAEDIC APPLICATIONS

Irfan Qayoom¹, Ashok Kumar^{1,2,3,*}

¹Department of Biological Sciences and Bioengineering; Indian Institute of Technology Kanpur, Kanpur-208016, UP, India,

² Centre for Nanosciences, Indian Institute of Technology Kanpur, Kanpur-208016, UP, India,

³ Centre for Environmental Sciences and Engineering, Indian Institute of Technology Kanpur, Kanpur-208016, UP, India,

1Email:sqirfan@iitk.ac.in; *Email: ashokkum@iitk.ac.in

Abstract

Bone infection in the bone and joints is caused by various causes including endogenous seeding (hematogenous dissemination) and exogenous seeding (direct seeding in trauma, prosthetic infections, etc.). The causal agents causing bone infections could vary from gram positive to gram negative bacteria like *Staphylococcus aureus* (Osteomyelitis) and *Mycobacterium tuberculosis* (Osteoarticular/bone tuberculosis). Osteomyelitis shows a prominent occurrence with incidence of joint replacement infections accounting for 0.3% to 2.4% for total hip arthroplasties and 1% to 3% for total knee arthroplasty and is mostly higher in cemented arthroplasties. Osteoarticular tuberculosis (TB) is one of the highest among all extrapulmonary tuberculosis (EPTB) cases. Surgical eradication to remove infected bone and secondary filling of dead space is the most common treatment. Long term systemic administration of high dosage antibiotics to prevent further recurrence of infections lead to emergence of multi resistant bacteria. Further, systemic administration limits the bioavailability of antibiotics at the infection site that are often toxic to the liver and kidney. This necessitates the use of a system that could act as a potent carrier to deliver antibiotics in a sustained and controlled manner and at the same time regenerate lost bone.

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DIPEPTIDE GELS FOR THE SUSTAINED RELEASE OF AN ANTIDIABETIC DRUG, GLIMEPIRIDE

*Moumita Halder, Yatin Bhatia, and Yashveer Singh**

*Department of Chemistry, Indian Institute of Technology Ropar,
Rupnagar-140001, Punjab, India*

*Corresponding Author E-mail: yash@iitrpr.ac.in

Abstract

Diabetes mellitus is a chronic metabolic disease characterized by hyperglycemia and deterioration of pancreatic β -cell function. According to the IDF Diabetic Atlas 2019, diabetes is one of the fastest growing health care challenges of the 21st century, with 463 million people currently living with diabetes worldwide¹. IDF also estimates that there will be 578 million adults with diabetes by 2030 and 700 million by 2045. Diabetes is associated with the overproduction of superoxides and free radicals from glucose, which leads to the organ damage due to the oxidative stress. Glucose oxidase catalyses the oxidation of glucose to gluconic acid and H₂O₂, which reduces the local pH.² Glimepiride is a third-generation sulfonylurea drug used in type II diabetes but associated with side effects, like lower half-life, faster elimination, and hypoglycemia.³ Therefore, the present work aims at developing self-assembled, ultra-short peptide gels, Fmoc-YY-NH₂ and Fmoc-WW-NH₂, to achieve pH-dependent controlled release of glimepiride and inhibit reactive oxygen species formed in mitochondria, endoplasmic reticulum, tubular epithelial, and endothelial cells of diabetic patients.⁴ Self-assembled peptide gels are among the most promising supramolecular gelators because of their chemical diversity, biocompatibility, high encapsulation capacity for both hydrophilic and hydrophobic drugs and their ability to target molecular recognition sites.⁵ Both dipeptides (2% w/v) self-assembled into gels in DMSO/Water (50:50 v/v) under ambient conditions at 37 °C and the gels were characterized for their viscoelastic properties, using a rheometer. Swelling and degradation studies were carried out in buffer (pH 5±0.05 and 7.4±0.05) at 37 oC, which indicated that the ditryptophan gels were able to retain their property even after 14 days and, therefore, were suitable for use as biomaterials for sustained drug delivery. The antioxidant properties of both peptides were examined and they exhibited more than 60% free radical scavenging activity within 30 minutes. Release of drug from both gels were measured in buffers of pH 5±0.05 and 7.4±0.05 and it was found that the ditryptophan gels exhibited better controlled release profiles than dityrosine gels. More drug was released at pH 7.4 than 5, which was contrary to anticipated acidic media-sensitive drug release. To overcome this, we are incorporating a third amino acid into the peptide sequence to develop glimepiride-loaded tripeptide gels that can attenuate the drug release at normal body pH but trigger it in diabetic condition, characterized by a reduced pH.

Keywords: Self-assembled; Peptide gels; Sustained release; Antidiabetic drug.

RESIDUAL DRUG VOLUME DETECTION IN IMPLANTABLE MICRO INFUSION PUMP FOR TARGETED DRUG DELIVERY USING MAGNETIC METHODS

*Sarath S Nair¹**, Nagesh D S²

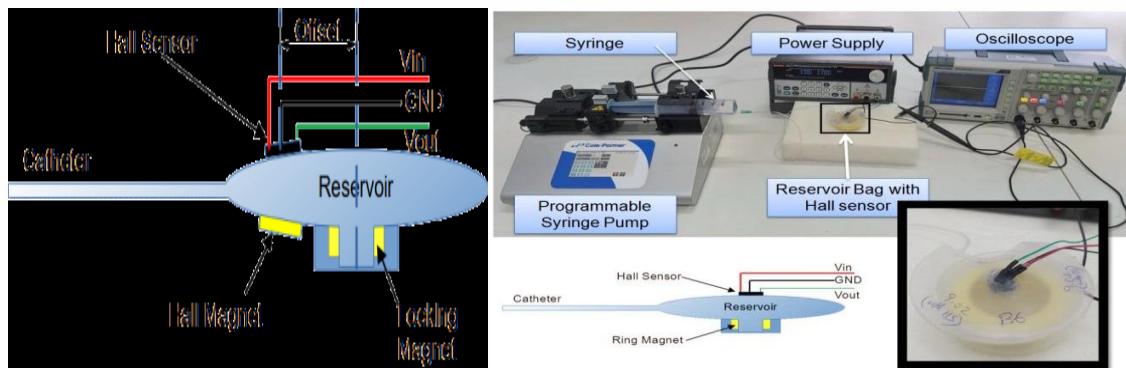
Department of Medical Devices Engineering, Biomedical technology Wing, SCTIMST, Trivandrum, Kerala, India

*Corresponding Author E-mail: saraths@sctimst.ac.in

Abstract

India along with other developing nations are suffering with many chronic diseases such as Cancer, Diabetes and Disability. India is considered as the diabetic capital of the world and currently there are more than 50 million people suffering from type 2 diabetes. It is estimated that; this number will be increased to more than 87 million by the year 2030. Similarly, more than 1 million new cases of cancer are diagnosed every year. It is estimated that 600 000–700 000 deaths in India were caused by cancer in 2012. Health statistics shows that, around 10% of the global population and more than 3.8% of Indian population is affected by Spasticity related disabilities. Nearly 15-20% of physically disabled children are affected by Cerebral Palsy. The estimated incidence of cerebral palsy in our country is around 3/1000 live births. For all these chronic diseases, long duration continuous administration of drug is required as a disease management strategy. Even though the existing treatment modalities like oral, intravenous and subcutaneous drug delivery shows promising results, the efficacy and safety of the drug can be improved many folds by adopting targeted drug delivery techniques (1). The targeted drug delivery system consists of a drug storage reservoir, a driving mechanism and a catheter (1,2,7). The reservoir stores drugs such as baclofen, morphine or insulin which is administered to either intrathecal space or peritoneal cavity through a catheter using the driving mechanism (8). Unfortunately, there is no fully developed technology for the same. The need is catered by imported devices from US and Germany. A major challenge in the development of a fully functional device is the determination of the residual volume of drug present in the reservoir (3, 4, 5,6). The information regarding the same is required by the clinician to remove the remaining drug as well as refill the pump without creating any failure modes. In this paper, a novel method is described which uses non-contact Hall Effect sensors for determination of residual volume of the drug within the reservoir. The reservoir is fitted with a magnet and a Hall Effect sensor. The magnet produces a magnetic field around the reservoir as shown in Figure 1. The Hall Effect sensor which is kept attached to the reservoir produces a voltage proportional to the magnetic field. Different configurations of the sensing method is studied with varying the position of the hall sensor and the magnet. A test setup is prepared with the different configuration to measure the accuracy of the measurement as shown in Figure 2. In vitro studies have shown that, the voltage information can be correlated to the amount of residual fluid present within the drug delivery systems as shown in Figure 3. In the paper, a method for the device design, placement criterion of the sensor and the results obtained are discussed. It has been envisaged that, incorporating the residual volume

mechanism on the targeted drug delivery pumps will improve the clinical usage of these devices.



Keywords: Targeted drug delivery, implantable micro pumps, smart drug delivery systems.

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RESEARCH PUBLICATION OF LASER TECHNOLOGY: A SCIENTOMETRIC STUDY

P. Mohanathan¹ and Dr. N.Rajendran²

1. Research Scholar, Periyar University, Salem

2. Librarian (S.G), Salem Sowdeswari College, Salem.

E:mail: rajendranlibra@gmail.com

Abstract

Since laser technology was developed in 1960, the laser has experienced quick advances, getting to be one of the most significant tools utilized in the field of medicine today. During the 1970s, laser technology began to enter our daily lives with a steady stream of practical applications. The present study discusses the “Laser Technology” as reflected in Web of Science for the period from 2014–2018. The findings indicate that the growth of literature pattern is linear, and journals articles (2435) are the most preferred form of publications by the researchers to communicate their research. Wang Y is found to be the most prolific author and Optics and Laser Technology is the most preferred journal. Chinese Academy Science was the leading institutions (262) and the China, USA, Germany, India and France were the top five most collaborative countries.

KeyWords: Web of Science, Laser Technology, Medicine, Document Types, Prolific Authors

FORMULATION OF ELECTROSPUN NANOFIBERS FILM FOR WOUND CARE APPLICATION USING PVA/ CHITOSAN/ SILK SERICIN

Abirami M1, Premasudha.P2, Rajendran. R1*

1PG & Research Department of Microbiology, PSG College of Arts & Science, Coimbatore, India

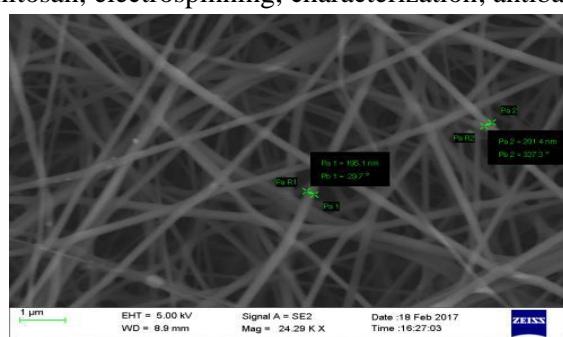
2Department of Nanoscience and Technology, Bharathiar University, Coimbatore, India

*Corresponding author E-mail: premasudha@buc.edu.in

Abstract

Due to the resistant evolved by microorganisms to the antibiotics used for medication, wound infection is a serious worldwide concern (Li and Webster, 2018). Wound healing is an evolving complicated process that demands an optimal condition to facilitate the recovery process. Because conventional dressings are unable to support the wound with a moist condition, modern dressings with quite efficient compositions have been introduced. Furthermore, to enhance the activity of the wound healing instead of simply cover it, modern wound dressing has been produced (Miguel et al., 2018). The current study is a similar kind of work where silk sericin (SS) has been employed to develop wound dressings; the dressings are antimicrobial in nature which enhances wound healing process. The wound dressing consisting of the protein was developed into nanofibers by electrospinning technique with natural and synthetic polymers of chitosan (Ch) and poly vinyl alcohol (PVA) (Ali, et al., 2019). The addition of synthetic and natural polymers with sericin protein to enhance the physical and biological properties of the developed nanofibers film and used to treat the wound. The research has been synthesized the nanofibers of PVA/ Ch/ SS electrospun scaffolds at a ratio of 50: 30:10. Subsequently it was characterized by physically, chemically and biologically. The antibacterial activity of nanofibers films was evaluated by MIC (Minimum Inhibitory Concentration) method, cell viability by L929 mouse fibroblast cell line and allergic reaction by HET-CAM assay by *in vitro* conditions. The topography of the nanofibers film was measured by scanning electron microscope and the average nanofibers diameter of 200 nm. The water contact angle of PVA and PVA/ Ch/ SS nanofibers were observed as 53° and 42° respectively. PVA/ Ch/ SS nanofibers had a swelling ratio and water vapour transmission rate of 71.3 ± 0.2 % and 2673 g/ m²/ day respectively. The film of nanofibers showed potent antibacterial activity and hemocompatibility, 80 % cell viability at levels of 200 µg / ml and also there was no irritant end point by HET – CAM method. The obtained results showed that these dressings were able to heal the wound and were proven to be biocompatibility, biodegradability and non-toxic in nature.

Keywords: Silk sericin; chitosan; electrospinning; characterization; antibacterial activity.



SEM analysis of PVA/ Ch/ SS electrospun nanofibers

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SYNTHESIS AND PHOTOTHERMAL TRANSDUCER EFFECT OF POLYPYRROLE COATED DIFFERENT SIZED GOLD NANOPARTICLES LINEAR CHAINS

K. Paul Reddy¹ and Arumugam Murugadoss^{1*}

*¹Department of Inorganic Chemistry, University of Madras,
Guindy Campus, Chennai – 600 025, India.*

*E-mail: ammuruga@gmail.com

Abstract

The assembly of gold nanoparticles (NPs) into one dimensional linear chain by using simple molecules is of great interest in cancer therapy and imaging¹⁻³. These simple molecules could not only control the number of particles involved in the assembly and also provide tuneable optical properties, especially in the NIR regions. Herein, we report the synthesis of citrate stabilized different sized Gold NPs (5, 20, and 50 nm) into linear chain by using acetanilide molecule through ligand exchange method. This different sized gold NPs chains showed tuneable optical properties in the NIR region. Interestingly, the optical property in the NIR region is further enhanced by polypyrrole (Ppy) coating demonstrates that Ppy coated gold NPs chains could be used as photothermal transducer. Our experimental observation indicates that Ppy coated gold NPs chains exhibits outstanding photothermal transducer effects and retain the excellent stability even prolong laser irradiation. Ppy coated gold NPs chains also showed good biocompatibility demonstrating it could be used as potential photothermal reagent in cancer therapy.

Keywords: Au NPs, Chain-like, Acetanilide, Polypyrrole, Photothermal transducer, and NIR.

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PLGA BASED PERSONALIZED NANOMEDICINE FOR BREAST CANCER THERAPY

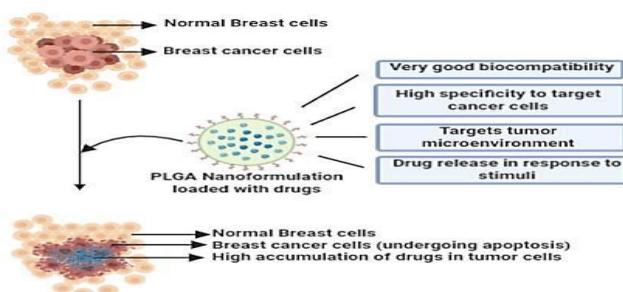
Samhita Vitta1,* , Sushma Kannapiran2, Balu Ranganathan1, Vidhya Rajagopal2

1Palms Connect LLC, Sandy, Utah, United States of America, 2Department of Biotechnology, Valliammal College for Women, Anna Nagar (East), Chennai-600 102, Tamil Nadu, India

*Corresponding Author E-mail: samhita98@gmail.com

Abstract

Breast cancer occurs in 1 in 4 cancerous women and is the leading cause of death in women with around 600,000 deaths worldwide in 2018[1]. Conventional chemotherapy has many side effects as it affects normal cells too. Thus, there is a need for effective therapies for breast cancer to reduce the mortality rate. Chemotherapeutic drugs loaded in biomaterial carriers popularly known as nanoformulations are more efficient than conventional chemotherapy as it results in higher drug accumulation within the tumor, reduced side effects and increased prognosis. Poly-lactic-co-glycolic acid (PLGA) is one such biodegradable copolymer that has been approved by the Food and Drug Administration (FDA) and European Medicines Agency (EMA). PLGA based nanoformulations are an excellent drug delivery system for breast cancer as it has targeted delivery, controlled release of drugs, and very good biocompatibility[2]. As a co-block polymer carrier, PLGA has been combined with D- α -Tocopheryl polyethylene glycol 1000 succinate (TPGS), montmorillonite (MMT), polyethylene glycol (PEG), casein, polyethylenimine (PEI) and other biomaterials to either deliver a single drug or a combination of two or more drugs like docetaxel, paclitaxel, salinomycin, tamoxifen for the treatment of breast cancer. Our focus is on the PLGA based nanoformulations, mechanisms of action as a drug delivery system, different combinations of PLGA nanoformulation ingredients as a co-block polymeric system along with the drugs they deliver and the various benefits of each combination for breast cancer therapy. Nanoformulations and nanobots as drug carriers are the future of breast cancer treatment by making personalized precision medicine possible with synergistic drug combinations with lower concentrations of the drugs that targets to kill specifically cancerous cells of the breast and target tumor heterogeneity as fast as possible with high precision and with very minimal side effects. Decapeptyl® SR manufactured by Ipsen Limited was the first FDA approved (1986) commercial PLGA nanoformulation, till date there are more than 15 such PLGA based nanoformulations approved by FDA for clinical and commercial use against different diseases. 27 PLGA based clinical trials have been reported. These 15 PLGA based commercial nanoformulations very much appreciably boost the personalized precision nanomedicine for translational research and technology development for breast cancer therapeutics involving convergence technology.



Keywords: Breast Cancer; Chemotherapy; Biomaterials; PLGA nanoformulations

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PEG-PLA COPOLYMER AS NANOFORMULATION CARRIER FOR BREAST CANCER THERAPY

Sushma Kannapiran^{1*}, Samhita Vitta², Balu Ranganathan², Vidhya Rajagopal¹

¹Department of Biotechnology, Valliammal College for Women, Anna Nagar (East), Chennai-600 102, Tamil Nadu, India, 2 Palms Connect LLC, Sandy, Utah, United States of America

*Corresponding Author E-mail: sushmakannan21@gmail.com

Abstract

Worldwide Breast cancer is the second most common type of cancer among women next to lung cancer. Recurrence is seen in 30% patients treated in their early stages of breast cancer due to therapeutic in-efficiency. Breast cancer accounts for 25% of the women cancerous patients. The major drawback of drugs are their side effects due to systemic delivery and non-targeted drug uptake. Nanoformulations-based drug delivery systems have the potential to ameliorate the problems associated with targeted delivery of potent drugs to the cancer cells thereby overcoming the side effects which at many times deprive the breast cancer patients the much needed quality of life. Polymer nanoformulations present advantageous properties as drug delivery systems when compared to conventional therapy and prognosis. PEG-PLA nanoformulations are biocompatible and biodegradable. The optimal size of nanoformulation is 10-200 nm. Polylactic acid (PLA) is a biodegradable polymer and in aqueous environments it is metabolized into water and carbon dioxide. Polyethylene glycol (PEG) presents outstanding properties like flexibility, biocompatibility, tailorabile properties and good hydrophilicity. Through copolymerised PEG-PLA has a great potential to be used for drug delivery systems as a nano carrier[1]. In PEG-PLA composition PLA is hydrophobic and PEG is hydrophilic. Wide spectrum of drug molecules like Anastrozole (ANS), Methotrexate (MTX), Bortezomib (BTZ), Thioridazine (Thio) and Doxorubicin (Dox) are loaded very effectively increasing their efficacy[2] . The main aim of the polymeric nanoformulation is rate controlled and tissue targeted release of specific drugs. PEG-PLA nanoparticles can be used for their biodegradability and amphiphilic characteristics. The drug release of PEG-PLA nanoformulations will be discussed, in particular for their modifiable characteristics, chemico-mechanical properties and their therapeutic efficacy against breast cancer. We are sending the drug inside using nanoformulations to kill the cells, along with the drugs can we send anything else for targeted delivery thereby increasing the drug payload onto the breast cancer tumor surface?

Keywords: PEG-PLA, Breast cancer, Nanoformulation, Drug delivery system

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HEMOCOMPATIBILITY STUDIES USING CHROMIUM DOPED COBALT OXIDE NANOPARTICLES ON HUMAN PERIPHERAL BLOOD CELLS

S.Sivarajanji¹, S.Mahalakshmi², P.P.Vijaya 1, 2*

Department of Nanoscience and Technology, Bharathiar University, Coimbatore – 641 046

Corresponding author: Email – vijayaparthasarathy@buc.edu.in (Dr.P.P.Vijaya)

Abstract

The cobalt oxide (Co_3O_4) and various ratios of chromium doped cobalt oxide (1% Cr: Co_3O_4 , 3% Cr: Co_3O_4 and 5% Cr: Co_3O_4) nanoparticles were synthesized using Co-Precipitation method. The prepared nanoparticles were characterized using X-ray diffraction (XRD), Field – Emission Scanning Electron Microscope (FESEM), and Energy dispersive X – ray spectroscopy (EDX). Subsequently, the various ratios of Cr: Co_3O_4 nanoparticles were analyzed for hemocompatibility via hemolysis assay, the prepared samples exhibited high biocompatibility against human Red blood cells, further insisting reliable implications in biomedical applications. From the comet assay, negligible DNA damage was observed in human peripheral blood samples treated with chromium doped cobalt oxide of various concentrations and with cobalt oxide. Therefore, Cr doped Co_3O_4 can be used efficiently as a biocompatible nanomaterials.

Keywords: Cobalt oxide nanoparticles; Cr doped Co_3O_4 nanoparticles; Hemolysis assay; comet assay.

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PARATHYROID HORMONE LOADED HYDROXYAPATITE NANORODS: IS IT AN EFFECTIVE WAY TO ENHANCE PTH ANABOLIC THERAPY?

Jay R. Dave¹, Ankush M. Dewlea, Suhas T. Mhaskea, Prashant T. Phulpagara,

Vikas L. Matheb, Supriya E. Moreb, Ayesha A. Khanc, Appala Venkata Ramana Murthyd,

Suwarna S. Datard, Ajay J. Joge, Megha Pagee, Geetanjali B. Tomara*

aInstitute of Bioinformatics and Biotechnology (IBB),

Savitribai Phule Pune University (SPPU), Pune, Maharashtra, India

bDepartment of Physics, Savitribai Phule Pune University (SPPU), Pune, Maharashtra, India

cDepartment of Chemistry, Savitribai Phule Pune University (SPPU), Pune, Maharashtra, India

dDepartment of Applied Physics, Defence Institute of Advanced Technology, (Deemed University),

Girinagar, Pune, Maharashtra, India

eDepartment of Dentistry, Deenanath Mangeshkar Hospital and Research Centre, Pune, Maharashtra, India

*Corresponding Author E-mail: geetanjalitomar13@gmail.com

Abstract

Osteoporosis is a physiological condition resulting from various factors including age, excessive usage of steroid drugs and post-menopausal estrogen deficiency. At cellular level it involves, increase in the activity of osteoclasts that result in degradation of inorganic component of bone, which eventually enhances the risk of fractures. Currently, intermittent parathyroid hormone (PTH) therapy is the only anabolic treatment approach that has been approved by FDA. But the adverse consequences associated with long term exposure of PTH limits the duration of this therapy. Moreover, the PTH is administered by sub-cutaneous mode that causes its uneven distribution to non-specific organs such as kidney and intestine. Therefore, targeted delivery of PTH to bone remains a challenge. Being the natural component of bone, use of hydroxyapatite for such a targeted delivery holds a great potential. Hydroxyapatite exhibits an overall negative surface charge, ability to solubilize at lower pH and provide a surface to adsorb various chemical species, thus making it an ideal candidate for targeted delivery of PTH to bone. In this study we focused on synthesis, characterization and evaluation of *in vitro* and *in vivo* efficacy of PTH adsorbed hydroxyapatite nanocarrier for synergistic enhancement in the anabolic activity of PTH for bone regeneration. We synthesized hydroxyapatite nanoparticles (nHAp) using wet chemical precipitation technique and adsorbed recombinant parathyroid hormone (PTH) (1-34) on these nanoparticles. The nanoparticles were characterized using scanning electron microscopy, transmission electron microscopy and dynamic light scattering. We determined that size (50-150 nm), Ca/P ratio (1.7) and the zeta potential (-14) of the PTH (1-34) conjugated nanorods. The release kinetics of PTH (1-34) from conjugate reveled that optimum release was at low pH (6.8) after 4 hour of administration, due to slow solubilization of nHAp. Our *in vitro* and *in vivo* findings claim that nHAp-PTH (1-34) conjugate supports our hypothesis by reducing osteoclast numbers (H&E Staining), increased calcium deposition (alizarin red S and alkaline phosphatase activity), enhanced expression of bone associated markers (alkaline phosphatase, RUNX2, osterix, collagen type I and osteocalcin) and overall improvement in bone health (colony formation). A net negative zeta potential on the nanocarrier facilitated its affinity to Ca²⁺ rich bone tissue and solubilized at low pH enhancing targeted delivery of PTH to the resorption pits in osteoporotic bone. In this process, PTH retained its anabolic effect and at the same time an increase in bone mineral content indicated enhancement of the net formative effect of the PTH anabolic therapy.

Keywords: Parathyroid hormone (1-34); Hydroxyapatite; Osteoporosis; Synergistic Anabolism.

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GREEN NANOCOLLOIDS TO CONTROL BOVINE MASTITIS PATHOGENS

S. Ranjani¹, Shruthypriya. P¹, Maroudam veerasami², M, Nachimuthu Senthil Kumar³, Ruckmani, K⁴. and S. Hemalatha^{1*}

¹*School of Life Sciences, B.S. Abdur Rahman Crescent institute of Science and Technology, Chennai-India*

²*Cisgen biotech discoveries Pvt limited, Chennai, Tamil Nadu, India.*

³*Department of Biotechnology, Mizoram University, Aizawl – 796 004, Mizoram, India*

⁴*Department of Pharmaceutical Technology, University College of Engineering, Anna University BIT Campus, Tiruchirappalli-620024, Tamilnadu, India*

*E-mail:*ranjani.sls@crescent.education; hemalatha.sls@crescent.education

Abstract

Mastitis is a widespread disease in dairy cattle occurring throughout the world. The application of antibiotics in dairy farming led to increased antibiotic resistance and represents a major complication for the treatment of mastitis. Recent advancements in nanotechnology led to the development of green nanocolloids to overcome disadvantages posed by conventional antimicrobial agents. Hence, Tri Green herbalNanocolloids (TNc) was formulated using the extracts of herbs and physiochemically characterised. Antibiotic resistant organisms were isolated from mastitis milk samples and sequenced as *Acinetobacter junii*, *Acinetobacter baumannii*. All the isolated strains were tested with TNc and compared with antibiotics. MIC, growth curve, MBC, and biofilm assays were performed at different concentrations and antibacterial effects were quantified and the genes responsible for antibiotic resistance were analyzed. In our results, TNc showed potent bacteriostatic, bactericidal and antibiofilm activity against all the strains. Further, the antibiotic resistant gene CTXM-15 expressions were suppressed upon treatment with TNc. Our results showed that TNc can reduce the virulence factors responsible for infection by different bacterial strains. This study confirmed that GNc had the potential to inhibit the growth of pathogenic bacteria and could be utilized as an alternative to antibiotics to inhibit MDR pathogens. Furthermore in vivo trials help us to develop potent anti-mastitis nanoformulation in protecting the Bovine from deadly infection.

Bacterial strains from Mastitis milk samples were isolated and identified by 16S rRNA sequencing. Phylogenetic tree was built using MEGA-X by maximum likelihood method. Bacterial species were identified as *Acinetobacter junii* and *Acinetobacter baumannii* and deposited in NCBI GenBank with accession number MK882940 and MK883039, respectively. From the Disc diffusion assay it was observed that *A. junii* and *A. baumannii* were resistant to ampicillin and susceptible to streptomycin, ceftriaxone, cefoperazone and enrofloxacin. The presence of antibiotic resistant genes in the test organism play a crucial role in making the test organism resistant to Ampicillin. The resistant genes code for enzyme beta lactamases which will hydrolyse the beta lactam ring present in Ampicillin and make the drug inactive. The raise of a greater number of antimicrobial

resistant organism is a major threat to all livelihood on the world. So, developing alternative to antibiotics is the need of the hour to solve the problem developed because of antibiotic resistant strains.

The qualitative analysis of polyherbal extracts for the presence of phytochemicals showed the presence of flavonoids, tannins, phenols, and steroids. The phenolic compounds are the largest groups of plant metabolites having aromatic ring. Phenolic compounds exhibit several biological properties in treating cancer, atherosclerosis, inflammation, cardiovascular disease and for endothelial function. Phenolic compounds such as flavonoids, phenolic acid, and phenolic diterpenes possess antioxidant effect through its quenching action on singlet and triplet oxygen. Tannins can inhibit the growth of microorganisms by binding to protein and interfere with enzymes involved during translation. Flavonoids are the phytochemicals present in plants which possess anti-inflammatory, antibacterial and antioxidant properties. They are hydroxylated phenolic compounds of plant extract act as potent anti-microbial agent. Steroids act as a potent antibacterial compound through interacting with membrane lipids of bacterial cell and initiating membrane leakages.

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EVALUATION OF ANTIBACTERIAL ACTIVITY FOR SYNTHESIS, CHARACTERIZATION; CHITOTRIAZOLAN VIA “AZIDE ALKYNE CLICK REACTION”

Sankar Rathinam¹, Martha Hjálmarsdóttir², Mikkel B. Thygesen³, Már Másson^{1*}

¹Faculty of Pharmaceutical Sciences, School of Health Sciences, University of Iceland, Hofsvallagata 53, IS-107 Reykjavík, Iceland. ²Biomedical Science, Faculty of Medicine, School of Health Sciences University of Iceland, Reykjavík, Iceland. ³Department of Chemistry, University of Copenhagen, Thorvaldsensvej 40, 1871 Frederiksberg, Denmark.

*Corresponding Author E-mail: mmasson@hi.is

Abstract

Click chemistry” is a term which was first described by K. B. Sharpless. To describe reactions that afford products in high yields and in excellent selectivity’s by carbon-hetero bond formation this methodology is an eco-friendly reaction [1]. Chitosan is derived from chitin and it is an abundant, renewable polysaccharide which exhibits attractive biopolymer properties for many biomedical applications such as non-toxicity, biocompatibility, and biodegradability [2,3]. There have been few studies on the modification of chitosan via click chemistry. Two studies have reported the conversion of the C-2 amino group to an azide and then click reactions [4, 5], and C-6 azido chitosan was synthesized as intermediate via C-2 amino group-modified phthalimide protection, then click reactions [6, 7]. The present work focused on design and synthesis of a new class of chitosan derivatives where all C-2 primary amino groups have been converted to aromatic 1,2,3-triazoles (Chitotriazolan). The chitosan amines were converted to azides and then reacted with terminal alkynes in the presence of Cu (II) catalyst and sodium ascorbate. Herein, we have synthesized chitotriazolan products by two pathways, with and without protection of hydroxy groups with TBDMS (C-3 and C-6 position). A previous study found that chitosan could not be converted in more than 40% from amines to triazole via N-azidated chitosan [5]. In the current work we were successful in obtaining full conversion to obtain the first water soluble chitotriazolans. Eleven chitotriazolans were synthesized through two routes and five of the structures had good water solubility. These structures were characterized by ¹H-NMR and IR spectroscopy. The degree of azidation to 1,2,3-triazole was more than 90%, as confirmed by ¹H-NMR. The antibacterial activity was evaluated against *S. aureus* and *E. coli* at pH 7.2. Two of the cationic chitotriazolans had good antibacterial activity whereas the anionic chitotriazolans were inactive.

Keywords: Click chemistry; Chitosan; 1,2,3-Triazole; Antibacterial activity.

Result Discussion:

The formation of trimethyl cationic chitotriazolan using Cu (II) catalyzed cycloaddition reaction in the presence of propargyl trimethylammonium bromide salt and then deprotection of OTBDMS using hydrochloric acid in methanol. The propargyl trimethylammonium bromide salt was synthesized according to the reported procedure briefly, an equimolar quantity of trimethylamine and propargyl bromide in acetonitrile at -20 °C the reaction mixture warmed to room temperature for 24 h to obtained white solid. In the first method chitotriazolan’s has been synthesized two samples with the difference of trimethyl and dimethyl chitotriazolan.

FLURO-PROTEIN C-PHYCOCYANIN DOCKED SILVER NANOCOMPOSITE AND ROLE OF TRANSCRIPTIONAL FACTOR NFkB DURING FIBROBLAST CELL MIGRATION

Madhyastha H1*, Eishika Chakraborty2, Madhyastha, R11., Ohe K3., Oshima T3., Sajitha L.S2., Sudhakaran R2., Maruyama M2., Nakajima.Y1.

1Department of Applied Physiology, Scholl of Medicine, University of Miyazaki, Miyazaki, Japan

2School of Biosciences and technology, VIT University, Vellore, India

3Department of Applied Chemistry, Faculty of Engineering, University of Miyazaki, Miyazaki, Japan.

*Correspondence Author Email: hkumar@med.miyazaki-u.ac.jp

Abstract

Silver conjugated nanoceutical in regenerative medicine is popular trend and there is an unmet demand for the control of tissue inflammation. Unfortunately, no or very little research being carried out on antioxidant dopped silver nanometals and its interaction on the signaling axis during the bio-interface action. Herein, cytotoxicity, metal decay, nanoconjugate stability, size expansion, antioxidant assay and signal transduction array of C-Phycocyanin (natural fluorescent protein) primed silver nano hybrids (AgcPCNP) were validated towards *in vitro* wound healing phenomenon. Physiologically relevant ionic solutions did not exhibit the adverse effect on the nanoconjugate stability however, acidic, alkali and ethanol solution completely denatured the AgcPCNP conjugates. Signal transduction RT2-PCR array demonstrated the NFkB and PI3K pathway associated genes significantly ($p<0.5\%$) fluctuated upon AgcPCNP than AgNP group. Specific inhibitor of NFkB (NFI) and PI3K (LY294002) pathways confirmed the involvement of NFkB and PI3K signaling axis. *In vitro* wound healing assay demonstrated that NFkB pathway plays the prime role in the fibroblast cell migration during process. In conclusion, the present investigation revealed surface functionalization by anti-oxidant bioagent C-phycocyanin suppresses the AgNP mediated stress responses and associated signaling axis in fibroblast cell during the cell migration scenario

Keywords: Silver doped C-phycocyanin (AgcPCNP), Cell migration, Pathway array, wound healing

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ANTIMICROBIAL AND PHOTOCATALYTIC INVESTIGATION ON PHYTO MEDIATED AG/FE₃O₄/GO NANO COMPOSITES

A. Gomathi1, S. Chandraleka1, T. M. Sridhar2, M. R. Kuppusamy1*

1 Dept. of Chemistry, R.V.Govt.Arts College, Chengalpattu-603001.

2 Dept. of Analytical Chemistry, University of Madras, Guindy Campus, Chennai-600025

* E-mail: rksamyrvg@gmail.com.

Abstract

The phytomediated Ag/Fe₃O₄/GO nano composites were synthesized from banyan and mangrove tree fresh aerial root tip extract. The phytochemical components cause banyan and mangrove aerial root tip extracts as a reducing and protecting agents to be able to reduce metal ions and stabilize produced NPs. The synthesized nano composites were characterized by analytical techniques (UV-visible, FTIR, XRD, SEM and VSM) and spectral studies. To determine the effectiveness of phytomediated plants aerial root tips extract-ternary nanocomposite of Ag/Fe₃O₄/GO for the removal of MB dye and its antibacterial activity. The MB dye content were estimated spectrophotometrically at 663 nm. Optimum adsorbent dose for MB dye initial concentration of 0.05g for nano composite. The antibacterial activities of the banyan and mangrove aerial root tip extracts Ag/Fe₃O₄/GO nano composite against gram negative bacteria as a *E.coli* and *colliforms* by Zol and MBC with appropriate controls. The blend of banyan and mangrove aerial root tip extracts Ag/Fe₃O₄/GO nano composite were remarkable percentage of bacterial activity against *E.coli* and *colliforms*.

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GREEN SYNTHESIS ASSISTED HYDROXYAPATITE-GRAPHENE OXIDE COMPOSITE FOR BONE REGENARATION

Sundara Ganeasan .M1 and Sridhar .T.M1*

1Department of Analytical Chemistry, University of Madras, Guindy Campus, Chennai-25.

*E mail; sundarganesh33@gmail.com, tmsridhar23@gmail.com.

Abstract

In recent years, the bone disorder diseases are becoming very common in which hydroxyapatite (HAP) has been a promising material for the bone regeneration and repairing hard tissues. The addition of polymers has strengthened the properties of biocompatibility and also favours in bone regeneration. The use of natural polymers has excellent biocompatibility and low toxicity. Even though polymer-hydroxyapatite composite has many advantages, certain properties like low tensile strength, low mechanical strength etc limits its use in biomedical applications. Graphene Oxide (GO) has been a promising material in diverse applications. The polymer-hydroxyapatite has been synthesized by wet chemical precipitation method and graphene oxide has been prepared by using modified Hummers method respectively. The surface morphologies were examined by optical microscopy, FTIR studies to identify the functional groups, XRD to determine the purity of the prepared composite. The immersion studies and bio-degradation studies can be done by using the Stimulated Body fluid (SBF), Tris HCL for a period of 14 and 7 days respectively.

Key Words: Hydroxyapatite, Graphene oxide, Pectin, SBF, Immersion Studies.

SYNTHESIZE OF ALOE-LIGNIN BASED ELECTROSPUN AIR FILTER

Liya Therese A J1*, Dhanakumar S1, Arunkumar M1, Kiruthika S2

1Department of Environmental Science, PSG College of Arts and Science,
Coimbatore, India.

2Department of Microbiology, PSG College of Arts and Science, Coimbatore, India

*Corresponding Author E-mail: liyathereseaj12@gmail.com

Abstract

Masks have now become a part of daily life since the outbreak of COVID-19 and to combat the increasing atmospheric pollution load and infectious microorganisms. Though the commercially available multi-layered synthetic masks claim better protection against air pollutants and microorganisms, most of them have shown disadvantages of poor PM2.5 rejection, low air permeability, and inefficiency against microorganisms. Further, the synthetic nature of the available masks takes a longer time for degradation, leading to environmental and health implications during usage as well as disposal and also economically not feasible for regular usage. In this context, the preparation of bio-based air filters with the ability to control common air pollutants and pathogenic microorganisms without affecting the environment is the need of the hour. The current study aimed to synthesize an *Aloe*-lignin-based electrospun air filter with an antimicrobial finish to improve filtration efficiency for particulate matters, gaseous pollutants, and pathogenic microorganisms. *Aloe Vera* was chosen as raw material for the extraction of lignin and antimicrobial agents. Methanol was identified as the better-extracting solvent to recover antimicrobial agents from powdered *Aloe Vera* gel extracted using Soxhlet extractor for 24 hrs and a zone of inhibition of 18 mm and 17 mm was observed for *Escherichia coli* and *Staphylococcus aureus*, respectively. Lignin from the dry *Aloe vera* rind was extracted using alkali treatment. The electrospun air filter was synthesized by electrospinning at optimal conditions of 0.8 g lignin, 0.2 g dried *Aloe vera* gel powder, and 0.5 g PBT, with a flow rate of 500 μ l at 10 kV and distance of 12cm for a period of 2 hrs. The electrospun layer was combined with non-woven polypropylene fabrics (coated on the interior and exterior layers with tested antimicrobial finish by Pad and Dry method), and activated carbon cloth as an effective approach leveraging its mechanical support and filtration efficiency to form hybrid masks. The synthesized material was characterized by SEM, FTIR, and the filtration efficiency was evaluated using Cigarette second-hand smoke for the electrospun air filter and hybrid mask. FTIR spectrum confirmed the presence of characteristic bands for functional groups like alcoholic and phenolic hydroxyl groups. SEM micrographs showed that the fibers were non-woven, homogenous, finely spun with the uniform binding of *Aloe vera* and lignin, that increased porosity for effective filtration of airborne contaminants. It was evaluated that the electrospun filter and hybrid mask showed better performance with above 95-99% for micron size particles and particulate matter and about 82-98% for various gaseous pollutants. Thus, this study can be regarded as a promising solution for air filtration and can be efficiently used as an alternative filter media that can alleviate air contamination and simultaneously preserve good breathability.

Keywords: Electrospinning, *Aloe*-lignin, Bio-air filter, Filtration Efficiency

SILK FIBROIN-SURFACTANT INTERACTION: MOLECULAR, STRUCTURAL AND RHEOLOGICAL INSIGHTS

Swarali Hirlekar^{1,5}, Debes Ray², Vinod K. Aswal², Asmita Prabhune^{3,5},
Sapna Ravindranathan⁴, Anuya Nisal^{1,5*}

¹ Polymer Science and Engineering division, ³ Biochemical Sciences Division, ⁴ Central NMR facility, CSIR- National Chemical Laboratory, Homi Bhabha Road, Pashan, Pune, India

² Solid State Physics Division, Bhabha Atomic Research Centre, Mumbai, India

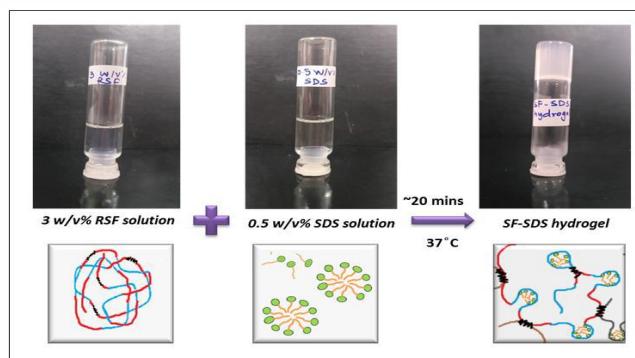
⁵Academy of Science and Innovative Research (AcSIR), Gaziabad, India

*Corresponding Author E-mail: aa.nisal@ncl.res.in

Abstract:

Silk fibroin (SF) hydrogels find wide applications in tissue engineering¹. However, their scope has been limited due to the long gelation time in ambient conditions. Reduction in gelation time of SF to minutes is seen upon doping with surfactants². The mechanism of gelation of SF by a model anionic surfactant Sodium dodecyl sulfate (SDS) was studied. Even though interactions between SDS and proteins have been extensively investigated, most of these studies have focused on globular proteins, which undergo denaturation³. The interaction with a fibrous protein such as SF is different and results in an altered secondary structure leading to gelation⁴. The concentration-dependent gelation process of the SF-SDS system was examined using rheology, SANS, FTIR, and NMR. We observed preferential binding of SDS to specific amino acids on the SF chain, which aids structural changes favouring β -sheet formation. This structural change ultimately leads to sol to gel transition. Further, doping of aqueous SF solution with a newly synthesized lauric acid sophorolipid (LASL) shows reduction in gelation time of silk fibroin to minutes. LASL comprises of a fatty acid - lauric acid (with 12 carbons aliphatic chain) that is derivatized by glucose molecules using a non-pathogenic yeast *Starmarella bombicola*. LASL was characterized using spectroscopic (FTIR) and chromatographic (HPLC, TLC and HRMS) methods. This gelation of SF by LASL is comparable to the effect of SDS owing to the similarity in their structures. The microstructure of SF-LASL hydrogel was investigated by Small angle neutron scattering (SANS) measurements and exhibited the beads-on-a-necklace model. The rheological properties of these hydrogels shows similarity to SF-SDS hydrogel. Since LASL is a bio-derived molecule, it presents a greener alternative as a gelling agent for tissue engineering applications.

Keywords: Silk fibroin; Gelation; Surfactant; Sophorolipid.



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MYRISTIC ACID DERIVED SOPHOROLIPID: SYNTHESIS AND APPLICATIONS

Isha Abhyankar a1, Ganesh Sevib2, Asmita A Prabhunec2,

Anuya Nisala*, Santhakumari Bayatigeri b2

a- PSE Division, CSIR-National Chemical Laboratory, Homi Bhabha Road, Pune-411008

b- CMC Division, CSIR-National Chemical Laboratory, Homi Bhabha Road, Pune-411008

c- Biochemical Sciences Division, CSIR- National Chemical Laboratory, Homi Bhabha Road, Pune

Email: aa.nisal@ncl.res.in

Abstract

Microbial glycolipids are one of the most interesting alternatives to chemical-based surfactants as they exhibit improved biodegradability and less toxicity. Despite this, narrow substrate specificity of the yeast enzymes and low product yield associated with sophorolipid biosynthesis, have hampered exploitation of their full potential. This study focuses on sophorolipid production by the yeast *Starmerella bombicola* using myristic acid, a medium-chain fatty acid that is rarely used as a substrate for sophorolipid production [1,2]. Analysis of its interfacial property revealed that the C14:0 sophorolipid has promising surface tension lowering abilities with CMC of 14 mg/L. The derived sophorolipid was structurally characterized by spectroscopic and chromatographic techniques followed by purification of individual congeners. Interaction between proteins and surfactants have been extensively studied [3,4]. This study focuses on hydrogels using sophorolipid and fibrous protein, silk fibroin. Silk fibroin is well known for tissue engineering due to its varied biological properties. Hydrogels using oleic acid sophorolipids have been explored earlier, however, the effect of different chain length substrate on the gelation time is yet to be explored. This study reveals that myristic acid derived sophorolipid drastically affects the gelation time of silk fibroin hydrogels. The gelation time is reduced to minutes. Further the C14:0 sophorolipid was found to be more potent against gram-positive than gram-negative organisms in terms of concentration and time interval. The derived sophorolipid exhibited superior antibacterial activity as compared to sophorolipid derived from the natural substrate oleic acid.

Keywords: Sophorolipid, myristic acid, Silk fibroin, hydrogels, anti-bacterial

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NEW GENERATION MODIFIED GRAPHENE OXIDE REINFORCED HDPE/UHMWPE BIOMATERIAL FOR ACETABULAR LINER IN TOTAL HIP JOINT REPLACEMENT

Vidushi Sharma^{a†}, Suryasarathi Boseb, *, Bikramjit Basua,c,*

*a*Laboratory for Biomaterials, Materials Research Centre, Indian Institute of Science,
Bangalore 560012, India

*b*Department of Materials Engineering, Indian Institute of Science, Bangalore 560012, India

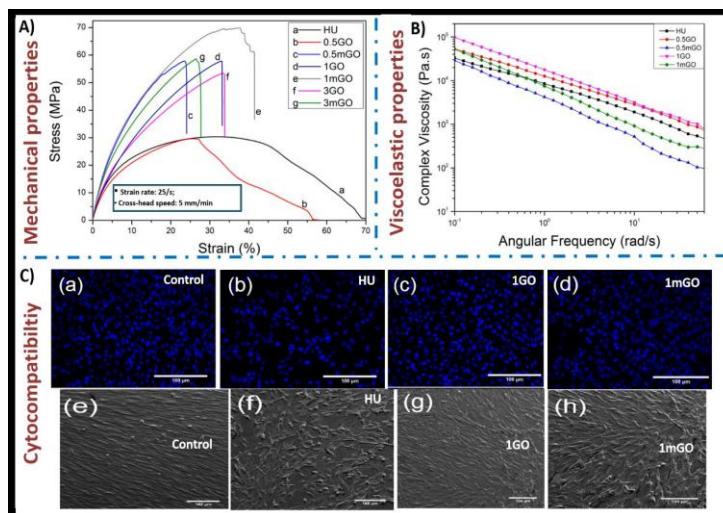
*c*Centre for Biosystems Science and Engineering, Indian Institute of Science,
Bangalore 560012, India

Authors' email address: vidushis@iisc.ac.in, bikram@iisc.ac.in

Abstract

The generation of wear debris at the articulating surface induces osteolysis, resulting in aseptic loosening, bone degradation, and bone formation suppression. To combat such clinically relevant issues, this study explores the development of new generation UHMWPE based nanocomposites. In the present work, a 'dual-hybrid' approach is employed for the fabrication of polymer-based nanocomposite, which consists of a blend of high-density polyethylene (HDPE) and Ultra-high molecular weight polyethylene (UHMWPE) reinforced with modified graphene oxide (mGO). This novel nanocomposite (NC) is processed using a conventional melt-mixing mode, which resulted in better dispersion of mGO in the HDPE/UHMWPE matrix (HU). The nanocomposite reinforced with 1wt% mGO showed better mechanical, structural, viscoelastic and cytocompatible (with C2C12) properties as compared to the pristine HU blend as well as other compositions, as shown in **Figure 1**. Moreover, from a clinical standpoint, the nanocomposite was then γ -sterilized with a dosage of 25 kGy, to understand its clinically relevant performance-limiting properties. These properties mainly include wear properties (tested using a pin-on-disc tribometer) and cytocompatibility (assessed via assays like WST, live/dead assay). We observed that γ -ray sterilized nanocomposite exhibited an improvement in the oxidative index (16%), the free energy of immersion (-12.1 mN/m), and hardness (42%) which further resulted in better wear properties predominantly coefficient of friction (CoF) [refer **Figure 2**]. Besides, the generated wear debris were observed under a transmission electron microscope (TEM), which demonstrated that most of the particles were phagocytosable ranging between 0.5 μ m to 4.5 μ m, as shown in **Figure 3**. Despite such a size range, these wear particles did not induce any cytotoxic effects on the proliferation and morphology of both human mesenchymal stem cells (hMSCs) and MC3T3 murine osteoblast cells when seeded in 5 mg/ml of concentration for 72 h [**Figure 4 and 5**]. The enhancement observed in the

nanocomposite properties is critically dependent on the uniform dispersion as well as on the scavenging effect of mGO in the polymer matrix even after gamma-sterilization. In the above backdrop, it can be concluded that this new generation mGO reinforced HDPE/UHMWPE nanocomposite can act as a promising candidate for load-bearing orthopedic applications, especially as an acetabular liner in total hip joint replacement (THR).



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A NANO POROUS MIXED OXIDE COATINGS OVER 316L SS FOR ORTHOPAEDIC IMPLANT APPLICATIONS

*Mahalakshmi Subbiaha, PadmaSanthiya MuthuKrishnanc,
Sabarinathan Venkatachalamab, Nagarajan Srinivasanc**

*a Department of Renewable Energy Science, Manonmaniam Sundaranar University,
Tirunelveli, India*

b Department of Physics, Manonmaniam Sundaranar University, Tirunelveli, India

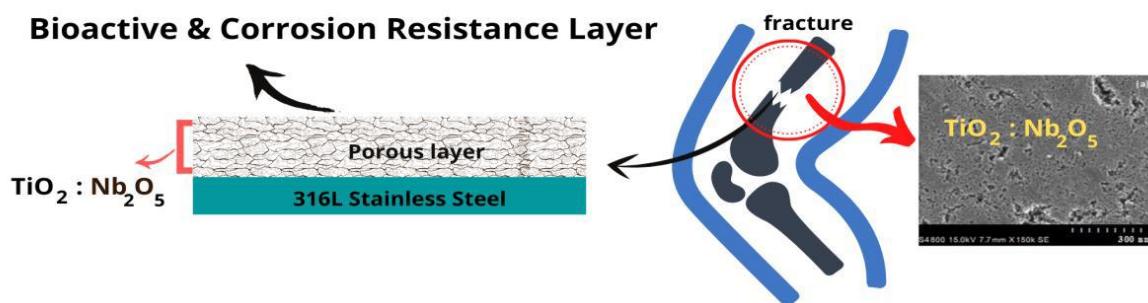
c Department of Chemistry, Manonmaniam Sundaranar University, Tirunelveli, India

*Corresponding Author: snagarajan@msuniv.ac.in

Abstract

This study intends to evaluate the corrosion resistance and biocompatibility of nanoporous titanium and niobium mixed oxides coating for orthopaedic bioimplants. A thin layer of nano mixed titanium and niobium oxide was coated on 316L stainless steel (SS) through dip-coating method. Surface analysis by AFM, TEM, and SEM with EDAX reveals that metal oxide coated film has high surface porosity and uniform distribution of highly crystalline particles. In-vitro bioactivity test of mixed oxide coating of niobium and titanium in SBF solution results in the formation of carbonate-containing apatite layer over the surface. The coated film acts as a barrier for the migration of ion in an electrolyte with the austenitic stainless steel results in offering the high corrosion resistance to suffer from localised corrosion.

Keywords: Crevice Corrosion, Niobium Oxide, Titanium Oxide, Superaustenitic Stainless Steel



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INFLUENCE OF ISOSTATIC AND UNIAXIAL COMPACTION DURING PROCESSING OF MEDICAL GRADE ULTRA-HIGH MOLECULAR WEIGHT POLYETHYLENE POWDER FOR BIO-MEDICAL IMPLANTS

Ashirbad Jana¹, S. Senthilvelan², S. Kanagaraj²

Department of Mechanical Engineering, Indian Institute of Technology Guwahati, Assam, India

Corresponding Author E-mail: j.ashirbad@iitg.ac.in

Abstract

Ultra-high molecular weight polyethylene (UHMWPE) is a high-performance bio-compatible polymeric material having high impact resistance, good wear resistance and chemical inertness. It is majorly used in bio-medical implants along with ship building, ballistic application and textile industries. However, processing of nascent UHMWPE powder to a defect free product is still a challenge due to its high molecular weight, entanglement density and melts viscosity. Limited processing techniques of UHMWPE like ram extrusion and compression moulding produced anisotropic products with numerous flaws including fusion defects. Sintering of polymer, inspired from powder processing technique, may emerge out as an alternative choice for the same. The objective of present study is to process medical grade UHMWPE GUR1050 powder by two different techniques with suitable processing parameters and to compare their mechanical properties along with inherent flaws. In case of the conventional compression moulding technique, the polymer powder was heated under uniaxial pressure (UP) using a metallic mould of desired geometry. In another technique, an unconventional way of processing the polymers, the cold compaction of UHMWPE powder was done using an isostatic press (IP), where flexible rubber mould of chosen shape was used to get desired green compact product followed by free sintering. A Scanning electron microscope (SEM) was used to observe the cross section of both UP and IP products to identify the inborn flaws corresponding to their processing techniques. Density, hardness and tensile properties of the materials processed by both techniques were measured and compared. UP material was found to have fusion defect and non-homogeneous coalescence, whereas IP material has no visible flaws. Relative density of the UP product was found to be 98.8% compared to 99.2% obtained for the IP product. Vickers hardness and tensile strength at yield of the IP material were observed to be higher by 8 % and 15%, respectively, compared to that of UP material. It is concluded that GUR 1050 UHMWPE powder can be processed alternatively by cold isostatic compaction and sintered to a product with less defects and better mechanical properties compared to compression moulding.

Keywords: Ultra high molecular weight polyethylene; compression moulding; fusion defect; cold isostatic compaction and sintering

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DEVELOPMENT OF SUPER HYDROPHOBIC POLY (ETHYLENE TEREPHTHALATE) SURFACE BY IMPREGNATION OF CARBON NANO PARTICLES FOR BLOOD CONTACT DEVICE APPLICATIONS

Balachander N1, Yuvaraj S2

Department of Materials science, Central university of Tamilnadu, Tiruvarur, India.1

Department of Physics, Coimbatore Institute of Technology, Coimbatore, India2

Abstract

The Polyethylene Terephthalate (PET) was impregnated by Carbon, acetylene plasma as a source. Ultrasonic cleaned PET samples cut into 5x5 cm and admitted for different plasma processing period of 10, 20 and 30 minutes with 60:60 sccm of acetylene argon mixture. The transparent PET sheet becomes yellowish to light grey in colour with respect to carbon impregnation over the polymer. Meanwhile the analysis with respect to structural, optical properties and hydrophobic activity also described in this work. Hereby the 2D peak of incorporated carbon and modes which present the effect of process was derived by Raman spectroscopy and the presence of functional groups with respect to the stretching and bending modes described by Fourier Transform Intra-Red spectroscopy. The presence of UV absorption and emission bands observed via UV-Visible spectroscopy and Photoluminescence Spectroscopy respectively. The water droplet flow over the pure and plasma processed PET samples are justified by manually assigned online protector and the maximum processed samples shown around 153° contact angle between water and solid reveals super hydrophobic activity of plasma processed PET sample. Plasma processed PET brings the unique properties applies to the medical field shows the blood storage devices and liquid medicines flow tubes due to high microbial and non-toxic behaviour to human cell tissues.

Keywords: Polyethylene Terephthalate (PET), Acetylene plasma, hydrophobic activity

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THERMORESPONSIVE POLYMER FOR CORNEAL CELL SHEET ENGINEERING: A PRELIMINARY VALIDATION STUDY

Anju MS, Deepa K Raj, Anil Kumar PR, Naresh Kasoju*

1Division of Tissue Culture, Department of Applied Biology, Biomedical Technology Wing, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram, Kerala, India

*Corresponding Author E-mail: naresh.kasoju@sctimst.ac.in (NK)

Abstract

Disease, aging or accidental damage of the ocular surface, particularly the corneal tissues which is a major component of the visual system, results in partial or complete blindness. Restoration of corneal epithelial tissue by the gold standard keratoplasty approach is limited due to shortage of donors. Cell sheet technology, a scaffold-free tissue engineering strategy, is a potential alternative approach to recreate commercially and clinically viable 3D corneal epithelial tissues. Cell sheet engineering allows the retrieval of intact cell layers without any changes in their naturally organized extracellular matrix, and overcomes the difficulty of finding a non-toxic, non-immunogenic and biocompatible scaffold as in conventional bottom-up approach. In the current study, we present Poly (N- isopropylacrylamide-co-glycidyl methacrylate) (NGMA) – a copolymer of (poly[N-isopropylacrylamide]) (NIPAAm) and Glycidyl methacrylate (GMA), as a thermoresponsive substrate for bioengineering corneal epithelial cell sheets. Briefly, we synthesized various batches of NGMA by following free radical random copolymerization of the monomers NIPAAm and GMA, in presence of 2,2'-azobisisobutyronitrile under inert conditions. All the synthesized batches are then characterized and confirmed for its various chemical, molecular, thermal, physical properties, by following Fourier transform infrared spectroscopy, nuclear magnetic resonance spectroscopy, gel permeation chromatography, differential scanning calorimetry, UV-Visible spectroscopy, surface profilometry and contact angle. The substrates were then tested for in vitro cytotoxicity as per ISO 10993-5 in an accredited laboratory. Subsequently, corneal cells were cultured on NGMA coated culture dishes at 37 °C and the cell sheets were retrieved by incubating the dishes in refrigerated conditions for short time. For the validation purpose, the physico-chemical characterization studies and the in vitro corneal cell culture studies were carried out on various batches of NGMA substrate and all the batches showed comparable results. To conclude, NGMA – a novel thermoresponsive polymer was successfully synthesized and characterized for its physico-chemical properties, and its potential applications as a substrate for corneal epithelial cell sheet engineering was established.

Keywords: corneal tissue engineering; thermoresponsive polymer; cell sheet technology

DESIGN AND CHARACTERIZATION OF GALACTOSE CONJUGATED POLYCAPROLACTONE NANOFIBROUS SCAFFOLDS FOR UTERINE TISSUE ENGINEERING APPLICATIONS

Srividya.H, Manasa Nune* Manipal Institute of Regenerative Medicine-Manipal Academy of Higher Education, GKV Post, Allalasandra, Yelahanka, Bengaluru, Karnataka 560065
Email: Srividya.h@learner.manipal.edu

Abstract

Introduction: One in every five hundred women in their fertile years are affected by Absolute Uterine Factor Infertility (AIFI), which is depicted as the improper uterine function due to tissue damage caused by previous procedures like cesarean section, myomectomy, etc. Course of treatment for this defect is usually organ transplantation. But the success rate of complete recovery after this procedure is very minimal considering the risk factors such as premature births, postpartum hemorrhage leading to hysterectomy amongst other complications. Another major disadvantage is the shortage in donor organs and long-term immunosuppression. Therefore, the concepts of tissue engineering in uterus have emerged as a potential solution. For Uterine tissue regeneration, the scaffold should ideally be made of materials with mechanical, physical, and biological properties similar to the native tissue. Uterine tissue is highly elastic in nature and is made up of several sheets of membranes and elastic fibrils which probably allow the uterus to maintain its tensile strength without exerting excess pressure on the growing fetus. Therefore, the objective of this study was to create a nanofibrous scaffolds similar to native ECM using polycaprolactone (PCL) as a biomaterial. PCL nanofibers being highly hydrophobic, were surface modified using wet chemistry method, where primarily amine groups were introduced on the surface followed by galactose (a lectin-binding sugar) conjugation. Rationale of this modification is presence of galactose enhances the hydrophilicity of the PCL fibrous substrate due to which cell adhesion is improved on fibers and also increases L-Selectin based interaction of fibers with uterine cells which leads to the activation of uterine fibroblasts which results in the remodeling of the ECM.

Methods: Nanofibers are synthesized by electrospinning process in which parameters such as polymer concentration, applied voltage, solution flow rate, distance between charged capillary and collector, needle gauge size were optimized. Surface modification was done by aminolysis and galactose conjugation and characterized using Scanning Electron Microscopy, contact angle analysis, Fourier Transform Infrared spectroscopy, Ninhydrin assay and ELLA assay. Cytocompatibility of the pristine and modified scaffolds was evaluated using Human uterine fibroblasts.

Results: Human uterine fibroblasts were grown on PCL and galactose grafted PCL scaffolds in order to study the effect of galactose on cell growth, attachment and proliferation. MTT assay and live-dead assay were performed and the obtained results proved that the galactose immobilization improved the cell attachment and proliferation rates on the modified scaffolds.

Conclusion: The designed nanofibers scaffold could potentially be used as a novel scaffold for uterine tissue engineering applications.

Keywords: Uterine Tissue engineering, Nanofibrous Scaffolds, Polycaprolactone, Electrospinning, Galactose grafting

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ENGINEERING AND FUNCTIONALIZATION OF LAYER-BY-LAYER SELF-ASSEMBLED BIOMATERIAL

Amreen Khan¹, Rohit Srivastava^{2*}

Department of Biosciences and Bioengineering, Indian Institute of Technology Bombay,

Mumbai, India

*Corresponding Author E-mail: rsrivasta@iitb.ac.in

Abstract

Layer-by-Layer (LbL) self-assembly has demonstrated multifunctional advents even in nanometer precision. As a drug delivery agent, LbL shows advancements in various applications including potential cancer treatment. Through depositing alternative layering of different material assisted by charged polyelectrolytes, various components including biomolecule can be carried to the targeted site releasing depots in a controlled manner [1][2]. However, the objective to achieve enhanced efficacy and reduced toxicity of polymeric nanoparticles or films using the most versatile and simple LbL technique remains obscure seeking resolution [1]. The engineering of nanoparticles still becomes more difficult when incorporating material with varying properties coupled for diagnosis. Here, we synthesized polymeric electrospun fibers and self-assembled hyaluronic acid- folic acid conjugated multipurpose carrier system to regulate cargos physiological stability with the extracellular environment. Secondary electron microscopy (SEM) characterization images revealed nanofiber size to range from 100 ± 10 to 186 ± 10 nm which upon cross linking is postulated to decrease further enhancing mechanical strength. Synthesis of self-assembled Hyaluronic acid- Folic acid (HA-FA) NPs had been investigated by peaks and functional group analysis through IR and NMR spectra. Further, uniformity and spherical NP shaped morphology were confirmed by SEM images. The hydrodynamic diameter in the nanometer range was reported by Dynamic Light Scattering (DLS). These results will assist in unraveling the underlying mechanism, efficiency, and off-target effect of biocompatible synergistic model in achieving better accuracy as a drug delivery and diagnostic vehicle. The relatively advancing modifications and patterning of LbL self-assembled structures with the sustained therapeutic outcome *in vivo* depending on the payload will also be established. With this diverse scope, we tend to explore the evolving next-generation simplification of biomaterial systems to uncover aspects of complexity and safety in design through the implementation of LbL self-assembly. This will further facilitate research into the progressive fields of nanobioreactors, artificial organs, and biosensors.

Keywords: Layer-by-layer self-assembly, biomaterial, drug delivery.

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SYNTHESIS OF CHOLIC ACID BASED THERMO AND PH RESPONSIVE THIOMERS AND ENCAPSULATION OF NOBLE METAL NANOPARTICLES FOR BIOLOGICAL APPLICATIONS

M. Yuvarani and N. Rajendian*

Department of Polymer Science, University of Madras, Guindy Campus, Chennai-25

Abstract

In recent years synthesis of PAA based smart thiomeric micelles will be one of the current challenging research owing to their alteration in the mucoadhesive properties, LCST, aggregation behavior, surface charge and hydrophobicity where it plays an important role in the therapeutic efficacy [1-3]. In this aspect, here we report synthesis of multifunctional thermo and pH responsive 3α -MECAME- PNIPAM thiomeric using cholic acid as pendent group. Since, cholic acids is a class of naturally occurring biosurfactant, good cell adhesion properties, special structure, rigid steroidal skeleton, with chemically different functional groups greatly influence the LCST and other physicochemical properties of the thiomers [4,5]. The prepared thiomeric significant influence on the swelling behavior and alteration in the LCST upon changing the pH of the medium as compared to 3α -MECAME- PNIPAM copolymer. Owing to the hydrophobic and hydrophilic nature the prepared thiomeric exhibit critical aggregation concentration where the core size of the micelles can be altered by changing the concentration of the polymer. Therefore, in the present investigation, we prepared highly monodispersed Ag and AuNPs with controlled size using this soft template without any reducing agent under sun light exposure. The haemocompatibility of the synthesized NPs was evaluated by in vitro hemolysis and erythrocyte sedimentation rate using human red blood cells (RBCs). The polymer encapsulated Ag and Au NPs show less toxicity on human erythrocytes (RBCs) up to the concentration of 120 and 140 μ g/mL.

Keywords: Thermo responsive; pH responsive; LCST; Drug delivery.

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SYNTHESIS AND CHARACTERIZATION OF ANTI-ADHESION TRICOMPOSITE ELECTROSPUN NANOFIBERS BARRIER MEMBRANES FOR USE IN POST-SURGICAL ADHESION CONDITIONS

P. B. Sathisha, R. Narmadhaa, R. Selvakumara,*

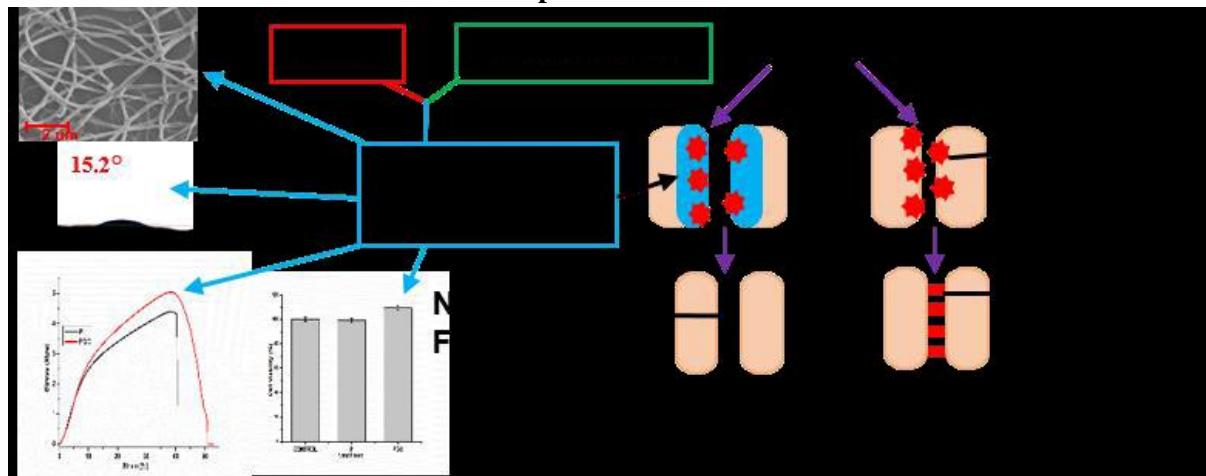
aTissue Engineering Laboratory, PSG Institute of Advanced Studies, Coimbatore-641004, India.

aEmail: pbs@psgias.ac.in , a,*Email: rsk@psgias.ac.in

Abstract

Adhesion formation is a crucial post-surgical problem that needs to be addressed by clinicians. In this study, we report the synthesis of a novel tricomposite electrospun nanofiber membrane as a potential barrier for prevention of post-surgical adhesion. The synthesized membrane was characterized using suitable techniques. The membrane showed excellent hydrophilicity (15.2° contact angle), mechanical stability (5.04 MPa with a strain of 50%) and biocompatibility (cell viability of 106%) required for a potential barriers membrane to be used in post adhesion surgical condition. This membrane can be an alternative membrane to address the drawbacks of currently used antiadhesion barrier membrane.

Graphical abstract



Keywords: Biomaterials, Polymeric composites, Tricomposite nanofibers, Post-surgical adhesion, Polycaprolactone (PCL).

COMPRESSION STRENGTH AND TAGUCHI L9 (27) DESIGN OF AUXETIC POLYURETHANE FOAMS FOR REHABILITATION APPLICATIONS

V Chaithanya Vinay², Dr. D S Mohan Varma^{1,*}

CBCMTI, School of Mechanical Engineering (SMEC)², VIT Vellore, Katpadi, Vellore, India

*Corresponding Author E-mail: mohanvarma@vit.ac.in

Abstract

Auxetic (negative Poisson's ratio) foams enable uniform pressure distribution and reduce the possibility of formation of pressure sores at the skin-cushion interface in seat cushions, hospital beds etc. Conventional PU foams can be converted to Auxetic PU foams using a thermo-mechanical process. Researchers have shown that a range of values for the fabrication parameters (heating temperature, compression factor and heating time) can be used to convert PU foams to APU foams. A heating temperature in the range of 150C to 250C, compression factors ranging from 2 to 4 and heating time ranging from 10 to 30 minutes (in two stage heating process) can be used in the conversion process. The aim of this work is to optimize the fabrication process parameters of flexible auxetic polyurethane (APU) foams using Taguchi L9 (27) orthogonal array for rehabilitation applications. In this work, Taguchi L9 (27) design methodology is used to determine 9 sets of process parameters. Using these parameters 9 PU foam samples were converted to APU foams. Poisson's ratio values were found using digital image correlation technique and MATLAB software. Compression tests were performed for all the samples and compression strength was determined. A highest compression strength of 0.02 MPa and lowest Poisson's ratio of -0.95 was obtained. This study enables the selection of appropriate auxetic foams suitable for rehabilitation applications like wheelchair cushions, hospital beds and prosthetic liners.

Keywords: auxetic foams; rehabilitation applications; Taguchi orthogonal array

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EVALUATION OF THE IN VIVO HEMOSTATIC POTENTIAL AND HEALING CHARACTERISTICS OF A LINT FREE ABSORBENT POLYMERIC WOUND DRESSING

Dr. Lynda Velutheril Thomas^{1*}, Sidharth Mohan¹, Prabha D Nair¹,
Mohanan PV¹, A Sababareeswaran¹

¹Division of Tissue Engineering and Regeneration Technologies, Department of Applied Biology,
Biomedical Technology Wing, SCTIMST, Poojapurra, Thiruvananthapuram - 695012

*Corresponding Author E-mail: lyndavt@sctimst.ac.in

Abstract

Introduction: Excessive bleeding or hemorrhage from mainly limb extremities are mainly through three routes 1) arterial, 2) venous and 3) capillary bleeding. In the case of arterial bleeding the blood flow is extremely high and is of high risk and life-threatening as it is difficult to control. A wound dressing that has optimum absorbency properties in addition to hemostatic potential is much warranted. In this study, we have developed a Chitosan-PVA lint free absorbent wound dressing that is mechanically stable, soft and pliable, has fast wicking, and has a high liquid holding capacity. The developed wound dressing has been assessed for its in vivo hemostatic potential and healing properties in a rabbit ear artery model and compared the results with a commercially available Alginate based dressing- Biatain Alginate.

Methodology: The porous lint free Chitosan –PVA blend dressings were assessed for it's in vivo hemostatic potential and its healing characteristics (IAEC approval-SCT/IAEC-299/JANUARY/2019/99). For the in vivo study on assessing hemostatic potential, six healthy, adult rabbits (2000–3000 g) were used. Using a longitudinal incision, 1.0 cm wound segments were made on the right and left marginal ear vein (one per ear). Through the blood flow, the incisions were immediately covered with 2×2 cm² piece of the lint free absorbent dressing of known weight (w1) and a control sample. Direct pressure was applied for 2 min and then the samples were removed and weighed immediately (w2) after hemostasis. Hemostasis was regarded as complete when bleeding was no longer observed in the wound site. The time taken for hemostasis was noted. Blood loss were calculated from the materials weights before and after absorbing blood. A similar study was performed by creating 1 cm diameter incisional wounds in rabbit ear and the healing was observed through gross and histology studies after a span of 2 week duration where the test and control dressings were changed every day.

Results: The controlled freeze drying process lead to the formation of channeled pores in the developed dressing. On conducting the in vivo studies it was noted that the CH-PVA dressing showed a better hemostatic potential when compared to the control where the time to hemostasis for the Chitosan-PVA dressing is about 359 ± 73 sec when compared to the control sample (539 ± 179 sec). The dressing also showed a higher blood holding capacity of about 0.184 ± 0.07 g. The study to evaluate the healing potential showed a much enhanced healing of the ear when assessed histologically through H&E staining.

Conclusion: Hence the study proves that the CH-PVA dressing prepared through the controlled freeze drying process leads to a hemostatic, good absorbent dressing which has better healing properties than the commercially available alginate based wound dressing.

Keywords: Absorbent wound dressing; Chitosan; Polyvinyl alcohol; hemostasis; wound healing.

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METAL-FREE POLYESTER NANOMATERIAL FOR BIOMEDICAL USE AND POTENTIAL CLINICAL APPLICATION

Piyush Kumar Gupta

Department of Life Science, School of Basic Science and Research, Sharda University, Plot no. 32-34, Knowledge, Park III, Greater Noida-201310, Uttar Pradesh, India

*Corresponding Author E-mail: piyush.kumar1@sharda.ac.in

Abstract

Polyester nanomaterials have been widely used in drug delivery application from a longer period of time. This study reports the synthesis of metal-free semi-aromatic polyester (SAP) nanomaterial for drug delivery and evaluate its *in vivo* acute and systemic toxicity for potential clinical application. The ring opening copolymerization of commercially available cyclohexene oxide (CHO) and phthalic anhydride (PA) monomers was carried out to synthesize fully alternating poly(CHO-co-PA) copolymer using metal-free activators. The obtained low M_n SAP was found to be biocompatible, hemocompatible and biodegradable nature. This copolymer was first-time used to fabricate curcumin (CUR) loaded nanoparticles (NPs). These NPs were physicochemically characterized. Further, these negatively charged core-shell spherical NPs exhibited slow sustained release behavior of CUR with anomalous transport and further displayed its higher intracellular uptake in SiHa cells at different time-periods compared to free CUR. *In vitro* anti-cancer therapeutic effects of free CUR and poly(CHO-alt-PA)-CUR NPs were evaluated on different cancer cells. We observed the increased cytotoxicity of CUR NPs with low IC₅₀ values compared to free CUR. These results were further substantiated with *ex vivo* data where, a significant reduction was observed in CUR NPs treated tumor spheroid's size as compared to free CUR. Furthermore, the different doses of metal-free poly(CHO-alt-PA) nanomaterial were tested for its acute and systemic toxicity in BALB/c mice. We did not observe any significant toxicity of tested nanomaterial on vital organs, blood cells and the body weight of mice. Our study suggest that this metal-free SAP nanomaterial can be used for potential clinical application.

Keywords: Polyester; Nanomaterial; Metal-free; Drug Delivery

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ANTIBIOFILM PEPTIDE INCORPORATED NANOFIBROUS MAT FOR WOUND INFECTION TREATMENT AND HEALING

Nanditha Chundayil Kalathil, Reshma Aravind V, G.S. Vinod Kumar*

Chemical Biology, Nano Drug Delivery Systems (NDDS), Bio-Innovation Center (BIC), Rajiv Gandhi

Centre for Biotechnology, Thiruvananthapuram, Kerala, India-695014.

Research Centre, University of Kerala, Thiruvananthapuram, Kerala

*Corresponding Author E-mail: gsvinod@rgcb.res.in

Abstract

Tissue regeneration using bioactive biomaterials has made a great progress in the field of wound healing. Biopolymers play a cardinal role in regenerative medicine by providing safe, biocompatible and bioresorbable support. The emerging fabrication technique in creating a suitable wound care material is electrospinning. PHBV1 and PLLA are FDA approved polymers having important applications in biomedical field. In this study, in order to increase the wound healing potential, PHBV was functionalized with –COOH group and electrospun nano-fibrous mat was produced using PHBV-COOH and PLLA blended solution. IDR-10182 antibiofilm peptide with immunomodulatory activity was incorporated into the blended solution to improve infected wound treatment by actively fighting against bacterial infections. Furthermore, in-vitro experiments including cell cytotoxicity assay and scratch wound healing assay was done to evaluate the potential of the synthesised bioactive material as a potential wound management aid.

Keywords: Wound Healing, Nanofibers, Antibiofilm peptide.

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DECORATING THE SURFACE OF GRAPHENE OXIDE WITH BOVINE SERUM ALBUMIN MITIGATES THE CYTOTOXIC EFFECT OF GRAPHENE OXIDE

S. Sivaselvam, R. Selvakumar, R. Narmatha, G. Srividya and N. Ponpandian*

*Department of Nanoscience and Technology, Bharathiar University,
Coimbatore 641046, India*

*Corresponding author E.mail: ponpandian@buc.edu.in

Abstract

Several recent studies have shown the potential application of graphene oxide (GO) in the biomedical field due to its intrinsic properties. Owing to its tunable characteristics, GO has turned out to be an excellent material in the biomedical field for drug delivery, cellular imaging, and bio-sensing. Although the applications of GO advance the biomedical field the interaction of GO with cell and biological molecule is still largely unclear and raises a safety concern. Thus, it is critical to understand the toxicity mechanism and to improve its biocompatibility to ensure its application in biomedical field. In the present study, we have decorated the surface of GO with the protein Bovine serum albumin (BSA) to mitigate the in-vitro toxic effect of GO in the mouse fibroblast L929 cells. The GO and GO-BSA were characterized using XRD, FTIR, Raman, UV, TEM and DLS. The GO-BSA at the concentration of 20-100 mg/L did not induce toxic effect on cell viability, ROS generation and LDH assay in contrast to GO treatment. The scanning electron microscopy analysis also confirmed the non-toxic behavior of GO-BSA and thus BSA coating potentially mitigated the cytotoxic effect of GO. The live/dead assay and nuclear staining results also showed the non-toxic behavior of GO-BSA. These findings provide new insights into the cytotoxic mechanism of GO and will have an impact on the future development of safer nanomaterial formulations of graphene and graphene-based materials for environmental and biomedical applications.

Keywords: Graphene oxide, Bovine serum albumin, cytotoxicity, surface modification.

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EFFECT OF LASER PENEING ON THE RESIDUAL STRESS DISTRIBUTION AND WETTABILITY CHARACTERISTICS OF TI-6AL-4V ALLOY FOR BIOMEDICAL APPLICATION

K. Praveenkumar 1*, Geetha Manivasagam 1,2, S. Swaroop 3.

1 School of mechanical engineering, Vellore Institute of Technology, Vellore, Tamil Nadu, India

2 Centre for Biomaterials, Cellular and Molecular Theranostics, Vellore Institute of Technology,
Vellore 632014, Tamil Nadu, India

3 Surface Modification Laboratory, School of Advanced Sciences, Vellore Institute of Technology,
Vellore 632014, Tamil Nadu, India

Corresponding Author E-mail: prveenkesavan@gmail.com

Abstract

Ti-6Al-4V is commonly used α - β alloy in the fabrication of orthopaedic & dental implants due to its biocompatibility, improved osteointegration and high corrosion resistance. It is a heat treatable alloy and is typically used in a solution treated condition wherein the microstructure consists of a mixture of primary α and $\alpha+$ (transformed) β colonies, with yield stress of around 850 MPa. The present study investigates the effect of laser peening in improving the surface properties of Ti-6Al-4V beneficial for biomedical applications. Laser peening without coating (LPwC) is an advanced mechanical surface treatment used to increase the premature failure by inducing deeper compressive residual stresses, also improves the corrosion resistance and osteointegration by high work-hardening effect and tailoring the surface roughness to modulate the wettability of the sample. In the present study, the as-received (AR) Ti-6Al-4V was solution treated (ST) at 920 °C for 1 h and subjected to laser shock peening without coating (LPwC) with a 10 ns pulsed Nd: YAG laser operating at 1064 nm. The power densities were chosen to be 3, 6 and 9 GW cm⁻², corresponding to a spot diameter of 0.8 mm and overlap of 70% between the adjacent spots. Microhardness measurements of the peened samples indicated largest surface hardness (530 HV0.1) in the sample peened at 6 GW cm⁻², in comparison with the unpeened sample (330 HV0.1). Similarly, sample peened at 6 GW cm⁻² exhibited maximum compressive residual stress of -450 MPa and -150 MPa was induced at a depth of 50 μ m for ST and AR samples from the surface. After the LPwC process, the hydrophilic unpeened ST and AR samples surface was transformed into the hydrophobic surface (laser peened at 6,9 GW cm⁻² samples), as evidenced from the static contact angle studies. This preliminary investigation clearly shows that the LPwC has a significant influence on the surface characteristics such as residual stress distribution, work-hardening and wettability characteristics in Ti-6Al-4V alloy.

Keywords: Ti-6Al-4V; Compressive residual stress; wettability; Laser peening;

STRONTIUM DOPED NANO BIOCERAMIC COATINGS FABRICATED BY ELECTROPHORETIC DEPOSITION FOR ORTHOPAEDIC APPLICATION

K. Aruna¹, Afa Ashraf¹, M. R. Kuppusamy², and T.M. Sridhar^{1*}

¹ Department of Analytical Chemistry, University of Madras,
Guindy Campus, Chennai 600 025.

²Dept. of Chemistry, R.V. Govt. Arts College, Chengalpattu-603001.
Email: *tmsridhar23@gmail.com

Abstract

Nano Hydroxyapatite [nHAP, Ca₁₀(PO₄)₆(OH)₂] has assumed substantial interest and importance because of its chemical and crystallographic similarity to natural calcium phosphate mineral present in the natural bone. nHAP could stimulate the bonding between the implant materials and host bone leading to faster bone healing ability and protect the substrates against corrosion. There is need for a long time evaluation of nHAP coatings in the physiological environment as they could be dissolved and affect the implant fixation. Therefore, it is necessary to improve the solubility of nHAP coatings by doping some trace element ions present as part of the inorganic composition of natural bones such as Mg²⁺, Na⁺, Sr²⁺, F⁻ etc. Strontium appears to be one of the most effective substances for the treatment of osteoporosis and other bone-related conditions. Strontium exists in the mineral phase of the bone and it has an individual effect on the vitality of the bone cells which can offer an appropriate role in bone growth. n-HAP & Sr-nHAP was synthesized through wet chemical precipitation method. The presences of functional groups were confirmed by FTIR. Zetapotential of the synthesized samples were obtained using DLS to analyse the stability of the suspension to carry out Electrophoretic deposition (EPD). Synthesized samples were coated on 316L SS through EPD at different potential and time. The coated samples were characterized by FTIR, AFM & EIS. The functional groups in the coated samples are detected by FTIR. Surface roughnesses of the coated samples are determined by AFM. The formation of stable coatings indicates their scope as an implant coating.

Keywords: HAP; Strontium, 316LSS; EPD.

INVITRO STUDIES ON PLASMA SPRAYED HYDROXYAPATITE COATINGS ON TITANIUM IMPLANTS

Satish Tailor^{1#}, Ankur Modi¹, M. Sundara Ganeasan², T. M. Sridhar^{2*}

¹Metallizing Equipment Co. Pvt. Ltd., Jodhpur - 342 005, India.

²Department of Analytical Chemistry, University of Madras, Chennai-25, Tamilnadu, India.

*,#Corresponding author: tmsridhar23@gmail.com, dr.saty@yahoo.in

Abstract

Metals and their alloys are used as biomedical implants mainly due to their mechanical properties, biocompatibility, etc. One of the major drawbacks of implants is that they are highly corrosive human body environment with unstable degradation take place. It reduces the structural integrity which reduces the reaction with the host. This can be eradicated by surface modification on the metallic implants with a bioactive coating which can modify the structure, morphology and composition. One such modification of the surface coating is the inorganic bone like material hydroxyapatite (HAp) which is widely used in biomedical applications such as tissue engineering, orthopedic devices etc. Various coating techniques are being used to deposit hydroxyapatite over titanium such as magnetron sputtering, chemical vapor deposition, plasma spraying, electrophoretic deposition of which plasma spraying has been widely used due to its strong bonding between the HAp layer and the implant material especially titanium. The main aim of this work is to deposit HAp layer on titanium substrate and also to evaluate its invitro properties. The prepared samples have been characterized by scanning electron microscopy (SEM). The invitro biominerization studies have been carried out to evaluate its biocompatibility and degradation properties for a period of 14 days and 7 days respectively. The biominerization studies indicate the deposition of new bone on the coated samples.

Keywords: Hydroxyapatite; Plasma Spraying; Titanium; Invitro studies.

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ELECTROCHEMICAL FABRICATION OF BIOCERAMIC COMPOSITE COATED 316L SS IMPLANTS AND THEIR IN-VITRO CORROSION RESISTANCE BEHAVIOR IN SIMULATED BODY FLUID

S. Arul Xavier Stango, U. Vijayalakshmi*

Department of Chemistry, Vellore Institute of Technology, Vellore, Tamilnadu, India-632014

*Corresponding Author E-mail: vijayalakshmi.u@vit.ac.in

Abstract

Bioceramic composite coatings were deposited on surgical grade 316L stainless steel substrate via in-situ electrolytic method by supplying the voltage of -1.5 V for 30 mins using three electrode arrangements. Formations of pure HAP/GO and HAP/*f*-MWCNTs composite films with good crystallinity were observed from X-ray diffraction and Fourier Transform-Infrared spectroscopic studies. Hydroxyapatite structure was retained even with incorporation of secondary hybrid materials into its matrix. Homogenously dispersed dense coating morphology was observed for the electrochemically derived HAP composite films on 316L surfaces through scanning electron microscopy (SEM). Tough attachment of GO and *f*-MWCNTs on the surface of hydroxyapatite particles were discovered using high resolution transmission electron microscopic (HR-TEM). *In-vitro* corrosion studies of the fabricated bioceramic composite coatings showed better corrosion protection against the body fluid. Bio-mineralization takes place in faster rate for the prepared bioceramic composite films; further enhance their bone bonding ability. The prepared HAP composite coatings showed high mechanical hardness on incorporation of GO and *f*-MWCNTs. These results concluded that the electrochemical deposition of bioceramic coatings on implant may be treated as an effective method for orthopedic repair and replacements.

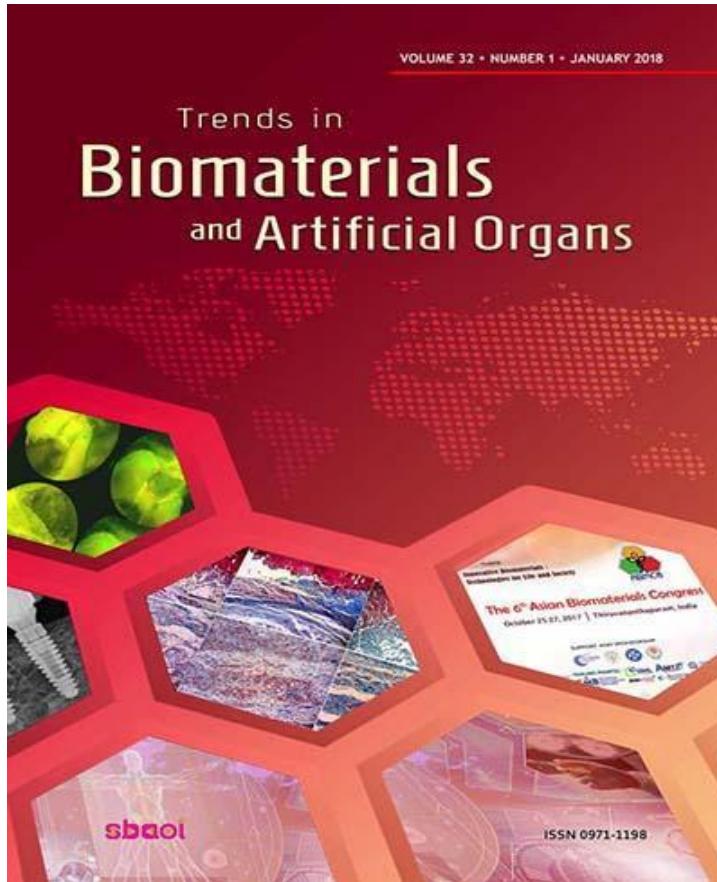
Keywords: HAP; 316L SS; Graphene Oxide; *f*-MWCNTs.

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