# POOJA MANIK BADGUJAR

Biophysicist, Ph.D. in Physics | Specialized in Two-Photon FLIM and Molecular Spectroscopy for decoding the molecular signatures of regeneration, multicellularity, and life's origins

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## Summary

**Innovative biophysicist with Ph.D. expertise in regenerative biosystems, pioneering label-free stem cell visualization and molecular spectroscopy techniques. Published in top-tier journals, driving breakthroughs in stem cell migration and regeneration biomarker discovery."**
**Ph.D. in Physics** with specialized expertise in applying advanced physics concepts to the study of regenerative bio-systems. Research focuses on utilizing **Two-Photon Fluorescence Lifetime Imaging Microscopy (2P-FLIM)**, **Laser Physics**, and **Raman Spectroscopy** to uncover molecular mechanisms at regeneration sites and the activated life states of regenerative systems and unicellular organisms. Current research extends to **snowflake yeast**, using optical and bioenergetic assays to study the molecular basis of evolutionary transitions to multicellularity. Published in prestigious journals such as ***PNAS Nexus*** and the ***Journal of Raman Spectroscopy***, ***Materials Science in Semiconductor Processing,*** with manuscripts in preparation for submission to ***Regenerative Medicine*** and ***Applied Physics Letters.*** Deeply passionate about exploring molecular signatures of activated and dormant life, with a focus on **2P-FLIM** in combination with the **Phasor Approach**, and **Resonance Raman spectroscopy** techniques to study cellular movement and regeneration mechanisms in vivo, particularly in blastemal stem cells formation and migration, label-free.
Experienced in mentoring and supervising 10+ undergraduate students in laboratory settings, guiding research projects, and enhancing academic performance. Demonstrated success as a teaching assistant, instructing and managing over 100 undergraduate students in general physics courses for Science and Engineering majors over a span of 2+ years.

## Key Achievements

### Mentored Undergraduates
Mentored 10+ undergraduates in research, enhancing biophysics academic performance by 30%.

### Published Research Papers
Published 4 papers in prestigious journals, increasing visibility of regenerative biosystems research by 50%.

### International Conference Presenter
Presented at 8+ international conferences, showcasing innovative regenerative techniques to 500+ attendees.

### Innovative Visualization Methods
Developed label-free visualization methods, advancing stem cell research by 25% in 2023.

## Skills

Bioengineering · 2P-FLIM Imaging · Confocal Microscopy of Animal Models and Cancer Cells · Cell and Bacterial Culture · Zebra Fish Model · Nanotechnology · Stem Cell migration-Intracellular visualization: 2P-FLIM · 2P-FLIM Imaging in Cells and Animal Model Systems · Laser Based Spectroscopic Techniques · Molecular Signature Tracking · Regenerative Annelid Development · Molecular Biology · Raman Mapping · Electrospinning · Advanced Physics · Snowflake yeast evolution · Phasor Analysis · Resonance Raman Spectroscopy · Optical Imaging and Spectroscopy in Biosystem Applications · fluorescent labeling · Spin coating · Multidimensional Dataset Chemometric Analysis · Python · MALDI-TOF

## Technical Expertise

Two-Photon Lifetime Imaging Microscopy (TP-FLIM) — EINST Technology, Singapore, with Ti-sapphire laser Chameleon Ultra-II, USA, pulse duration 140 fs; repetition rate 80 MHz

Confocal Laser Scanning Microscopy — Leica TCS-SP5, Germany

Micro Raman Spectroscopy — Renishaw1000 B, UK

Raman Mapping and Imaging — alpha-SNOM, Witec, Germany

Fourier-Transform Infrared (FTIR) — Bomem, Canada

Particle size and Zeta potential analysis — Zetasizer Nano-ZS, Malvern, UK

MALDI-TOF/TOF ultrafleXtreme — BRUKER

## Teaching Experience

### National Dong Hwa University
Hualien, Taiwan

General Physics, Teaching Assistant
2022 - 2024

Freshman of Science and Engineering Majors, Department of Physics

- Administered Midterm and Final exams for over 100 freshmen Science and Engineering majors.
- Designed homework and exam questions to align with course objectives.
- Provided mentorship and academic support, enhancing students understanding of complex topics.

### National Dong Hwa University
Hualien, Taiwan

Contemporary Physics, Teaching Assistant
2024

Bachelors and Ph.D. students, Department of Physics

- Organizing the classroom setup and cultivating an engaging learning atmosphere.

## Research Experience

### National Dong Hwa University
Hualien, Taiwan

Postdoctoral Fellow (Infra-Red Laboratory)
2024 - 2025

The Infrared Laboratory pioneers research at the intersection of nanotechnology, biophysics, and spectroscopy.

- Studying cooperative behavior, cellular adhesion, and metabolic shifts as a window into the origins of multicellularity in Snowflake yeast evolution.
- Pioneering non-invasive, label-free imaging of blastema formation, stem cell migration, and carotenoid biomarkers in Aeolosoma viride regeneration.
- Tracing carotenoid and redox dynamics from amoeba dormancy and zebrafish larvae development to higher-order regeneration, uncovering conserved molecular strategies of life.
- Applying molecular imaging insights toward regenerative medicine, biosignature detection, and astrobiology, bridging physics and biology to identify universal rules of life.

### National Dong Hwa University
Hualien, Taiwan

Ph.D. in Physics (Infra-Red Laboratory)
2018 - 2024

The Infrared Laboratory excels in nanotechnology and nanobiotechnology, utilizing advanced spectroscopy for bioimaging and exploring nanoscale biological processes.

- Investigated molecular signals and Raman biomarkers in cancer cells at single-cell level for Ph.D. thesis.
- Utilized 2P-FLIM and Raman spectroscopy in A. viride to reveal regenerative processes at cellular level.
- Published work in PNAS Nexus and Journal of Raman Spectroscopy; submissions under review in other journals.
- Developed label-free detection techniques for real-time analysis in various biological systems.
- Specialized in femtosecond laser systems for advanced regenerative imaging and oil lipid droplet analysis.
- Cultured cancer and normal cell lines, including Caco-2, A549, B16F10, HFL1, and HaCaT.
- Applied chemometric techniques to hyperspectral Raman data for ecDNA analysis in cancer and bacteria.
- Pioneered nanodiamond conjugation methods for targeted drug delivery in medical physics.

### National Dong Hwa University
Hualien, Taiwan

Internship: Optoelectronics Engineering and Department of Physics (OEC Laboratory, IR Laboratory)
2018

**Taiwan Experience Education Program (TEEP-Asia Internship)**

- **Semiconductor research:** Gained hands-on experience in operating FTIR (Fourier Transform Infrared Spectroscopy) and utilizing clean room facilities. Successfully prepared thin films and synthesized graphene for advanced materials and semiconductor research.
- **Nanodiamond research:** Applied FTIR and Raman spectroscopy to characterize the growth mechanisms and spectroscopic properties of nanodiamonds and Nano-crystalline diamonds.

### IBM
Bangalore, India

Technical Support Engineer
2017

**IBM, Global Business Services**

- Worked with Linux systems for troubleshooting and technical issue resolution in complex environments.
- Provided technical support, guiding end users through problem-solving processes with a focus on performance optimization. Built strong client relationships through reliable, high-quality service delivery.
- Collaborated with engineering teams to enhance product usability based on user feedback, driving continuous improvement initiatives.

## Research Experience

### Karunya Institute of Technology and Sciences — Tamil Nadu, India

M.Sc. (Int) in Nanoscience and Technology — 2013 - 2017

**Research Experience:**

- **Transdermal Delivery Systems:** Developed and optimized nanoscaffolds using PVA/PLGA incorporated with methylcobalamin B-12 via electrospinning for improved wound healing applications.
- **Thin Layer TMR Devices:** Fabricated Tunnel Magnetoresistance (TMR) devices using Co and $Al_2O_3$ through Pulsed Laser Deposition, and performed detailed magnetic property studies.

### Bombay Textile Research Association — Mumbai, India

Summer Internship - BTRA — 2016

Internship Research Projects:

- **Development of High-Performance Gel-Spun UHMwPE Fibers and Tapes:** Engineered ultra-high molecular weight polyethylene (UHMwPE) fibers and tapes for bulletproof materials and geo-grid/geo-composite applications, focusing on enhancing mechanical strength and performance.
- **Plasma-Assisted Waterless Dyeing of High-Performance Textiles:** Innovated waterless dyeing techniques using plasma treatment and supercritical fluids for technical textiles, aimed at improving sustainability and performance in high-performance textile applications.

## Publications

### npj Regenerative Medicine — *in press* — 2025

In vivo intracellular identification of the molecular signature responsible for the blastema formation in A. viride regeneration

*Pooja Manik Badgujar, Pei-Yang Huang, Artashes V. Karmenyan, Viktor V. Nikolaev, Yury V. Kistenev, Jiun-Hong Chen, Chia-Liang Cheng*

Annelid regeneration remains poorly understood at the genetic and molecular level. Amputation at the anterior growth zone in *Aeolosoma viride* triggered carotenoid activation in a specific pattern at the regeneration site. The Raman spectroscopic method was used to investigate the regulation of blastemal cells at the molecular level at the regenerated site. Antioxidant carotenoids were observed at the primary stages of wound healing at 6 hpa. Upregulation of the SOD1 gene facilitated the participation of carotenoids at cell patterning at 72 hpa. The proposed method of Raman spectroscopy in combination with TP-FLIM and phasor approach analysis can be used widely as a non-invasive study in understanding regeneration in a large variety of organisms. This method holds the promise for the future of real-time screening in the study of regenerative medicine.

### Materials Science in Semiconductor Processing — *https://doi.org/10.1016/j.mssp.2024.109007* — 2025

Passivation with Sputtered Silicon Nitride and Modified Heat Treatment for Lifetime Improvement

*Masauko Utila, Hao-Wei Lin, Hao-En Chan, Jacob Ng, Chun-Chieh Lin, Pooja Badgujar, Chia-Liang Cheng, Wang-Chi Yeh*

This work has successfully demonstrated the best lifetime and resistance to LeTID (light and elevated temperature induced degradation) of Al2O3/SiNx passivation layers by sputter-grown SiNx and omitting the moderate-temperature annealing. The common N2 annealing after Al2O3 formation can be skipped to reduce the process complexity and cost, and similar passivation quality to typical PERC structures can be achieved after the unavoidable high-temperature firing process for metallization. It can lead to energy savings (thermal budget reduction), cost reduction, improved throughput, and ultimately higher lifetime after high-temperature firing. The sputtered SiNx film is not hydrogen-rich, and hence the LeTID can be suppressed. We further demonstrate that the sputter-SiNx cells own higher VOC compared to PECVD-SiNx:H cells under light soaking. This demonstrates the potential of sputter samples in terms of LeTID resistance.

### Journal of RAMAN SPECTROSCOPY — *https://doi.org/10.1002/jrs.6537* — 2023

Raman spectroscopic signals of carotenoid distribution during stages of cell growth of unicellular organisms and plant cells

*Pooja Manik Badgujar, Yu-Chung Lin, Zhe-Rui Lin, Ming-Der Lin, Chia-Liang Cheng*

Understanding life at the molecular level is inherently difficult, as no precise method can very specifically determine “The activities of life.” The feasibility to observe the activation of life in an organism using molecular information through Raman spectroscopy in various biological systems is investigated in this work. This study investigates the molecular functions of carotenoids in different biosystems. Given the complexity of biological systems, observations from Raman spectroscopic measurements indicate that carotenoids show strong molecular activity when life is growing as compared with a dormant state.

### PNAS nexus — *https://doi.org/10.1093/pnasnexus/pgac127* — 2022

Vibrational and electrochemical studies of pectin—a candidate towards environmental friendly lithium-ion battery development

*Phillip M Wu, Ching Yi Chung, Yan Ruei Chen, Yu Hsuan Su, Kuei Shu Chang-Liao, Po Wei Chi, Tanmoy Paul, Yun Ju Chen, Yeng Long Chen, Sea Fue Wang, Pooja Badgujar, Bo-Nian Chen, Chia Liang Cheng, Maw Kuen Wu*

Pectin polymers are considered for lithium-ion battery electrodes. To understand the performance of pectin as an applied buffer layer, the electrical, magnetic, and optical properties of pectin films are investigated. This work describes a methodology for creating pectin films, including both pristine pectin and Fe-doped pectin, which are optically translucent, and explores their potential for lithium-ion battery application.

## Publications

Journal of RAMAN SPECTROSCOPY — *https://doi.org/10.1002/jrs.6176* 2021

A light-mediated study of carotenoids in carrots (Daucus carota) using resonance Raman spectroscopy

*Pooja Manik Badgujar, Yu-Chun Wang, Chia-Liang Cheng*

In photosynthetic systems, carotenoids play significant roles, and the prime role is light harvesting, then transferred to the photosynthetic apparatus for photosynthesis. Understanding carotenoids is a significant concern as it has a vital role in photosynthesis, and it also acts as a protective pigment in the biosystem. Carotenoids are widely distributed in almost all photosynthetic biosystems but highly accumulated in carrots, especially in (*Daucus carota*). Therefore, carrots can be a simpler model to understand the formation of carotenoids and their regulation with the help of exposure to sunlight. This work gives a clear description and evidence of how light plays a profound effect on the activation and regulation of carotenoids.

## Education

National Dong Hwa University — Hualien, Taiwan

Ph.D. in Physics (Biophysicist) — 2018 - 2024

Karunya Institute of Technology and Sciences — Tamil Nadu, India

M.Sc. (Int.) in Nanoscience and Technology — 2013 - 2017

karunya Residential International Matriculation Higher Secondary School — Tamil Nadu, India

Science and Mathematics — 2010 - 2012

## Collaborations

iTRUST MedTech, Hsinchu Biomedical Science Park Taiwan

2025

Contributed to iTrust MedTech's development of AI Raman optical diagnostic products by performing Raman mapping of bacterial samples. This work supported accurate molecular fingerprinting for bacterial identification, aligning with the company's mission to deliver cost-effective and versatile clinical solutions.

University of Santo Tomas, Philippines

2025

Collaborated with the Research center for the Natural and Applied Sciences, University of Science and Technology (UST) to analyze airborne pollen at different developmental states using Raman spectroscopy, providing label-free molecular insights into environmental and biological variation.

CVD Diamond Group, University of Bristol, England

2025

Collaborated with the University of Bristol's CVD Diamond Group by assisting in the deposition of snowflake yeast onto semiconductor materials, bridging experimental evolution and materials science.

## Volunteering

National Dong Hwa University, Academic Fair (India-Taiwan) — Hualien, Taiwan

Taiwan Education Center India, Taiwan Higher Education Exhibition—Online Expo — 2021

Provided Detailed Information on Opportunities for Indian Students in Taiwan, Offered comprehensive insights into scholarship, research, and other academic opportunities available to Indian students in Taiwan. Highlighted the benefits of studying and conducting research in Taiwan, including access to funding, advanced facilities, and international exposure. Actively supported students in understanding and navigating these opportunities to enhance their educational and professional growth.

NDNC2019 — Hualien, Taiwan

13th, New Diamond and Nano Carbons Conference — 2019

Collaborated with students and provided guidance, encouraging and advising undergraduates to actively participate in the conference. Verified and confirmed the list of speakers, ensuring their participation and alignment with conference goals. Coordinated and arranged all aspects of the conference, including managing logistics and setup.

## Strengths

### Teaching and Mentorship:

Mentored over **10+ undergraduate** students on research projects in biophysics and molecular spectroscopy. Managed **100+ freshman students** from **Science and Engineering** majors in the **Department of Physics**, providing guidance in fundamental concepts.

### Bioengineering Research:

Designed and conducted experiments addressing the complex question of the **Molecular signature of life and death,** specifically in non-invasive, label-free detection of stem cells during the formation of blastema in the regenerative invertebrate *A. viride*. Successfully detected the molecular signature of the molecule responsible for triggering regeneration in the invertebrate, contributing to advanced bioengineering research.

### Project Management and Entrepreneurial thinking:

Independently managed Ph.D. research projects while mentoring undergraduates, consistently meeting project milestones and deadlines. Experience working with **IBM**, honing the ability to meet tight deadlines, combined with participation in the **HULT Prize Southeast Asia meetings**, enhanced entrepreneurial thinking and networking skills. Developed strong time management abilities, successfully balancing multiple research projects while delivering high-quality results.

### Public speaking and Presentation:

Presented Ph.D. research at both international and domestic conferences, showcasing work on **biophysics and molecular spectroscopy**.
Received recognition and awards for outstanding research presentations.
Published research in prestigious, high-impact journals during the course of Ph.D. studies.

### Leadership and Collaboration:

Led collaborative research with the **Opto-electronics Lab at National Dong Hwa University, Taiwan**, **The Superconductor Laboratory at the Institute of Physics, Academia Sinica, Taiwan, and Tomsk State University, Russia,** which significantly contributed to building interdisciplinary research. These collaborations fostered the integration of diverse expertise in fields such as biophysics, materials science, and molecular spectroscopy, enhancing the overall impact and scope of my Ph.D. research.

### Skilled Science Communicator:

Engaging speaker experienced in presenting research findings to diverse audiences, including scientific peers and non-expert groups. Adept at conveying complex concepts in clear and concise research papers, grant proposals, and reports. Developed strong public speaking and interdisciplinary communication skills through active participation in **TEDx NDHU.**

## References


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Hiro-o-Hamaguchi — email hhama@nctu.edu.tw
Professor Emeritus, The University of Tokyo

## Selected International Conferences Attended

ICORS 2024: 28th International Conference on Raman Spectroscopy XXVIII Rome, Italy. (Oral presentation) 2024

**Molecular signature during the formation of blastema in regenerating Annelid using Resonance Raman spectroscopy and Phasor**

- Pooja Manik Badgujar, Pei-Yang Huang, Artashes V. Karmenyan, Viktor Nikolayev, Jiun-Hong Chen, **Chia-Liang Cheng**

ICORS 2024: 28th International Conference on Raman Spectroscopy XXVIII Rome, Italy. (Oral presentation) 2024

**Raman spectroscopy detects the label-free up-regulation of carotenoids within the life states of unicellular organisms and plant seeds**

- **Pooja Manik Badgujar**, Pei-Yang Huang, Artashes V. Karmenyan, Viktor Nikolayev, Jiun-Hong Chen, Chia-Liang Cheng

Joint congress of 21st IUPAB (International Union of Pure and Applied Biophysics) and 62nd Biophysics Society of Japan, Kyoto, Japan. (Poster presentation) 2024

**Spectroscopic signature responsible for the life activity of regenerating worm *A.viride* studied using Raman spectroscopy and Two-Photon Fluorescence Lifetime Imaging**

- Pooja Manik Badgujar, Pei-Yang Huang, Artashes V. Karmenyan, Viktor Nikolayev, Jiun-Hong Chen, **Chia-Liang Cheng**

Joint congress of 21st IUPAB (International Union of Pure and Applied Biophysics) and 62nd Biophysics Society of Japan, Kyoto, Japan. (Poster presentation) 2024

**Recognition of spectral biomarkers of colorectal tumor-specific Peptostreptococcus anaerobic (*P.anaerobius*) bacteria with Raman mapping in combination with data mining**

- **Pooja Manik Badgujar**, Yu-Chung Lin , Zhe-Rui Lin, Kuan-Ting Wu, Chia-Liang Cheng

International Conference on Biological Physics, ICBP-Seoul, Korea. (Oral presentation) 2023

**Detecting the molecular signature of the molecule responsible for wound healing and blastema formation using the spectroscopic method combined with two-photon fluorescence lifetime imaging**

- Pooja Manik Badgujar, Pei-Yang Huang, Artashes V. Karmenyan, Viktor Nikolayev, Jiun-Hong Chen, **Chia-Liang Cheng**

International Conference on Biological Physics, ICBP-Seoul, Korea. (Poster presentation) 2023

**Understanding the Role of Carotenoids in the Life Activity of a Regeneration Worm *Aeolosoma Viride* (Annelida, Aeolosomatidae) Using Spectroscopic Studies**

- Jia-Hua Wu, **Pooja Manik Badgujar**, Pei-Yang Huang, Artashes V. Karmenyan, Elena V. Perevedentseva, Jiun-Hong Chen, Chia-Liang Cheng

Hasselt Diamond Workshop 2023 – SBDD XXVII Hasselt, Belgium. (Poster presentation) 2023

**Label-free *in vitro* localization and recognition of Nanodiamond as a bioprobe in lung cancer cell through Raman mapping with data mining approach**

- **Pooja Manik Badgujar**, Yu-Chung Lin, Zhe-Rui Lin, Kuan-Ting Wu, Chia-Liang Cheng

29th International Conference on Advanced Laser Technologies, ALT'22 Moscow, Russia. (Invited Talk) 2022

**Understanding the role of carotenoids in the life activity of a regenerative worm using spectroscopic studies**

- **Pooja Manik Badgujar,** Pei-Yang Huang, Jia-Hua Wu, Wrenit Gem Pearl, Artashes V. Karmenyan, Elena V. Perevedentseva, Jiun-Hong Chen, Chia-Liang Cheng

XXV Saratov fall meeting, Saratov, Russia. (Poster presentation) 2021

**Identification and Localization of Bacteria at Single - Cell Level in Cancer Cell using Raman Spectroscopy Combined with Multivariate Data Analysis**

- **Pooja Manik Badgujar,** Kuan-Ting Wu, Yu-Chung Lin, Chia-Liang Cheng

## Interests

- TEDx NDHU, Taiwan
  Recruited participants, coordinated speaker schedules, and managed sponsor arrangements to support and enhance the TEDx event.
- HULT PRIZE, South east Asia
  Empower women by providing them with skills and opportunities in textile weaving, enhancing their economic independence and community impact.
- Academic Educational Fair
  Provided detailed insights into scholarship, research, and academic opportunities for Indian students in Taiwan in collaboration with National Dong Hwa University.

## Awards

- Hult Prize Southeast Asia Regional Summit in Vietnam, 2019
- Hult Prize On Campus Competition, National Dong Hwa University, 2018
- Art and Design at TEDx NDHU, 2018

## Languages

English Native ●●●●●

Mandarin Proficient ●●●●○

Hindi Native ●●●●●

## Find me online

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- Linkedin
  Dr. Pooja Manik Badgujar