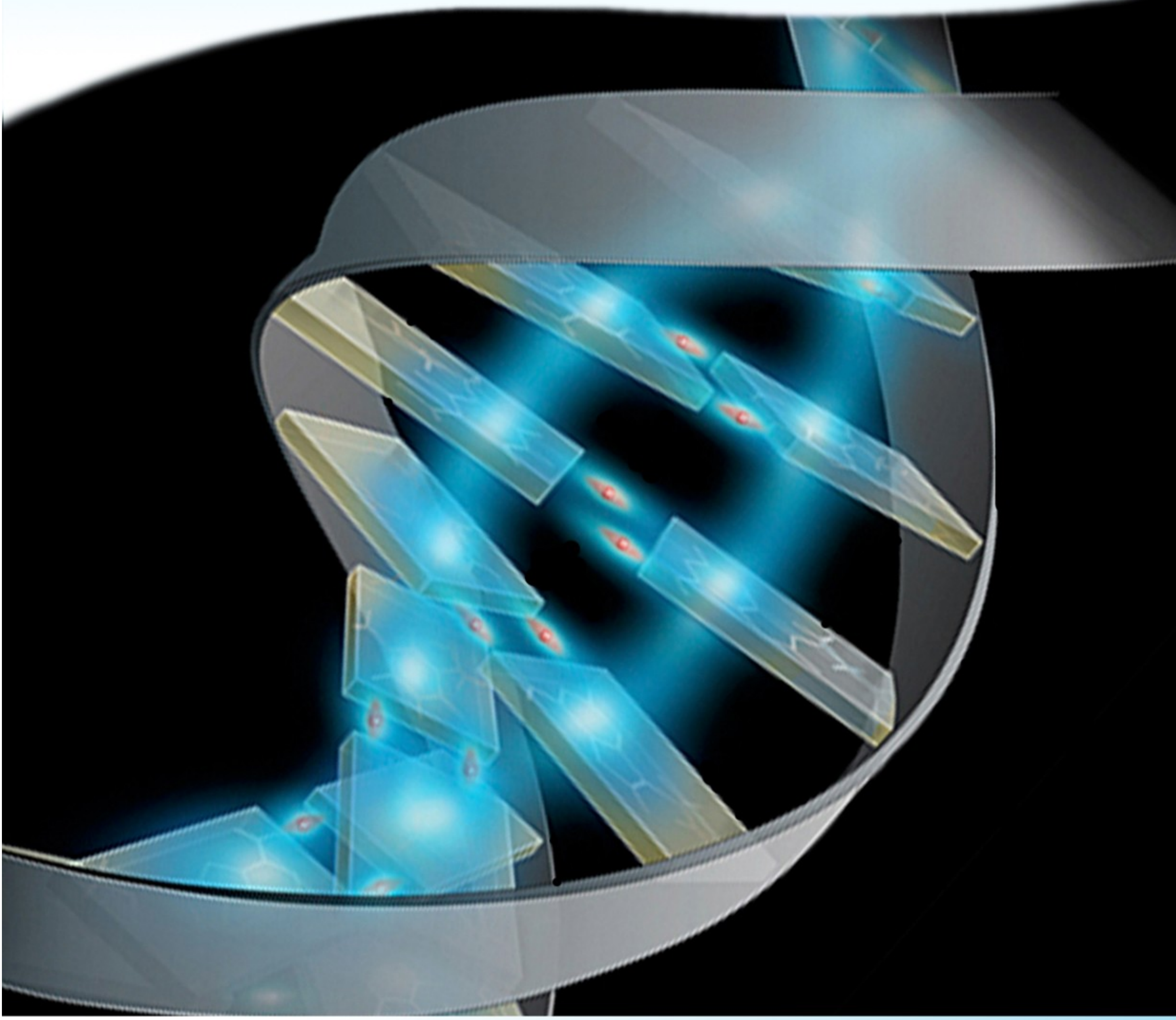
Dhatuki

Issue 5, Jan 2009



Metallurgical Engineering & Materials Science

Dear Readers,

I am sure all of you enjoyed reading the 4th issue of Dhatuki! Team Dhatuki is now presenting its 5th issue now. They have selected Biomaterials as the theme of this issue. This is a very important area of research offering tremendous scope for materials development. New materials with exotic properties are necessary to solve many issues on the frontier of health care science and the various researchers in the MEMS department are doing their best towards this end. The team has put in a lot of hard work in collecting relevant and interesting information along with the other exciting information in the student's arena. A very informative article on the various aspects of bio-engineering from the point of health care should generate enthusiasm in students to take up career opportunities in this exciting research field.

Coming out with Dhatuki issues in the printed form is being made possible through generous grants from our admirers and well wishers. Personally I would like express my gratitude to them for their encouragement of the student's activity. I am sure that the 5th issue of Dhatuki would once again be an enjoyable reading experience. Compliments to the publishing team who has done a very good job! Finally I would urge all readers to give their feedback to us so that we can make future issues more interesting and informative.

(**Prof. Rajiv Dusane**)
(Head of the Dept.)

Inside this Issue

From Team Dhatuki

A warm hello and a very Happy New Year to readers from the editorial team for the year 2008-09. We bring to you a new issue this new year with the theme being 'Biomaterials'. As always, we all have enjoyed the process of bringing this issue to you and we hope you enjoy reading it.

We are open to suggestions and welcome even more enthusiastic participation from students in the issues to come.

Enjoy Reading!

- Editors Chinmay and Milind.

Materials Research Symposium '08

Materials Research Symposium, or MR, as it is known by the students of this department, was first held in 2002. Since then, it has been held every year as an in-house symposium, with participation from research scholars and M.Tech students from IIT Bombay. In 2008, under the auspices of the Golden Jubilee of IIT Bombay, the organizing committee of the symposium decided to take it to the national level. Taking this decision was not easy. There were many known challenges, and several unknown ones, as I can say in hindsight.

In the beginning, the organizers, the research scholars did feel that they were venturing into unknown waters. However, every time, they were kept on course by the constant compass of the faculty advisory committee's guidance. Slowly, but steadily, the student organizers involved gained more experience.

One of the major challenges was to secure the kind of funding that is required for a symposium of this scale. Many industries, scientific equipment manufacturers, and equipment suppliers were approached. We were surprised to see an overwhelming response. Initially it was somewhat slow, but as the symposium date drew closer, the response from the sponsors was really wonderful. Soon, finance problems were a thing of the past. Another new feature was the souvenir, that contained the abstracts of every paper that was presented, and also the profiles of the research scholars working in the department.

With these preparations done, the organizers were now ready for the final two days of the symposium. On 17th May, 2008, the National Symposium for Materials Research Scholars, MR08 was inaugurated. The chief guest for this programme was Prof J. Vasi, Deputy Director, IIT Bombay. The keynote address was delivered by Dr Amit Biswas, Vice-president, Reliance Polymer Research & Technology Centre. Dr Biswas' address was enthralling, as he walked the audience through the many applications of polymers, and showed how commercially feasible and the logical choice that polymers have become today.

Now began the oral paper presentations by nearly 200 participants, from places as near as Mumbai, and as far as Kashmir and Assam. The academic background was even more varied than the geographic ones. A wide spectrum, physics, chemistry, bioscience, metallurgy & materials engineering, chemical engineering, mechanical engineering and even electrical engineering, was seen.

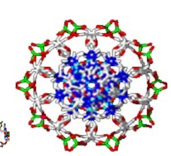
While a large fraction of this population was here for poster presentations, there were still many who were selected for oral presentations. The topics encompassed several areas of materials research. The sessions were divided by research area. Therefore, we had sessions on Processing, Composites, Biomaterials, Thin films, Magnetic Materials, Ceramics, Nanoscience, Corrosion, Modeling and Forming. In total, there were 35 presentations. The best presentation prize was handed out to Mr. Abir Bhowmick, then a final year dual degree student at the Department of Metallurgical Engineering and Materials Science, IIT Bombay, for his work on Simulation of grain growth in the HAZ of steel welds using Monte Carlo technique. The poster presentation events, two in total, saw 105 entries.

There was also an invited lecture by Dr Valerio Causin, of the Dipartimento di Science Chimiche, Università di Padova Via Marzolo, Padova, Italy. Dr Causin spoke on Morphological and Structural Characterization of Nano-composites with a Polyolefinic Matrix.

At the end of the two-day symposium, the awards were given out at the valedictory function. The chief guest at this function was Dr S Banerjee, Director, Bhabha Atomic Research Centre, and the guest of honour was Prof Isaac Kurien, Associate Dean (R&D), IIT Bombay. The valedictory function was chaired by Prof V S Raja, Department of Metallurgical Engineering and Materials Science, IIT Bombay.

With that, the efforts of more than four months culminating into one successful event, the National Symposium for Materials Research Scholars, MR08, ended. However, this does not flag the end of this tradition, rather it signals a new beginning. With the in-house symposium of previous years going to a national level, and also receiving such a great response from the research scholar community, the enthusiasm of the organizers has only grown, and even as you read this, team-building activities are afoot for MR09! What new horizons will be explored this time is yet to be decided, but the team MR is only looking forward to making this symposium a landmark event in the calendar of materials research scholars throughout our nation.

-Adhish Majumdar



Internship Experiences

Come Junior Year and the buzzword in every undergraduate's mind is Internship. Although landing the perfect internship and accomplishing some groundbreaking work is one's ultimate goal, the internship work profile is hardly known by anyone before actually working. Here we try to present a picture of the kind of projects students do during their internships. Be it research or an industrial outlook you are looking for, substantial amount of knowledge and experience is up for grabs through an internship. We learn about industrial internships through Harshad who worked at Tata Motors, Pune for his internship and about research internships through Neelkanth who worked at Alcan Research Centre in France.

Industrial Internship

Tata Motors is the largest automobile manufacturer in India. The company is split into two halves known as passenger car business unit (PCBU) and commercial vehicle business unit (CVBU). PCBU engages in manufacture of the Indica and Indigo cars; while CVBU manufactures trucks, buses and utility vehicles.

During the summer of 2008, I had the opportunity to work at the CVBU unit in Pune. The department in which I was placed was known as materials pricing committee (MPC). The primary task of MPC is to fix prices of various raw materials and assemblies. They not only evaluate prices of assemblies based on cost of raw materials, but also try to reduce the cost by suggesting alternate materials, processing procedures or designs. The three projects that I did at CVBU were mostly concerned with alternate materials selection.

Magic is a small commercial vehicle manufactured by Tata Motors. The rear part of Tata Magic contains a heavy (82 kg) steel assembly made up of welded tubes. A lighter and cheaper alternative to steel would reduce weight and cost of the assembly. Before attempting to find alternate materials, I paid visits to the vehicle assembly line and fabrication shops. I had extensive discussions with the designers and consultants. This helped me pinpoint the mechanical and other properties which the assembly was supposed to have. Once this was done, Aluminium alloys (AA 2018), Aluminium matrix composites (AMC) and fiber reinforced polymer matrix composites (PMC) were selected as alternates because they possess mechanical properties similar to those of steel. But after taking into account costs and concerns about manufacturability, it turned out that steel was the most suitable material indeed. A weight reduction of around 3 kg was suggested by making minor changes in design.

The second project that I did was about suggesting alternates for steel in bumper assembly of heavy commercial vehicles. Material for bumper must possess mechanical properties like high strength, dent resistance and corrosion resistance. I developed a detailed understanding of such requirements by consulting designers and personally inspecting vehicles of Indian and foreign make. Based on this fiber reinforced polymer (FRP), polypropylene (PP) and Xenoy plastic (a specialty product of GE plastics) were suggested as alternates. FRP turned out to be the material with optimum properties like cost, availability and environmental factors.

Determining cost of processing operations is a critical task while determining prices of assemblies. This is because many automobile assemblies undergo operations like painting and passivation during their manufacture. Anodizing is a passivation and coating process used with Al alloys. My third project was about determining cost of the anodizing process. For this I visited the factory where this anodizing was carried out. The complete process of anodizing was divided in several logical steps. I evaluated consumption of raw materials like acids, water, dye in each step. Based on this, cost of anodizing per kg of assembly produced was established.

During this internship I gained substantial knowledge. I got accustomed to traditional industrial environment, got exposure to enterprise tools and got an opportunity to apply knowledge of materials science. However I think that the following aspects should be considered by any prospective intern:

1. Automobile industry is a secondary manufacturer with reference to metallurgy, since they use metals as raw materials, which are products of primary metallurgical industries. Because of this the materials science expertise demanded is inherently limited.

2. Automobile industries in India have to work with very low and uncertain profit margins. This limits their investment towards research and development. This means that the internships they offer are more operations oriented than research oriented.

-Harshad Paranjape

Research Internship

Founded in 1902, **Alcan** is the world's largest manufacturer of aluminum (by sales). A subsidiary of Rio Tinto PLC (the Australian mining giant), Alcan has a network in 61 countries, over 68,000 employees, with revenues in excess of US $24 billion. This internship was undertaken at the largest Research Center of Alcan, at Voreppe, near Grenoble, France.

Progress in computing technology has enabled finite element models to be implemented, to simulate complicated metal forming processes. However, the accuracy of the numerical simulations is very much dependent on the constitutive equations that are applied to describe the material behavior during deformation. Deformation testing to large strains at elevated temperatures has therefore become important, to formulate such constitutive equations.

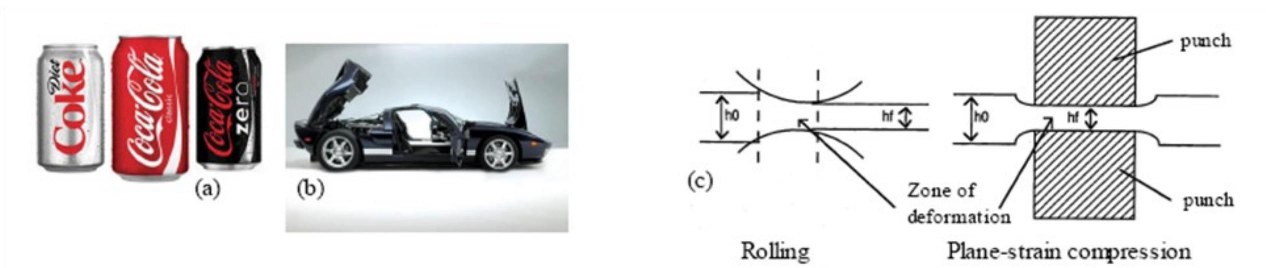


Fig.1: (a) & (b) A large spectrum of products, from the very simple beverage cans, to the highly engineered sports cars make use of rolled Aluminum sheet metal. (c) The analogy between Rolling and the PSC test.

Plane Strain Compression (PSC) testing is particularly suited to the idealized simulation of hot rolling, which is of major technological importance, since hot rolling is used at some stage of metalworking for about 50% of all manufactured metals and alloys. The setup used for the PSC test is a Servo-hydraulic machine, rated at a maximum force of 50 tons, at a strain rate of 100s-1. This test generates raw load–displacement data, which needs to be converted to meaningful Stress–Strain data.

The challenge given for this internship was to optimize the correction factors for taking into account the effects of *lateral enlargement*, *friction* and *variation in thickness* of the sample, on the PSC test output. The objective was to obtain as best an overlap as possible, for the corrected Stress–Strain curves corresponding to different test conditions. The resulting curve can be taken as a unique representation of the flow stress of the material. For this purpose, a comparative study of the models available was performed. These models were then implemented in a MATLAB code, using inputs from the PSC test, to generate Stress–Strain curves.

The figure alongside shows an example of the effectiveness (good overlap) of the models in smoothing out the variations in the test procedure. Needless to say, 10 weeks is a very short time to take care of each and every problem: in my case, there is room for improvement by incorporating the effects of work hardening in the finite element model for thickness variation.

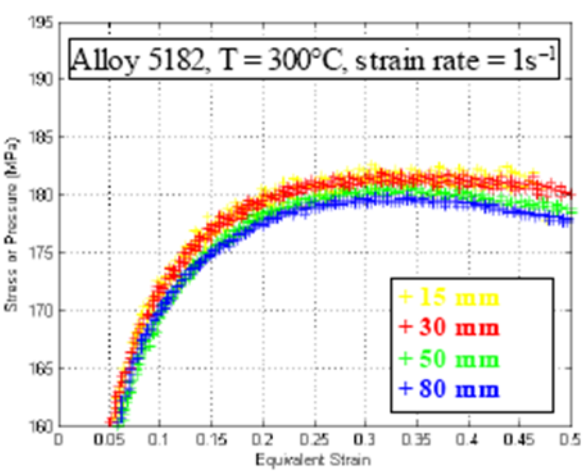


Fig.2: Stress – Strain curves for different initial thickness of the test specimen, keeping the alloy, temperature, strain and strain rate constant.

Overall Experience

With a fundamental belief in the value of human capital, Alcan provided me with a environment to innovate, and look for new ways of doing things. This, coupled with challenges, opportunities, recognition and an enthusiasm and drive to think out of the box, made for an immensely satisfying and wonderful experience. I believe that such a practical training definitely helps to support and promote the professional development of students. Given a chance, I would love to work again for such a company.

My message to the future generations of MEMS students would be to go in for an industrial internship in a company that upholds human potential, that gives full freedom of thought and action for you to discover your hidden talent and utilize it constructively within the given resources and time frame, that would be mutually beneficial to both you and your employer.

-Neelkanth Bardhan

Padarth '09 - A Preview

Students of our department have always been involved in extra curricular activities. The Metals and Materials Association (MMA) has been organizing various events in the department for years now. A couple of years ago, we even had our own rock band called '*Meta United*'.

Two years ago, two students of our department came up with an idea of having a Department Festival. The main motivation behind this was to increase the interaction between students of our Department and the faculty members. Also it was thought that, through the competitions, the students would do some hands-on work in the laboratories. And that's how *Padarth* started. In it's first year the event had competitions like *Sakht* (where one was supposed to harden a metal by doing heat treatment) and *Materials Business Plan*. The response of students to this initiative was simply overwhelming. Taking inspiration from this, last year Padarth was again organized on similar lines and this year we plan to take it to a new level.

Padarth 2009 will be organized in early March and will invite entries from all students of IIT Bombay. The festival will be full of exciting competitions, workshops, lectures by the best in industry and research and will have many more fun events to keep everyone entertained.

There are four competitions. In '***DemoTech***' one has to create a demonstration which would explain a materials science phenomenon. This is your chance to prove the competition's motto that '*A demo is worth a thousand lectures*'. Someone has said that '*To know how to suggest is the art of teaching*'.

If you want to check how good a teacher you are, then '***Materials Exposition***' is the platform for you. Present a short talk on a topic of your choice to an audience.

Failure assessment is one of the major areas where materials science is of great use. '***BreakThrough***' is a competition where you have to make a model to demonstrate what materials science phenomena were the cause of any catastrophic failure.

Apart from competitions, Padarth '09 will have several online and on the spot events like Materials Puzzles, photography contest and more. Last year **Materials Quiz** was great fun and saw a huge participation and this year we assure you that it would be more exciting than before.

Workshops and lecture series would also be a part of Padarth '09. We believe it would be a great experience for us to listen to veterans from industry and research who have been working on the cutting edge of Materials Science. Workshops will provide students a glimpse of the facilities and cutting edge instruments in the field of materials science and engineering.

With such great events happening we hope to see an enthusiastic participation at Padarth '09. Stay tuned!

-The Padarth '09 Team
(www.met.iitb.ac.in/padarth)

Biosciences @ IITB

Looking at the human body one finds a whole variety of materials with a gamut of structures, properties and applications placed in very innovative manners inside by nature itself. For example, bones, arteries and veins, ligaments and tendons are called biological materials. Bioengineering then deals with understanding of the characteristics and behaviour of such materials, their use in curing diseases as well as replication in some cases to replace existing systems in human body. The theme of research is very basic: to better understand biological systems and to increase the quality of human life.

A materials scientist's approach to understanding biological materials is via microscopy and various mechanical and chemical analyses to reach at structure-property correlations that explain their behaviour inside the active human system. This is used to design new materials – called *biomaterials* – the engineered, inert materials that are used to assist or replace structural or functional units inside the human body. A materials engineer hence plays a crucial role in Bioengineering.

A lot of research is being done on biomaterials recently. The demand of the research comes from the medical field. The research can broadly be divided into material design for diagnostics (identification) and for therapeutics (treatment and cure). Some of the finest research is going on for targeted drug delivery to infected tissues of the body, bio-implants to replace structure and functioning of body parts (for example bones, joints, heart valves) and stimulate tissues to perform a certain work, as in the case of 'stem cells'.

Research in biosciences and bioengineering at IIT Bombay is steered by *'School of Biosciences and Bioengineering*'. It is a leading institute in the country working on a variety of challenges in the field. Some recent projects that have been taken up are broadly based in the following categories.

Biomaterials for Diagnostics

- *Biosensors*- to sense existence of a specific molecule in the body by which a certain disease can be detected.

Biomaterials for Treatment

- Cancer treatment via drug delivery
- Nanoparticles for drug delivery
- Tissue engineering

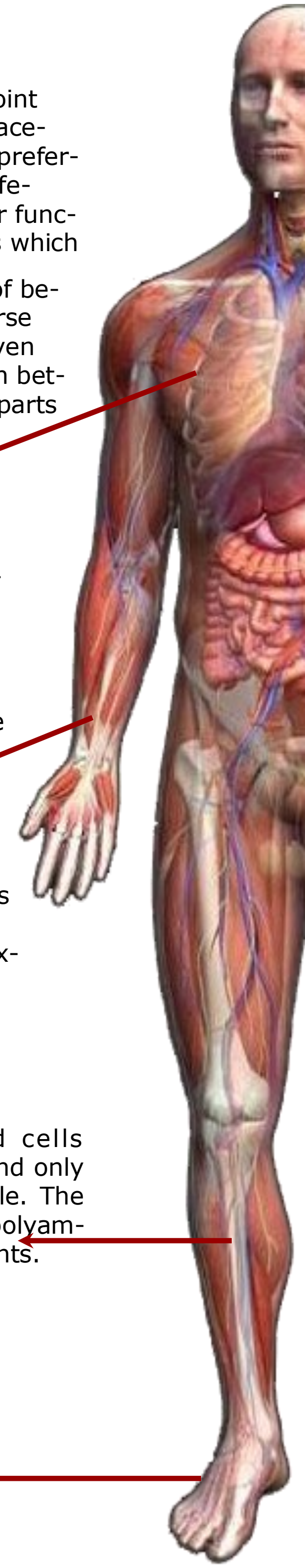
There has been a collaboration among MEMS faculty and Biosciences faculty for some interdisciplinary projects. Prof. Vitta is one faculty from our department who is working on structural and mechanical properties of biomaterials. Prof R. Banerjee from School of Biosciences is working in collaboration with Prof. Bahadur from our department on magnetic materials. The ongoing research under collaboration involves material design for cancer treatment via *dual therapy*. Another project also aims to develop a treatment called '*hyperthermy'* to kill cancer cells and targeted delivery of drugs (based on temperature sensitivity of materials). Pointing out a huge need as well as scope for research in this new field, Prof. Banerjee encourages materials science students, even undergraduates, to pick up interdisciplinary projects with School of Biosciences. Prof. Banerjee has already worked as co-guide for some of the students of MEMS department for their B. Tech Project under Prof. Bahadur.

The School of Biosciences at IIT Bombay holds some courses like biomaterials and advanced study, bionanotechnology etc., most of them being Post Graduate courses. Purpose of these courses is to make the students understand the behavior of biomaterials. In the new curriculum for undergraduates, School of Biosciences offers a minor degree to the students of all departments. Courses include introduction to molecular cell biology, molecular biophysics, physiology for engineers etc. This year a few sophomore undergraduate students have opted for a minor in Biosciences. The numbers is definitely expected to increase next year, as the field promises great opportunities for both research as well as entrepreneurship in future.

-Nikhil Tiwale and Milind Gadre

Bionic Man

From as early as a century ago artificial materials and devices have been developed to a point where they can replace various components of the human body. The demand for such replacements has increased due to a number of reasons like the ageing population, an increasing preference of the newer generation to undertake surgery, improvements in the technology and lifestyle, a better understanding of body functionality, improved aesthetics and need for better function. A biomaterial, by definition, is "a non-drug substance suitable for inclusion in systems which augment or replace the function of bodily tissues or organs". These materials are capable of being in contact with bodily fluids and tissues for prolonged periods of time without any adverse reaction. The key factors in a biomaterial usage are its biocompatibility, biofunctionality. Even though the biomaterials of today are a lot more sophisticated, research is on to make much better materials. Here we try to introduce the reader to the biomaterials used in the different parts of the body implants.



Blood Vessel

Some of the most commonly used blood compatible materials are polyacrylonitrile, Polytetraflouroethylene, nylon, polycarbonate, PET, polymethyl meth acrylate, pyrolytic and low temperature isotropic carbons.

Bone plates

Osteosynthesis plates, widely used in orthopaedic surgery to heal fractured long bones, are generally made of stainless steel, Co-Cr or Ti alloys.

Bone Cement

The ready bone cement is a compound consisting of 90 % of polymethylmethacrylate, (PMMA), and a liquid monomer MMA (methyl methacrylate) and the rest are mainly crystals of BaS or Zr_2O_3 that make the resulting product radio-opaque. The polymerizing fluid glues together the pearls into a firm, strong, but brittle mass. Bone cement is used as filler for fixing of artificial joints to the skeleton.

Artificial Ligaments and tendons

An artificial ligament is permanent and is able to react more with blood cells and the surrounding tissues compared to an external bandage, which is temporary, and only contacts the outer skin tissue. Hence the implantable device should be biocompatible. The materials usually used for artificial tendons are Polytetrafluoroethylene, polyester, polyamides, silk, and polyethylene. Polyester and carbon are used for artificial ligament implants.

Skin repair devices

Chitin is usually used as the principal material for skin repair devices. This chitin is mostly used in the non-woven form.

Artificial cornea

Polymethyl methacrylate, silicones, collagen are the primary materials used for making artificial cornea. Soft contact lenses are made of transparent hydrogel with high oxygen permeability. Hard contact lenses are made of PMMA and cellulose acetate butyrate. Flexible contact lenses are made from silicone rubber.

Dental implants

Major requirements of dental polymers include translucence or transparency, stability, good resilience and abrasion resistance, insolubility in oral fluids, non toxicity, relatively high softening point and easy fabrication and repair. The most widely used materials are PMMA and its derivatives, polysulfone and polyetherpolysulfone. Dental implants are coated with a layer of hydroxyapatite (calcium phosphate with a mineral content identical to that of human bone)

Heart Valves

Two types of materials are used for artificial heart valves: "Soft" bioprosthetic materials such as denatured porcine aortic valves or bovine pericardium and "Hard" man made materials used in mechanical heart valves, the most successful being pyrolytic carbon. PET and Polytetrafluoroethylene are usually used for artificial vascular grafts.

Joint replacements

Their main components consist of a plastic cup placed in the joint socket, made of ultrahigh molecular weight polyethylene (UHMWPE), and a metal or ceramic ball attached to a metal stem. The ball may be constructed out of metals such as titanium or cobalt chromium alloy or moulded from ceramics such as aluminium oxide or zirconium oxide

Finally on the closing note, we should really appreciate the fact that each of the body implants has to be made carefully using so many different material combinations and taking into account numerous factors. With the advent of technology, we can only make an attempt to reach the perfection with which God has made us.

-Aayesha Ghanekar, Meghana Gokhale,
Rahul Wamanacharya

Climate protection through intelligent construction

In an article from our sponsors **Bayer MaterialScience**, we look at the cutting edge materials science at work in a prospective project coming up —-

'Adapting a building to the climate is better than adapting the climate to a building'. This would be an apt slogan for Bayer MaterialScience's "*EcoCommercial Building*" (ECB) initiative. It reflects the principle of bringing together the best materials, systems and technologies in order to construct a building to suit the climatic conditions at the site in question.

In the recent past, the basic principles of ecologically-sound construction have often been neglected in architecture. As a result, huge amounts of energy have often been used to air-condition standard-design buildings so as to create a pleasant indoor climate even in the face of extreme environmental conditions.

The ECB initiative aims to find a better solution. As well as developing several project ideas for a range of climate zones, Bayer MaterialScience is also searching for construction partners around the world who can help implement model projects. The aim is to gather experience on everything from design and construction to operation and analysis of the operating situation and use this for efficient concept development. By functioning like a forum, an open knowledge platform will help to encourage industry-wide debate on EcoCommercial Buildings. Bayer MaterialScience is inviting its customers in the building materials industry, construction companies, architects, designers, engineers and technology partners from the various projects, as well as universities and research institutes, national legislative and standards bodies and associations to get involved in the initiative.

Bayer laid the foundation stone for the first EcoCommercial Building in March 2008 in Greater Noida, near New Delhi in India.
When complete, the building will be used by Bayer as an administrative center.

Commissioned by *Bayer MaterialScience* at a cost of some EUR five million, the first project to be implemented as part of the "*EcoCommercial Building*" initiative is the BMS Innovation Center in Noida, near New Delhi in India. The project consists of an office building with a usable area of some 1,200 square meters for approximately 50 employees and an adjoining display hall that will cover around 1,000 square meters and have a ceiling height of six meters. The building is scheduled to be completed by mid-2009.

The fundamental design of the building, which was developed in cooperation with Bayer Technology Services and other renowned experts such as architects *Banz & Riecks* and energy specialists *Solares bauen GmbH*, takes account of both the local climatic conditions and the technical infrastructure at the site. For example, there are plans to mount some 600 square meters of solar modules on the roof of the display building that will allow both the office building and display hall to operate without an external power supply. The *EcoCommercial* building in India is the first groundbreaking example of a zero-emissions building to be developed as part of the ECB initiative.

However, the entire concept is not just ecologically sound, it is also economically attractive. Experts anticipate that the ecologically sound measures implemented in the project will pay for themselves in no more than ten years!

In 2004, the greenhouse gas emissions emanating from the construction and running of buildings amounted to some 18 percent, or almost a fifth, of all emissions produced by human activity. This includes energy that is generated outside the buildings themselves but is used within them, for example electricity and district heating. Experts believe that the consistent use of high-performance insulation materials could almost halve future growth in building-related energy consumption. The potential for savings is especially significant in the new-build sector in regions where efficiency standards have previously been relatively low, for example in newly industrializing and developing countries.

In general, saving energy is the best way to combat climate change. And that is exactly how *Bayer MaterialScience* is making an important contribution to climate protection – through its cutting-edge, energy-efficient production processes and by working with customers as part of the ongoing search for new, ecologically sound applications. Products from *Bayer MaterialScience* offer tremendous potential for unlocking energy savings. Examples include rigid polyurethane foam insulation used in buildings and for heating pipes, and insulating materials used in refrigerators, freezers and lightweight vehicle construction.

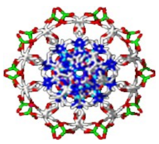
Comprehensive studies have demonstrated the impressive energy balance offered by the high-performance insulating material *polyurethane*. For example, when used as heat insulation in the roofs of residential buildings, this foam material will, over a period of 50 years, save seventy times the amount of energy needed to manufacture it. Moreover, the material usually pays for itself within just a few years, thereby making efficient heat insulation an extremely attractive climate protection tool in both ecological and economic terms.

Transparent and translucent *Makrolon*® multiwall sheets in the i-LINE product range marketed by *Bayer Sheet Europe* also offer outstanding thermal insulation properties. This makes them ideal for atrium roofing and façade cladding. Compared with solid sheeting, they enable energy savings of up to 25 percent.

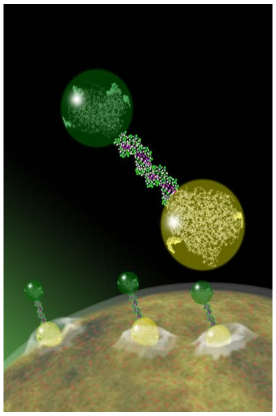
Bayer MaterialScience is contributing to environmentally sound, eco-friendly construction in other ways too; for example through its polycarbonate and thermoplastic polyurethane components for photovoltaic modules and raw materials for low-solvent and solvent-free coatings and adhesives.

Did You Know?

Nanosensors are being developed that can detect bacteria such as salmonella on the surface of food at a packaging plant. This point-of-packaging testing will reduce the chance of contaminated food reaching grocery store shelves. There are also nanosensors being developed to detect pesticides on fruits and vegetables. While this would be useful at a packing plant, let's wait for the handheld version to check the apples and grapes in our local grocery store!



Biomaterials @ MEMS



Biomaterials, as the portmanteau suggests, are materials used for biological applications. And as this field has started catching the researchers' eye, MEMS IIT Bombay is gradually picking up the pace.

Of course, the major slice of the projects and research in the institute is being done by the Bio School, but we also have a say.

The work in Prof. Bahadur's lab is eye catching. They've set their foot into the real bio-materials world when they synthesize nano-structured materials for biomedical applications.

Dr. Sudeshna Rao and Pallab Pradhan in the Magnetic Materials Laboratory tell us that magnetic nanoparticles are being developed as a highly selective cancer treatment which in a nutshell involves heating tumour and cancerous cells to death while the surrounding healthy cells do not feel the heat (pun intended)! This project is being taken care of by the ***Nano Mission*** of ***the Department of Science and Technology (DST)*** of the Government of India**.** Quoting Dr. Rao, "We have developed a multifunctional magnetic nanoparticle containing anticancer drug like *doxorubicin* which would be used for combined therapy of cancer by magnetic hyperthermia and chemotherapy". These magnetic nanoparticles are also being investigated as a potential processor and MRI contrast agent. A patent has been granted on the processing of ferrofluids for these kinds of applications.

The magnetic hyperthermia refers to elevating the temperature of the magnetic nanoparticles by exposing them to alternating magnetic fields which releases the drug. The magnetic behaviour of the liposome makes them traceable through MRI and hence easy to monitor.

Another project funded by the **DST** is being done in the same laboratory. It revolves around utilizing the properties of dendrimers for drug delivery. The unique properties of dendrimers, such as their high degree of branching, multivalency, globular architecture and well-defined molecular weight, make them promising new scaffolds for drug delivery. Research scholar Pallab says, "We are focusing on the design and synthesis of biocompatible dendrimers and Layered Double Hydroxides (LDH) for their application to many areas of bioscience including controlled and targeted drug delivery". Himanshu, who's working on anti-cholesterol drugs quips, "LDH has the potential to intercalate drug molecules inside the layer and significantly stabilize the otherwise unstable Statin family of drugs, or anti-cholesterol drugs. A patent has been filed on this work".

Another lab where biomaterials research has seeped in is the Powder Metallurgy Lab, where research scholar Ms. Preeti Bajpai is striving to improve upon the properties of ceramic dental crowns. This is being done under the supervision of Prof. Parag Bhargava. As Ms Preeti puts it, "In all ceramic restorations a number of material systems are used, but among them alumina and zirconia have shown best properties. So it is planned to fabricate dental crown using alumina/ zirconia composite material through different processing methods. In this work zirconia is added as a reinforcing agent in alumina matrix. This work is being carried out using slip casting and injection molding process".

The undergraduates, not much behind, are also riding the biomaterials wave. Nayan Chakravarty and Arunabh Sinha have done their bachelor's and master's project respectively in this emerging field under Prof. Satish Vitta's guidance. While Nayan concentrated on structural differences between an adult and a baby tooth, Arunabh devoted his time in comparing properties of bone of a human and chicken! Not to miss the boat, this humble author is also studying orthopedic implants failure under Prof. R.C. Prasad's guidance.

Looking at the bigger picture, the view d'ensemble, does make you believe in Beth Orton's words, "*..each generation finds new materials. It's evolution, isn't it?"* I think it is. What do you think?

-Devasheesh Mathur

...And More Biomaterials!

Biocompatibility is one of the most important factors when it comes to designing biomaterials. The material introduced inside the body should be non-intrusive and should not be deleterious to the body in any way. This is especially true in case of bone and muscle implants. The surface of any material is what comes into contact with the body fluids. So, surface modification of biomaterials is becoming an increasingly popular method to improve device multifunctionality, tribological and mechanical properties, as well as biocompatibility of artificial devices .

Life of metallic implants can be enhanced by increasing their mechanical properties such as wear and abrasion as well as their corrosion resistance and biocompatibility. Vivek Panvekar, a student of Prof. Khanna has worked towards attaining long-life metallic implants for hip-joints and knee-joints. Biocompatibility was ensured by application of a hydroxyapatite coating (HA) on the metallic parts made of stainless steels and titanium. These were further improved by blending with zirconia, titania and alumina powders which gave it high hardness and abrasion resistance.

Prof. Dusane's students on the other hand have worked to develop biocompatible sensors to be used inside the body. Measurements of pressure, drug concentration, etc. inside the body is achieved by means of cantilevers which bend in proportion to the stimulus. The bending is detected by appropriate piezoresistive transducers to determine the strain in it which is proportional to the quantity measured. Harshad Rokade completed his M.Tech Project involving fabrication of micro-cantilevers of Hot Wire CVD Silicon Nitride. Aditya Prakash, a dual degree student, worked on increasing gauge factor of microcrystalline-Si:H thin films for biosensor applications for which he received an award from the Indian Society for Advancement of Materials and Processing Engineering, Bangalore. Dr. Bibhu Prasad Swain did his PhD on Hot Wire CVD a-SiC:H alloy thin films. These films find application in bio-implant coatings.

Doctoral research was carried out on Pulsed Laser deposition of hydroxyapatite on electropolished ASTM 316L Stainless Steel for biocompatibility in orthopedic implant application by Dr. Vrishali S. Madhav under the guidance of Prof. R. Raman of our department. Hydroxyapatite crystals along with collagen fibres form the major constituent of a human bone. The purpose of this research was to modify the properties of bulk metallic biomaterial 316L SS at surface level to meet requirements of orthopedic implant materials.

All these are slow but sure steps towards realizing perfect, non-intrusive biomaterials which would lead to advancement of medical technology by leaps and bounds. Reading this, it should not be hard to believe that it is materials that drive most technological breakthroughs. Who knows, tomorrow we might be able to possibly replace everything in our body!

Condolences

Mr. Raviraj D. Bihari who was working in the Metallurgical Engineering and Materials Science Department as Attendant, passed away recently. The faculty, students and staff of the department will always remember the immense amount of help he provided with all activities.

May his soul rest in peace.

ArbiTech!

Unobtainium refers to an extremely rare, costly, or physically impossible material needed to fulfill a given design for a given application. The properties of any particular "unobtainium" depend on the intended use. For example, a pulley made of unobtainium might be massless and frictionless.

The name unobtainium also closely resembles the systematic element name for undiscovered elements that have an atomic number of 100-199. Like unobtainium, these all have 5 syllable names beginning with "*un*" and ending in "*ium*". However this is a case of life imitating art, as unobtainium came first.

Another largely synonymous term includes ***wishalloy*** which is a material that usually doesn't exist at all. The term ***handwavium*** usually is used to indicate a material that probably cannot even in principle be real.

"*Shake and shake the ketchup bottle. None'll come, and then a lot'll*." --Richard Armour

Have you ever wondered why tomato ketchup is so difficult to pour? Ketchup is a pseudo-plastic non-Newtonian fluid, or "shear thinning" material, with high viscosity. Inverting the bottle and hitting the bottom with hand can make the ketchup flow out rapidly since shear forces introduced in its bulk causes it to thin or its viscosity to reduce. The faster the ketchup is sheared (by shaking or tapping the bottle), the more fluid it becomes. After the shear is removed the ketchup thickens to its original viscosity.

It is very difficult to predict the behavior of ketchup when it is poured out. Says researcher Robert Berg of the National Institute of Standards and Technology , 'The chains of interactions between molecules are so long that computers just aren't powerful enough to do it!'

A solution to this problem is plastic squeeze bottles introduced by Heinz and others. An "upside-down" bottle further remedies the problem by keeping the remaining ketchup at the mouth of the bottle. These bottles are also fitted with a control valve in the nozzle designed to eliminate the build-up of ketchup in the cap after use!

A similar principle works for paint. How can paint be thin enough at one moment to flow from a stroked brush, and an instant later be thick enough not to drip down the wall? The principle of shear-thinning again!

And, if you are ever stuck in quicksand, make sure you *Don't Panic* and swim to the edge as slowly as possible. Quicksand acts like a shear-thickening fluid. The rapider your movements, the more the resistance offered to motion!

Special Thanks

Team Dhatuki wishes to thank **Dr. Raja Wusirika**, eminent Scientist from Corning Inc. for the gracious contribution to the cause of Dhatuki. He provides us with a message—

'Innovations in Materials Science play a very important role in the area of energy, nanomaterials and other growth areas that will shape our future for a long time to come. You are the best and the brightest. So I urge all of you to stick to your area of expertise and participate in shaping the future and not jump to whatever appears to be the fashion of today.'

Dr. Raja is an alumnus of IIT Bombay of the B.Tech—Metallurgy Batch of 1966. A resident of Hostel—3, he went on to complete his Ph.D in Materials Science and Engineering in 1972 from the University of Utah, USA. Since 1974, he is a scientist at Corning Inc. and has 40 Patents and 20 Publications in Automotive and Diesel pollution control, Catalysis, Fuel Cells, Electronic Ceramics, Glass, etc. American Chemical Society honoured him with an award for the invention on metal monoliths for meeting cold-start automotive emissions. He has also received Exploratory Research Award and the People Development award from Corning Inc. The team wishes him many more successes in the future.

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