

**XXII<sup>nd</sup> RENCONTRES  
DU VIETNAM** | **UNESCO'S OFFICIAL PARTNER**  
Gặp gỡ Việt Nam lần thứ 22 | Đối tác chính thức của UNESCO



**INTERNATIONAL CONFERENCE ON  
ADVANCED MICROSCOPY  
FOR LIFE SCIENCES AND MATERIALS**



**ICAM-2026**

**ABSTRACT BOOK**

**2026** February  
**24 -27**  
ICISE QUY NHON, VIETNAM

# ICAM-2026

INTERNATIONAL CONFERENCE ON ADVANCED  
MICROSCOPY FOR LIFE SCIENCES AND MATERIALS:  
**THE FRONTIERS OF MICROSCOPY IN  
UNDERSTANDING LIFE SCIENCES  
AND MATERIALS**

**24<sup>th</sup> - 27<sup>th</sup> February, 2026**

ICISE, Quy Nhon, Vietnam

UNITING EXPERTS IN MICROSCOPY, BIOPHYSICS,  
MATERIALS, LIFE SCIENCES & AI

STRENGTHEN VIETNAM'S MICROSCOPY NETWORK, PROMOTE KNOWLEDGE EXCHANGE, AND  
ENHANCE CONNECTIONS WITH SOUTHEAST ASIA AND THE GLOBAL MICROSCOPY COMMUNITY

## PLENARY / KEYNOTE SPEAKERS



## SCIENTIFIC SESSIONS

- #1** Workshop: Hands-on Microscopy Training
- #2** Development and Applications of Advanced Microscopy in Life Sciences and Materials
- #3** Accelerating Microscopy Education, Training, and Shared Infrastructure

## PARTICIPANTS

- Southeast-Asian National Microscopy Societies, Imaging Southeast Asia (ISEA), Asia-Pacific Societies for Microscopy (APSM), and Microscopy Society of Vietnam (MSV) scientists specializing in microscopy, life sciences, and materials science
- Engineers in instrumentation development
- Representatives from scientific equipment companies
- Postdoctoral researchers, PhD students, and outstanding students

**ABSTRACT SUBMISSION AND REGISTRATION DEADLINE: JANUARY 18TH, 2026**

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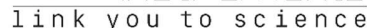
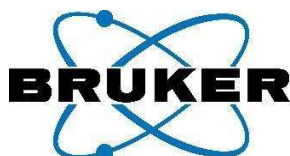
# ORGANIZERS

ICAM-2026 is organized by Rencontres du Vietnam, International Centre for Interdisciplinary Science and Education (ICISE), Vietnamese Biophysical Society, The Microscopy Society of Vietnam, Phenikaa University, and other Institutions and Universities.



# SPONSORS

Beside the main sponsors of Rencontres du Vietnam and ICISE, ICAM-2026 sincerely appreciates the financial contributions and technical support of microscopy provided by the following sponsors:



## Welcome Message from the Organizing Committee of ICAM-2026

Dear Colleagues and Participants,

On behalf of the Organizing Committee, we warmly welcome you to the **XXII Rencontres du Vietnam: International Conference on Advanced Microscopy for Life Sciences and Materials (ICAM-2026)**.

We are delighted to bring together outstanding scientists and researchers from around the world. The conference is devoted to the interdisciplinary frontiers of microscopy and its role in advancing our understanding of both life sciences and materials.

ICAM-2026 is more than a scientific meeting. Alongside the main sessions, it features hands-on training activities and aims to serve as a catalyst for collaboration in advanced microscopy. The program includes plenary lectures by internationally recognized experts, keynote and invited talks, oral and poster presentations, and dedicated discussions on education, training, and international research partnerships. It is also a particularly meaningful event for the microscopy community in Asia and Vietnam, offering local researchers valuable opportunities to engage with the global academic and industrial landscape.

We encourage you to actively participate in the scientific discussions, build new connections, and explore future collaborations. Your engagement will make this meeting both productive and inspiring. We also hope you will enjoy the unique atmosphere of the ICISE in the beautiful coastal city of Quy Nhon, which provides an ideal setting for thoughtful exchange and interaction.

Thank you for being part of ICAM-2026.

With warm regards,

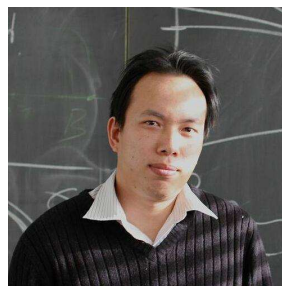
The Organizing Committee of ICAM-2026  
Quy Nhon, Vietnam  
February 24-27, 2026



**Tran Quang Huy**  
Chairman



**Ngo Xuan Kien**  
Chairman



**Pham Thanh Tri**  
Co-Chairman



**Nguyen Kim Hung**  
Co-Chairman

## Preface

The International Centre for Interdisciplinary Science and Education (ICISE) in Quy Nhon, Central Vietnam, was founded to promote science through education and international collaboration. It provides a meeting place where scientists from the Asia–Pacific region and worldwide exchange ideas, inspire young researchers, and address scientific challenges.

The XXII Rencontres du Vietnam – *International Conference on Advanced Microscopy for Life Sciences and Materials (ICAM-2026)*, organized by Rencontres du Vietnam and hosted at ICISE, brings together scientists, engineers, early-career researchers, and students to discuss advances in microscopy and their applications in nano-biotechnology, life sciences, and materials science, while encouraging training and regional cooperation.

Microscopy has continuously transformed our understanding of nature. Modern approaches—including Atomic Force Microscopy, Scanning Ion Conductance Microscopy, Electron Microscopy (Cryo-EM, Cryo-ET, SEM, TEM, STEM), super-resolution imaging, and correlative techniques—now enable visualization from cells to near-atomic detail. The integration of artificial intelligence further accelerates image analysis and expands experimental capabilities, supporting discoveries across biology, biophysics, nanotechnology, and materials research.

Under the theme “Frontiers of Microscopy in Understanding Life Sciences and Materials”, ICAM-2026 contributes to Vietnam’s growing research capacity by providing a platform for knowledge exchange and collaboration. Although advanced microscopes are increasingly available in universities, hospitals, and industry, structured training and networking remain limited. The conference therefore aims to strengthen the national microscopy community and its connections with the Asia–Pacific and global scientific networks.

ICAM-2026 will be held on February 24–27, 2026, at ICISE, an inspiring venue between mountains and the sea. Participants from many countries—including Vietnam, Japan, Kazakhstan, Spain, United States, Canada, Thailand, Singapore, Malaysia, India, China, Taiwan, and across Asia—will share their latest work through plenary, keynote, oral, and poster sessions.

We sincerely thank Prof. Jean Tran Thanh Van, Prof. Le Kim Ngoc, our supporting institutions, ICISE members, microscopy companies, and the ICISE travel bursary whose sponsorship, including grants supporting young students and scientists, makes this conference possible.

We warmly welcome all participants to Quy Nhon and look forward to building a vibrant international microscopy community together.

**The Organizing Committee**

**ICAM-2026**

February 24-27, 2026

## MICROSCOPY SOCIETY OF VIETNAM (MSV)

The Microscopy Society of Vietnam is a national scientific organization that brings together scientists, researchers, and specialists in microscopy and related disciplines. With the mission of fostering collaboration and promoting the application of advanced microscopy technologies, the Society seeks to integrate knowledge and methodologies from microscopy, physics, biology, mathematics, computer vision, artificial intelligence, and materials science to effectively support life science research.

Life sciences, together with biology, biophysics, materials science, and nanomaterials technology, are rapidly developing interdisciplinary fields worldwide. They combine principles of physics with modern biology, chemistry, and mathematics to investigate the physical and chemical properties and processes in biological systems as well as in advanced materials. In this context, nanotechnology plays an important role in the design and application of nanoscale structures, contributing to new solutions in biomedicine, high-tech agriculture, precision medicine, renewable energy, and the semiconductor industry, etc.

The Society was established in 1997 by Professor Nguyen Van Man, an expert in Transmission Electron Microscopy (TEM) for the diagnosis of infectious diseases. He previously worked at the Poliomyelitis Vaccine Research and Production Center, 135 Lo Duc Street, Hanoi, Vietnam. With strong professional expertise and dedication to developing the microscopy community, he laid the foundation for an academic organization oriented toward connectivity and international integration.

During its early stage, the Society mainly focused on academic exchanges, while collaborative networks remained limited. The linkage between microscopy technology research and development (R&D) and practical applications, as well as between equipment suppliers and research institutions, was not yet well coordinated.

Since 2024, the Society has revitalized its activities through domestic workshops and training courses, notably the *Vietnam Workshop on Microscopy 2024*, and has participated in and co-organized international conferences on advanced microscopy, including ICAM-2026. Through these efforts, the Society aims to build a professional microscopy community, strengthen cooperation among scientists, engineers, and industry partners, promote technology transfer, develop high-quality human resources, and expand international collaboration.

With a long-term vision, the Microscopy Society of Vietnam is committed to connecting the national microscopy network with the Asia–Pacific region and the global scientific community, contributing to enhancing Vietnam’s scientific and technological standing in the era of innovation and international integration.

### Official Website, Email, and Logo

<https://vietmicroscopy.vn/>

Email: [vbs@vietmicroscopy.vn](mailto:vbs@vietmicroscopy.vn)



## **VIETNAMESE BIOPHYSICAL SOCIETY (VBS)**

The Vietnamese Biophysical Society (VBS) is a subdivision of the Vietnam Physical Society, serving as the national representative body for the advancement of education, research, and development in biophysics. The Society was founded to connect scientists, lecturers, and students, while promoting academic exchange, enhancing the quality of training and research, and fostering the application of biophysical achievements in life sciences, medicine, agriculture, and technology.

VBS is the official representative of Vietnam in the International Union for Pure and Applied Biophysics (IUPAB) and maintains close collaborative relationships with regional and international biophysics societies. Through conferences, workshops, training programs, and joint research initiatives, VBS plays a vital role in integrating the Vietnamese biophysics community into the global scientific arena, while contributing to the sustainable development of science and technology in the country.

The idea of establishing VBS originated from a group of lecturers and scientists from Phenikaa University, Nong Lam University, Vietnam Military Medical Academy, Hue University, Vietnam National University, Hanoi Medical University, HCM City University of Technology, University of Medicine and Pharmacy at HCM City, together with academic support from Kanazawa University (Japan). Driven by the urgent need to create a professional community for research collaboration and educational advancement, the founding group engaged in extensive discussions and preparations.

After a period of groundwork and advocacy, VBS was officially established in 2025 with broad consensus from research institutions and biophysics experts both within and outside Vietnam.

From its inception, VBS has set forth key strategic goals:

- To encourage fundamental and applied research in biophysics.
- To establish a forum for academic exchange, research collaboration, and the training of high-quality human resources.
- To promote scientific publications, including the future establishment of a specialized journal to disseminate research results.
- To support the development of policies and strategies for scientific and technological advancement in medicine, agriculture, environment, and biotechnology.

Among its prominent activities, VBS organizes national and international scientific conferences and workshops, as well as specialized training courses for lecturers and young researchers. The Society also actively participates in interdisciplinary projects and international collaborations, thereby enhancing Vietnam's scientific standing on the global stage.

With its mission to promote biophysical research, education, and applications, VBS is steadily affirming its pioneering role in connecting the scientific community, fostering international integration, and contributing to the sustainable development of science and technology in Vietnam.

### **Official Website, Email, and Logo**

<https://vietbiophysics.vn/>

Email: [vbs@vietbiophysics.vn](mailto:vbs@vietbiophysics.vn)



# Committees

## Scientific advisory committee

- **Prof. Dr. Jean Tran Thanh VAN**, President of Rencontres du Vietnam, France
- **Prof. Dr. Le Kim NGOC**, ICISE, Rencontres du Vietnam, France
- **Prof. Dr. Eric Hanssen**, President of Committee of Asia Pacific Societies for Microscopy (CAPSM)/ The University of Melbourne, Australia
- **Dr. Teng-Leong Chew**, Director of Advanced Imaging, HHMI Janelia Research Campus, USA

## Program committee

- **Assoc. Prof. Dr. Tran Quang HUY** – Phenikaa University Nano Institute, Phenikaa University, Hanoi, Vietnam (He/him/his)
- **Assist. Prof. Dr. Ngo Xuan KIEN** – WPI Nano Life Science Institute, Kanazawa University, Kanazawa, Japan; IFIRSE, ICISE, Quy Nhon, Vietnam (He/him/his)
- **Assist. Prof. Dr. Pham Thanh TRI** - Department of Biology, School of Sciences and Humanities, Nazarbayev University, Republic of Kazakhstan (He/him/his)
- **Assoc. Prof. Dr. Nguyen Kim HUNG** - Institute of Science Tokyo, Japan (He/him/his)
- **Prof. Dr. Eric Hanssen** - President of Asia-Pacific Societies for Microscopy, The University of Melbourne, Australia (He/him/his)
- **Assoc. Prof. Dr. Bui Khanh HUY** - McGill University, Canada (He/him/his)
- **Assist. Prof. Dr. Vu Quang CONG** - WPI Nano Life Science Institute, Kanazawa University, Kanazawa, Japan (He/him/his)
- **Dr. Nguyen Thanh THUY** - National Institute of Hygiene and Epidemiology, Vietnam (She/her/hers)
- **Dr. Le Thi Hong PHONG** - Institute of Materials Sciences, VAST, Vietnam (She/her/hers)
- **Dr. Le Thi Phuong NGAN** – Institute for Integrative Biology of the Cell (I2BC), CNRS UMR9198, Inserm U1280, Gif-sur-Yvette, France (She/her/hers)
- **Dr. Tran Thi QUYNH** – The Physical Chemistry Institute (ICP), University of Paris Saclay, France (She/her/hers)

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- **Co-Chairman: Nguyen Kim HUNG** – Institute of Science Tokyo, Japan (He/him/his)
- **Bui Khanh HUY** – McGill University, Canada (He/him/his)
- **Le Thi Phuong NGAN** - Institute for Integrative Biology of the Cell (I2BC), CNRS UMR9198, Inserm U1280, Gif-sur-Yvette, France (She/her/hers)
- **Nguyen Anh DUNG** - Le Mans University, France; Hanoi University of Industry, Vietnam (He/him/his)
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- **Tran Thanh SON** - ICISE, Quy Nhon, Binh Dinh, Vietnam (He/him/his)
- **Nguyen Thanh THUY** - National Institute of Hygiene and Epidemiology, Vietnam (She/her/hers)
- **Le Thi Hong PHONG** - Institute of Materials Sciences, VAST, Vietnam (She/her/hers)
- **Trinh Duy CHI**, Department of Life Sciences, University of Science and Technology of Hanoi (USTH), Vietnam (He/him/his)

### Secretariat

- **BSc. Nguyen Thi BICH** – Phenikaa University, Hanoi, Vietnam (She/her/hers)
- **MSc. Nguyen Thi HUE** – Phenikaa University, Hanoi, Vietnam (She/her/hers)

### Finance, Sponsorship, Technique and Transportation

- **MSc. Tran Pham Quynh NHU** – Office manager of ICISE, Quy Nhon, Vietnam
- **Ms. Nguyen Thi LOI** - ICISE, Quy Nhon, Vietnam
- **Ms. Pham Thi Truc LY** - ICISE, Quy Nhon, Vietnam
- **Ms. Tran Thi Hai LIEN** - ICISE, Quy Nhon, Vietnam
- **MSc. Nguyen Trong NHAN** – ICISE, Quy Nhon, Vietnam
- **Mr. Nguyen Dinh THE** - ICISE Quy Nhon, Vietnam
- **Ms. Nguyen Thi Thanh LOAN** - ICISE Quy Nhon, Vietnam

**PROGRAM**  
**TRAINING COURSE ON ADVANCED MICROSCOPY**  
(ICISE, Quy Nhon 24/2/2026)

| <b>Training Course on Advanced Microscopy</b><br><b>Tuesday, February 24, 2026</b>                             |                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8:15–8:30                                                                                                      | Moving to ICISE from Seagull Hotel by Shuttle Buses                                                                                                                                                                                                                                                                                                                                                    |
| 8:30–9:00                                                                                                      | Registration                                                                                                                                                                                                                                                                                                                                                                                           |
| 9:00–9:30                                                                                                      | <ul style="list-style-type: none"> <li>• Opening speech for the training course by Assist. Prof. Ngo Xuan Kien, Chairman of ICAM2026</li> <li>• Group photo</li> </ul>                                                                                                                                                                                                                                 |
| 9:30 - 9:50                                                                                                    | Coffee break                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>WORKSHOP SESSION, HALL 2</b><br><b>Chairs: Assoc. Prof. Tran Quang Huy and Assist. Prof. Pham Thanh Tri</b> |                                                                                                                                                                                                                                                                                                                                                                                                        |
| 10:00–10:45                                                                                                    | <b>Theoretical lecture 1:</b> Scanning electron microscopy in biology: 3D analysis of biological specimens<br><br><b>Prof. Dr. Ivan Vorobyev</b><br><br>Department of Biology, School of Science and Humanities, Nazarbayev University and National Laboratory Astana, Astana, Kazakhstan                                                                                                              |
| 10:45–11:15                                                                                                    | <b>Theoretical Lecture 2:</b> Atomic Force Microscope for probing the structure and mechanical properties of materials and biological samples at nanoscale<br><br><b>Dr. Nguyen Anh Dung</b><br><br>Institut des Molécules et Matériaux du Mans (IMMM), CNRS-UMR 6283, Le Mans Université, France<br><br>School of Electrical and Electronic Engineering, Hanoi University of Industry, Hanoi, Vietnam |
| 11:15–12:00                                                                                                    | <b>Gold sponsor's presentation:</b> Conventional specimen preparation for SEM and TEM<br><br>Singapore Winner Scientific Instruments PTE. LTD                                                                                                                                                                                                                                                          |
| 12:00–13:30                                                                                                    | Lunch                                                                                                                                                                                                                                                                                                                                                                                                  |

| <b>WORKSHOP SESSION, HALL 2</b><br><b>Chairs: Assist. Prof. Ngo Xuan Kien and Dr. Nguyen Anh Dung</b> |                                                                                                                                                                                                                                                                                                                                 |
|-------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 13:30–14:00                                                                                           | <b>Theoretical lecture 3:</b> Optical microscopy in life sciences: Time-lapse imaging of living cells to uncover biological processes<br><br><b>Assist. Prof. Dr. Pham Thanh Tri</b><br><br>Department of Biology, School of Science and Humanities, Nazarbayev University, Astana, Kazakhstan                                  |
| 14:00–14:30                                                                                           | <b>Silver sponsor’s presentation:</b> Electron Microscopy for Life Sciences & Materials analyses from Thermo Fisher Scientific<br><br>Minh Khang Technical Service & Trading Co., Ltd                                                                                                                                           |
| 14:30–16:00                                                                                           | <b>Practical Lab 1:</b> Advanced image processing to extract relevant information from live cell imaging data<br><br><b>Assist. Prof. Dr. Pham Thanh Tri</b><br><br>Department of Biology, School of Science and Humanities, Nazarbayev University, Astana, Kazakhstan                                                          |
| 16:00–16:30                                                                                           | Coffee break                                                                                                                                                                                                                                                                                                                    |
| 16:30–18:00                                                                                           | <b>Practical Lab 2:</b> Image and force-distance curve data processing and analysis<br><br><b>Dr. Nguyen Anh Dung</b><br><br>Institut des Molécules et Matériaux du Mans (IMMM), CNRS-UMR 6283, Le Mans Université, France<br><br>School of Electrical and Electronic Engineering, Hanoi University of Industry, Hanoi, Vietnam |
| 18:00–18:30                                                                                           | Moving to hotels by shutter buses, free excursion                                                                                                                                                                                                                                                                               |

**PROGRAM**  
**INTERNATIONAL CONFERENCE ON ADVANCED MICROSCOPY FOR LIFE SCIENCES AND**  
**MATERIALS (ICAM-2026)**  
(ICISE, Quy Nhon, 25-28/2/2026)

| DAY 1<br>Wednesday, February 25, 2026                       |                                                                                                  |                                                                                   |
|-------------------------------------------------------------|--------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| 7:45–8:15                                                   | Moving to ICISE from Seagull Hotel by Shuttle Buses                                              |                                                                                   |
| 8:15–9:00                                                   | Registration                                                                                     |                                                                                   |
| 9:00–9:30                                                   | Opening ceremony                                                                                 |                                                                                   |
|                                                             | ● Welcome speech from representative of Gia Lai Province                                         |                                                                                   |
|                                                             | ● Speech from Representative of ICISE                                                            |                                                                                   |
|                                                             | ● Opening speech by Assoc. Prof. Tran Quang Huy, Chairman of ICAM2026                            |                                                                                   |
| 9:30 - 9:50                                                 | ● Group photo                                                                                    |                                                                                   |
|                                                             | Coffee break                                                                                     |                                                                                   |
|                                                             | PLENARY SESSION, HALL 1                                                                          |                                                                                   |
|                                                             | Chairs: Assist. Prof. Ngo Xuan Kien and Prof. Clemmens Cabernard                                 |                                                                                   |
| 9:50–10:50                                                  | PL-01: Visualizing Life Across Biological Length Scales with Emerging Technologies               | Dr. Teng-Leong Chew<br>HHMI's Janelia Research Campus, USA                        |
| 10:50–11:10                                                 | SP-01: Protochips in operando TEM solution                                                       | Singapore Winner Scientific Instruments PTE. LTD                                  |
| 11:10–11:40                                                 | K-01: Networking for Diagnostic Electron Microscopy in Infectious Diseases                       | Prof. Hing Hiang Lian<br>First City University College, Malaysia                  |
| 11:40–12:10                                                 | K-02: Nanoscopic Gateways: Reconciling Protocell Transport and Peptide-Mediated Endosomal Escape | Prof. Ian Liao<br>National Yang-Ming Chiao-Tung University, Taiwan                |
| 12:10–14:00                                                 | Lunch                                                                                            |                                                                                   |
| PLENARY SESSION, HALL 1                                     |                                                                                                  |                                                                                   |
| Chairs: Dr. Teng-Leong Chew and Assoc. Prof. Huy Quang Tran |                                                                                                  |                                                                                   |
| 14:00–14:30                                                 | K-03: AFM Nanomechanics to Connect Macro- and Nanoscopic World                                   | Prof. Ken Nakajima<br>Institute of Science Tokyo, Japan                           |
| 14:30–15:00                                                 | K-04: Recent Advances in AI-Driven Visual Data Science for HS-AFM and Cryo-EM Analysis           | Assoc. Prof. Ly Quoc Ngoc<br>VNUHCM–University of Science, Vietnam                |
| 15:00–15:45                                                 | PL-02: Frontiers in atomic force microscopy: Interfacial water and cell mechanobiology           | Prof. Ricardo Garcia<br>Instituto de Ciencia de Materiales de Madrid, CSIC, Spain |
| 15:45–16:15                                                 | Coffee break                                                                                     |                                                                                   |

| PARALLEL SESSIONS |                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                             |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                   | <b>Session 1: Life Sciences (Hall 1)</b><br><b>Chairs: Assist. Prof. Pham Thanh Tri, Assist. Prof. Hayato Yamashita</b>                                                                                                                                                             | <b>Session 2: Materials (Hall 2)</b><br><b>Chairs: Assoc. Prof. Nguyen Viet Hung, Assoc. Prof. Pham Hung Vuong</b>                                                                                                                                          |
| 16:15–16:40       | <b>IL-01:</b> High-Speed Atomic Force Microscopy Visualizes Target DNA Search Dynamics of a Transcription Factor<br><b>Assist.Prof. Hayato Yamashita</b><br>The University of Osaka, Japan                                                                                          | <b>IM-01:</b> Electron Microscopy as a Central Tool for Understanding Growth Mechanisms in ALD Nanocoatings and Stabilization Mechanisms in Nanowire Networks<br><b>Assoc. Prof. Nguyen Viet Hung</b><br>Phenikaa University, Vietnam                       |
| 16:40–17:05       | <b>IL-02:</b> Conformational dynamics of actin filaments crosslinked with alpha-actinin and their roles in suppressing cofilin-induced helical shortening and cluster formation<br><b>Assist.Prof. Ngo Xuan Kien</b><br>WPI Nano Life Science Institute, Kanazawa University, Japan | <b>IM-02:</b> Microscopy in analysis of TiO <sub>2</sub> nanotubes-cell interactions<br><b>Assoc.Prof. Pham Hung Vuong</b><br>Hanoi University of Science and Technology, Vietnam                                                                           |
| 17:05–17:30       | <b>IL-03:</b> Advanced biosynthesis to boost the production of natural antibiotics for medicinal and food industries<br><b>Assist.Prof. Pham Thanh Tri</b><br>Nazarbayev University, Republic of Kazakhstan                                                                         | <b>IM-03:</b> Imaging techniques for semiconducting industry: from front-end to back-end<br><b>Dr. Hoang Duc Quang</b><br>Ho Chi Minh City University of Technology and Engineering, Vietnam                                                                |
| 17:30–17:55       | <b>IL-04:</b> Multi-scale structural characterization and physicochemical profiling of Tor douronensis muscle for cultivated Fish Meat<br><b>Dr. Witchukorn Phuthong</b><br>Kasetsart University, Thailand                                                                          | <b>IM-04:</b> An excellent non-paraffin-stick coating achieved by silicone microfilament deposition on a micro- and nanostructured ZnO-coated CT3 steel surface<br><b>Dr. Nguyen Thi Phuong Nhung</b><br>Petrovietnam University, Ho Chi Minh city, Vietnam |
| 17:55–18:15       | <b>OL-01:</b> Optimizing and real-time monitoring the formation of neurospheres on 3D microarray plates<br><b>Dr. Duc Long Nguyen</b><br>Gia Dinh University, Ho Chi Minh City, Vietnam                                                                                             | <b>OM-01:</b> Effect of Tool Geometry on Microchannel Fabrication in Micro Ultrasonic Machining<br><b>Dr. Vivek Jain</b><br>Thapar Institute of Engineering & Technology, India                                                                             |
| 18:15–18:30       | Moving to hotels by shuttle buses, free excursion                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                             |

| DAY 2                                                                                        |                                                                                                                    |                                                                         |
|----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|
| Thursday, February 26, 2026                                                                  |                                                                                                                    |                                                                         |
| 8:15–9:00                                                                                    | Moving to ICISE from Seagull Hotel by Shuttle Buses, and hanging posters                                           |                                                                         |
| PLENARY SESSION, HALL 1<br>Chairs: Prof. Hing Hiang Lian and Prof. Ken Nakajima              |                                                                                                                    |                                                                         |
| 9:00–9:30                                                                                    | K-05: Cellular asymmetry and asymmetric cell division                                                              | Prof. Clemmens Cabernard<br>University of Washington, USA               |
| 9:30–10:00                                                                                   | K-06: Unconventional Approach by Electron Microscopy to Visualize Structural-Changes of Rapidly Moving Targets     | Dr. Eisaku Katayama<br>Waseda University, Japan                         |
| 10:00–10:30                                                                                  | K-07: Role of cytoskeletal components in epithelial-to-mesenchymal transition                                      | Prof. Ivan Vorobyev<br>Nazarbayev University, Republic of Kazakhstan    |
| 10:30–11:00                                                                                  | Coffee break                                                                                                       |                                                                         |
| PLENARY SESSION, HALL 1<br>Chairs: Prof. Ivan Vorobyev                                       |                                                                                                                    |                                                                         |
| 11:00–11:30                                                                                  | K-08: From Molecules to the Globe - Putting Microscopy in the Hands of Scientists Worldwide                        | Dr. Teng-Leong Chew<br>HHMI's Janelia Research Campus, USA              |
| 11:30–12:00                                                                                  | Networking events:<br>Accelerating Microscopy Education, Training, and Shared Infrastructure                       | Drs. Teng-Leong Chew, Tran Quang Huy, Ngo Xuan Kien                     |
| 12:00–14:00                                                                                  | Lunch                                                                                                              |                                                                         |
| PLENARY SESSION, HALL 1<br>Chairs: Assist. Prof. Pham Thanh Tri                              |                                                                                                                    |                                                                         |
| 14:00–15:30                                                                                  | All sponsors                                                                                                       | Equipment demonstration at their exhibition booths for all participants |
| 15:30–16:00                                                                                  | Coffee Break                                                                                                       |                                                                         |
| 16:00–17:30                                                                                  | Poster presentation                                                                                                |                                                                         |
| 17:30–21:00                                                                                  | Cocktails and Gala Dinner                                                                                          |                                                                         |
| 21:00                                                                                        | Moving to hotels by shuttle buses                                                                                  |                                                                         |
| DAY 3                                                                                        |                                                                                                                    |                                                                         |
| Friday, February 27, 2026                                                                    |                                                                                                                    |                                                                         |
| 8:30–9:00                                                                                    | Moving to ICISE from Seagull Hotel by Shuttle Buses                                                                |                                                                         |
| PLENARY SESSION, HALL 1<br>Chairs: Assoc. Prof. Ly Quoc Ngoc and Assist. Prof. Ngo Xuan Kien |                                                                                                                    |                                                                         |
| 9:00–9:30                                                                                    | K-09: Expanding the Frontiers of Autonomous Bioluminescence: Multicolor Variants and Applications for Life Science | Prof. Takeharu Nagai<br>Osaka University, Japan                         |
| 9:30–10:00                                                                                   | K-10: The Frozen Architecture of Life: Visualizing Biology at Atomic Resolution                                    | Assoc.Prof. Bui Khanh Huy<br>Mc Gill University, Canada                 |

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|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                   |                                                                                                                                                                                                                      |                                                                                                                                                                                                                               |
| 10:00–10:30       | <b>K-11:</b> Optical Physics–Based Characterization of Advanced Materials: Spectroscopy, Photonic Response, and and Multiscale Surface Probing                                                                       | <b>Assoc.Prof. Tan Le Hoang Doan</b><br>Advanced Materials Technology Institute, National University Ho Chi Minh City, Viet Nam                                                                                               |
| 10:30–11:00       | Coffee break                                                                                                                                                                                                         |                                                                                                                                                                                                                               |
| PARALLEL SESSIONS |                                                                                                                                                                                                                      |                                                                                                                                                                                                                               |
|                   | <b>Session 1: Life Sciences (Hall 1)</b><br><b>Chairs: Dr. Nguyen Minh Duc and Dr. Siti Hawa Ngalim</b>                                                                                                              | <b>Session 2: Materials (Hall 2)</b><br><b>Chairs: Assoc.Prof. Nguyen Kim Hung and Dr. Mai Thanh Tam</b>                                                                                                                      |
| 11:00–10:25       | <b>IL-05:</b> Structural Basis of Tigecycline bound Mitochondrial Ribosome revealed by Cryo-Electron Microscopy<br><b>Dr. Nguyen Minh Duc</b><br>Phenikaa University, Hanoi, Vietnam                                 | <b>IM-05:</b> Electron Backscatter Diffraction helps observe the initiation of stress corrosion cracking phenomenon in pipeline steels<br><b>Assoc.Prof. Le Manh Tu</b><br>Phenikaa University, Vietnam                       |
| 11:25–11:50       | <b>IL-06:</b> Engineering Protein–Lipid Interfaces on Giant Unilamellar Vesicles as a Platform for Membrane Mechanobiology<br><b>Dr. Siti Hawa Ngalim</b><br>Universiti Sains Malaysia, Malaysia                     | <b>IM-06:</b> Insights into the Structure and Mechanics of Polymer-Based Lightweight Materials through AFM and Complementary Microscopy Techniques<br><b>Assoc.Prof. Nguyen Kim Hung</b><br>Institute of Science Tokyo, Japan |
| 11:50–12:15       | <b>IL-07:</b> Bacterial cell - nanoparticle interactions through transmission electron microscopy<br><b>Assoc.Prof. Tran Quang Huy</b><br>Phenikaa University, Hanoi, Vietnam                                        | <b>IM-07:</b> Strain-induced crystallization near a crack tip: Micro-scale insights from unfilled and filled elastomers<br><b>Dr. Mai Thanh Tam</b><br>University of Science, VNU-HCM, Vietnam                                |
| 12:15–14:00       | Lunch                                                                                                                                                                                                                |                                                                                                                                                                                                                               |
| PARALLEL SESSIONS |                                                                                                                                                                                                                      |                                                                                                                                                                                                                               |
|                   | <b>Session 1: Life Sciences (Hall 1)</b><br><b>Chairs: Dr. Hoang Vu Mai Phuong</b>                                                                                                                                   | <b>Session 2: Materials (Hall 2)</b><br><b>Chairs: Assoc.Prof. Le Manh Tu</b>                                                                                                                                                 |
| 14:00–14:25       | <b>IL-08:</b> Reduced cell wall stiffness is partially responsible for reduced shape robustness in the Arabidopsis mutant vip3<br><b>Dr. Trinh Duy Chi</b><br>University of Science and Technology of Hanoi, Vietnam | <b>IM-08:</b> Three-dimensional reconstruction and quantitative analysis of confocal microscopy z-stack images<br><b>Dr. Le Vu Phuc</b><br>University of Technology, VNU-HCM, Vietnam                                         |
| 14:25–14:50       | <b>IL-09:</b> Label-free Full-Spectrum Cytometry of Autofluorescence                                                                                                                                                 | <b>IM-09:</b> Redox controlled nanopatterning of graphene                                                                                                                                                                     |

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|---------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
|                                                                                                               | <b>Prof. Natalie S.Barteneva</b><br>Nazarbayev University, Republic of<br>Kazakhstan                      | surface by electro-active<br>molecules<br><b>Assoc.Prof. Phan Thanh Hai</b><br>Quy Nhon University, Vietnam |
| 14:50–15:20                                                                                                   | Coffee break                                                                                              |                                                                                                             |
| <b>MIXING ORAL PRESENTATIONS (Hall 1)</b><br><b>Chairs: Dr. Trinh Duy Chi and Assoc. Prof. Phan Thanh Hai</b> |                                                                                                           |                                                                                                             |
| 15:20–15:40                                                                                                   | <b>OL-02:</b> AFMnanoX: Geometry-Aware Analysis of HS-AFM Data Using Intensity and Height Cues            | <b>Msc. Nguyen Tran Vinh Thuyen</b><br>University of Science, VNU-HCM, Vietnam                              |
| 15:40–16:00                                                                                                   | <b>OL-03:</b> The characterization of SARS-CoV-2 circulated in Viet Nam, 2020-2025                        | <b>Dr. Hoang Vu Mai Phuong</b><br>National Institute of Hygiene and Epidemiology, Vietnam                   |
| 16:00–16:20                                                                                                   | <b>OL-04:</b> Probing structure and mechanical properties of human skin by atomic force microscopy        | <b>Dr. Nguyen Anh Dung</b><br>Le Mans Université, France and Hanoi University of Industry, Vietnam          |
| 16:20 - 16:40                                                                                                 | <b>OM-02:</b> Microstructural Study on Microwave-processed Pure Cu vs Commercial Cu                       | <b>Dr. Dheeraj Gupta</b><br>Thapar Institute of Engineering & Technology, India                             |
| 16:40–17:00                                                                                                   | <b>Poster awards and closing ceremony by Assist. Prof. Ngo Xuan Kien</b>                                  |                                                                                                             |
| ~17:00                                                                                                        | Moving to Seagull Hotel by Shuttle Buses/Free Excursion                                                   |                                                                                                             |
| <b>Saturday, February 28, 2026</b>                                                                            |                                                                                                           |                                                                                                             |
| 8:00–16:00                                                                                                    | Networking and Excursion in Quy Nhon<br>Planning place: Kỳ Co Eo Gió<br>(Register and self-paid expenses) |                                                                                                             |

# CONTENTS

| No.   | Plenary Lectures                                                                                                                                                      | Page |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| PL-01 | <b>Visualizing Life Across Biological Length Scales with Emerging Technologies</b><br>Teng Leong Chew<br>HHMI's Janelia Research Campus, USA                          | 24   |
| PL-02 | <b>Frontiers in atomic force microscopy: Interfacial water and cell mechanobiology</b><br>Ricardo Garcia<br>Instituto de Ciencia de Materiales de Madrid, CSIC, Spain | 25   |
| II    | <b>Keynote Lectures</b>                                                                                                                                               |      |
| K-01  | <b>Networking for Diagnostic Electron Microscopy in Infectious Diseases</b><br>Hing Hiang Lian<br>First City University College, Malaysia                             | 26   |
| K-02  | <b>Nanoscope Gateways: Reconciling Protocell Transport and Peptide-Mediated Endosomal Escape</b><br>Ian Liao<br>National Yang-Ming Chiao-Tung University, Taiwan      | 27   |
| K-03  | <b>AFM Nanomechanics to Connect Macro- and Nanoscopic World</b><br>Ken Nakajima<br>Institute of Science Tokyo, Japan                                                  | 29   |
| K-04  | <b>Recent Advances in AI-Driven Visual Data Science for HS-AFM and Cryo-EM Analysis</b><br>Ly Quoc Ngoc<br>VNUHCM–University of Science, Vietnam                      | 32   |
| K-05  | <b>Cellular asymmetry and asymmetric cell division</b><br>Clemmens Cabernard<br>University of Washington, USA                                                         | 38   |
| K-06  | <b>Unconventional Approach by Electron Microscopy to Visualize Structural-Changes of Rapidly Moving Targets</b><br>Eisaku Katayama<br>Waseda University, Japan        | 40   |
| K-07  | <b>Role of cytoskeletal components in epithelial-to-mesenchymal transition</b><br>Ivan Vorobyev<br>Nazarbayev University, Kazakhstan                                  | 44   |
| K-08  | <b>From Molecules to the Globe – Putting Microscopy in the Hands of Scientists Worldwide</b><br>Teng-Leong Chew<br>HHMI's Janelia Research Campus, USA                | 45   |

|            |                                                                                                                                                                                                                                                     |    |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| K-09       | <b>Expanding the Frontiers of Autonomous Bioluminescence: Multicolor Variants and Applications for Life Science</b><br>Takeharu Nagai<br>Osaka University, Japan                                                                                    | 46 |
| K-10       | <b>The Frozen Architecture of Life: Visualizing Biology at Atomic Resolution</b><br>Bui Khanh Huy<br>McGill University, Canada                                                                                                                      | 47 |
| K-11       | <b>Optical Physics–Based Characterization of Advanced Materials: Spectroscopy, Photonic Response, and Multiscale Surface Probing</b><br>Tan Le Hoang Doan<br>Advanced Materials Technology Institute, National University Ho Chi Minh City, Vietnam | 48 |
| <b>III</b> | <b>Invited &amp; Oral Presentations (Life Sciences)</b>                                                                                                                                                                                             |    |
| IL-01      | <b>High-Speed Atomic Force Microscopy Visualizes Target DNA Search Dynamics of a Transcription Factor</b><br>Hayato Yamashita<br>The University of Osaka, Japan                                                                                     | 49 |
| IL-02      | <b>Conformational Dynamics of Actin Filaments Crosslinked with Alpha-Actinin</b><br>Ngo Xuan Kien<br>WPI Nano Life Science Institute, Kanazawa University, Japan                                                                                    | 52 |
| IL-03      | <b>Advanced Biosynthesis to Boost the Production of Natural Antibiotics</b><br>Pham Thanh Tri<br>Nazarbayev University, Republic of Kazakhstan                                                                                                      | 57 |
| IL-04      | <b>Multi-scale Structural Characterization and Physicochemical Profiling of Tor douronensis Muscle</b><br>Witchukorn Phuthong<br>Kasetsart University, Thailand                                                                                     | 61 |
| IL-05      | <b>Structural Basis of Tigecycline-Bound Mitochondrial Ribosome by Cryo-EM</b><br>Nguyen Minh Duc<br>Phenikaa University, Hanoi, Vietnam                                                                                                            | 66 |
| IL-06      | <b>Engineering Protein–Lipid Interfaces for Membrane Mechanobiology</b><br>Siti Hawa Ngalim<br>Universiti Sains Malaysia, Malaysia                                                                                                                  | 69 |
| IL-07      | <b>Bacterial Cell–Nanoparticle Interactions via TEM</b><br>Tran Quang Huy<br>Phenikaa University Nano Institute, Phenikaa University, Hanoi, Vietnam                                                                                                | 73 |

|           |                                                                                                                                                                                                                         |     |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| IL-08     | <b>Reduced cell wall stiffness is partially responsible for reduced shape robustness in the Arabidopsis mutant vip3</b><br>Trinh Duy Chi<br>University of Science and Technology of Hanoi, Vietnam                      | 78  |
| IL-09     | <b>Label-free Full-Spectrum Cytometry of Autofluorescence</b><br>Natalie S. Barteneva<br>Nazarbayev University, Republic of Kazakhstan                                                                                  | 82  |
| OL-01     | <b>Optimizing and real-time monitoring the formation of neurospheres on 3D microarray plates</b><br>Duc Long Nguyen<br>Gia Dinh University, Ho Chi Minh City, Vietnam                                                   | 84  |
| OL-02     | <b>AFMnanoX: Geometry-Aware Analysis of HS-AFM Data</b><br>Nguyen Tran Vinh Thuyen<br>University of Science, VNU-HCM, Vietnam                                                                                           | 90  |
| OL-03     | <b>Characterization of SARS-CoV-2 Circulated in Vietnam 2020–2025</b><br>Hoang Vu Mai Phuong<br>National Institute of Hygiene and Epidemiology, Vietnam                                                                 | 96  |
| OL-04     | <b>Probing Structure and Mechanical Properties of Human Skin by AFM</b><br>Nguyen Anh Dung<br>Le Mans Université, France & Hanoi University of Industry, Vietnam                                                        | 100 |
| <b>IV</b> | <b>Invited &amp; Oral Presentations (Materials)</b>                                                                                                                                                                     |     |
| IM-01     | <b>Electron Microscopy as a Central Tool for Understanding Growth Mechanisms in ALD Nanocoatings</b><br>Nguyen Viet Huong<br>Phenikaa University, Vietnam                                                               | 51  |
| IM-02     | <b>Microscopy in Analysis of TiO<sub>2</sub> Nanotubes-Cell Interactions</b><br>Pham Hung Vuong<br>Hanoi University of Science and Technology, Vietnam                                                                  | 56  |
| IM-03     | <b>Imaging Techniques for Semiconducting Industry: from Front-end to Back-end</b><br>Hoang Duc Quang<br>Ho Chi Minh City University of Technology and Engineering, Vietnam                                              | 59  |
| IM-04     | <b>An Excellent Non-paraffin-stick Coating Achieved by Silicone Microfilament Deposition on a Micro- and Nanostructured ZnO-coated CT3 Steel Surface</b><br>Nguyen Thi Phuong Nhung<br>Petrovietnam University, Vietnam | 64  |

|          |                                                                                                                                                                                                                                                                    |     |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| IM-05    | <b>Electron Backscatter Diffraction Helps Observe the Initiation of Stress Corrosion Cracking Phenomenon in Pipeline Steels</b><br>Le Manh Tu<br>Phenikaa University, Vietnam                                                                                      | 67  |
| IM-06    | <b>Insights into the Structure and Mechanics of Polymer-Based Lightweight Materials through AFM and Complementary Microscopy Techniques</b><br>Nguyen Kim Hung<br>Institute of Science Tokyo, Japan                                                                | 71  |
| IM-07    | <b>Strain-induced Crystallization Near a Crack tip: Micro-scale Insights from Unfilled and Filled Elastomers</b><br>Mai Thanh Tam<br>University of Science, VNU-HCM, Vietnam                                                                                       | 75  |
| IM-08    | <b>Three-dimensional Reconstruction and Quantitative Analysis of Confocal Microscopy z-stack Images</b><br>Le Vu Phuc<br>University of Technology, VNU-HCM, Vietnam                                                                                                | 81  |
| IM-09    | <b>Redox Controlled Nanopatterning of Graphene Surface by Electro-active Molecules</b><br>Phan Thanh Hai<br>Quy Nhon University, Vietnam                                                                                                                           | 83  |
| OM-01    | <b>Effect of Tool Geometry on Microchannel Fabrication in Micro Ultrasonic Machining</b><br>Vivek Jain<br>Thapar Institute of Engineering & Technology, India                                                                                                      | 87  |
| OM-02    | <b>Microstructural Study on Microwave-Processed Pure Cu vs Commercial Cu</b><br>Dheeraj Gupta<br>Thapar Institute of Engineering & Technology, India                                                                                                               | 95  |
| <b>V</b> | <b>Poster Presentations</b>                                                                                                                                                                                                                                        |     |
| PP-01    | <b>Contribution of Xyloglucans to Growth and Development at the Cell Level in <i>Arabidopsis thaliana</i></b><br>Duy Chi Trinh, Ha Hai Anh Nguyen, Minh Chau Nguyen<br>University of Science and Technology of Hanoi (USTH), Hanoi, Vietnam                        | 101 |
| PP-02    | <b>Self-assembly of DNA Origami Crystals</b><br>Tuan Thanh Nguyen <sup>1</sup> , Gregor Posnjak <sup>2</sup> , Tim Liedl <sup>2</sup><br><sup>1</sup> University of Warsaw, Warsaw, Poland<br><sup>2</sup> Ludwig Maximilian University of Munich, Munich, Germany | 102 |
| PP-03    | <b>Applications of Transmission Electron Microscope in the study on Morphology and Structure of Nanoparticles</b><br>Le Tai The, Tran Thai Tu, Tran Danh Nhan, Tuong Phi Vuong<br>69 Institute, The Command of the Ho Chi Minh Mausoleum, Vietnam                  | 103 |

|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |     |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| PP-04 | <p><b>Optimization of Excitation Wavelength for the SERS Detection of Dopamine using Ag-Decorated ZnO Nanofibers</b></p> <p>Le Thi My Nhi<sup>1</sup>, Nguyen Thanh Trung<sup>2</sup>, Le Thi Ngoc Loan<sup>1</sup></p> <p><sup>1</sup>Department of Physics – Materials Science, Faculty of Natural Sciences, Quy Nhon University, Gia Lai, Viet Nam</p> <p><sup>2</sup>Faculty of Education, Quy Nhon University, Gia Lai, Viet Nam</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 104 |
| PP-05 | <p><b>Effect of Synthesis Time on the Optical Properties of Co-doped CdSSe Semiconductor Quantum Dots</b></p> <p>Nguyen Thi Thu Hoan<sup>1,2</sup>, Giap Tung Duong<sup>1</sup>, Bui Thi Huyen Chang<sup>1</sup>, Nguyen Van Truong<sup>1</sup>, Nguyen Xuan Ca<sup>2</sup>, Do Thi Hue<sup>3</sup>, Vu Thi Kim Lien<sup>4</sup>, Nguyen Thi Hang Nga<sup>5</sup>, Pham Van Duong<sup>6</sup>, Pham Thanh Hieu<sup>7</sup>, Pham Minh Tan<sup>7*</sup></p> <p><sup>1</sup>University of Technology, Thai Nguyen University, Thai Nguyen, Viet Nam</p> <p><sup>2</sup>University of Science, Thai Nguyen University, Thai Nguyen, Viet Nam</p> <p><sup>3</sup>University of Education, Thai Nguyen University, Thai Nguyen, Viet Nam</p> <p><sup>4</sup>Institute of Theoretical and Applied Research-Duy Tan University, Viet Nam</p> <p><sup>5</sup>Thuy Loi University, Ha Noi, Viet Nam</p> <p><sup>6</sup>Institute of Physics, Viet Nam Academy of Science and Technology, Viet Nam</p> <p><sup>7</sup>Posts and Telecommunications Institute of Technology, Ha Noi, Viet Nam</p> | 105 |
| PP-06 | <p><b>Synthesis and Surface Modification of Rice Husk-Derived Activated Carbon with Metal Oxide Nanoparticles for Enhanced H<sub>2</sub>S Removal</b></p> <p>Huynh Thi Mai Diem, Bui Thanh Trang, Nguyen Van Nghia, Hoang Nhat Hieu, Le Thi Thanh Lieu and Nguyen Minh Vuong</p> <p>Faculty of Natural Sciences, Quy Nhon University, 170 An Duong Vuong, Quy Nhon Nam, Vietnam</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 109 |
| PP-07 | <p><b>Applying Electron Microscopy on the Studying of Photocatalysts</b></p> <p>Mai Viet Tri Thuc, Dang Hoang Thai, Thanh-Truc Pham</p> <p>Ho Chi Minh City University of Technology and Engineering (HCM-UTE), Ho Chi Minh City, Vietnam</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 110 |
| PP-08 | <p><b>Preparation of an Oil-Absorbent Material from Recycled Cigarette Butts</b></p> <p>Truong Tien Nguyen, Vu Viet Linh Nguyen</p> <p>Faculty of Applied Sciences, Ho Chi Minh City University of Technology and Engineering, Ho Chi Minh City, Viet Nam</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 114 |
| PP-09 | <p><b>Design and microscopy-based characterization of sub-micrometer silica particles and liposomal nanostructures for functional material application</b></p> <p>Van Tinh Vo</p> <p>Faculty of Chemical and Food Technology, Ho Chi Minh City University of Technology and Education, Ho Chi Minh City, Vietnam</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 116 |
| PP-10 | <p><b>Growth-Temperature Engineering of Optoelectronic and Thermoelectric Characteristics in In-Doped ZnO Thin Films</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 120 |

|       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |     |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
|       | <p>Diu-Tho H. Duong<sup>1</sup>, Bao Quan Tran<sup>1</sup>, Khắc Bình Nguyen<sup>2,3</sup>, Hai Dang Ngo<sup>1</sup>,<br/>Hoai Phuong Pham<sup>2,3</sup>, Thi Kim Hang Pham<sup>1</sup></p> <p><sup>1</sup>Faculty of Applied Sciences, Ho Chi Minh University of Technology and Engineering, 720000 Ho Chi Minh City, Vietnam.<br/> <sup>2</sup>Nguyen Tat Thanh University Center for Hi-Tech Development, Saigon Hi-Tech Park, Ho Chi Minh City, Vietnam.<br/> <sup>3</sup>NTT Hi-Tech Institute, Nguyen Tat Thanh University, Ho Chi Minh City 700000, Vietnam</p> |     |
| PP-11 | <p><b>Annealing-Driven Optimization of <math>\alpha</math>-FeOOH for Photocatalytic Degradation of Malachite Green</b></p> <p>Bich-Diep T. Pham, Thi Kim Hang Pham, and Hai Dang Ngo</p> <p>Faculty of Applied Sciences, Ho Chi Minh University of Technology and Engineering, 720000 Ho Chi Minh City, Vietnam</p>                                                                                                                                                                                                                                                    | 124 |
| PP-12 | <p><b>Ag Nanowire SEIRA Substrates for Ultralow Concentration Detection</b></p> <p>Dinh Tuan Tran, Hai Dang Ngo, and Thi Kim Hang Pham</p> <p>Faculty of Applied Sciences, Ho Chi Minh University of Technology and Engineering, 720000 Ho Chi Minh City, Vietnam</p>                                                                                                                                                                                                                                                                                                  | 128 |
| PP-13 | <p><b>Impact of Soybean Variety on Structure and Quality Attribute of Soy Yogurt</b></p> <p>Quyen Thi Nguyen<sup>1,2</sup>, Kim Moens<sup>2</sup>, Than Thi Huong<sup>1</sup>, Koen Dewettinck<sup>2</sup>, Dinh Thi Tran<sup>1*</sup></p> <p><sup>1</sup>Vietnam National University of Agriculture, Hanoi, Vietnam<br/> <sup>2</sup>Food Structure &amp; Function Research group, Ghent University (Belgium)</p>                                                                                                                                                     | 132 |
| PP-14 | <p><b>Biological Treatment of Okara Using Enzymes and Microorganisms and Its Application in Gluten-Free Biscuits</b></p> <p>Than Thi Huong<sup>1</sup>, Vu Thi Hanh<sup>1</sup>, Nguyen Thi Quyen<sup>1,2</sup>, Dinh Thi Tran<sup>1</sup></p> <p><sup>1</sup>Vietnam National University of Agriculture, Hanoi, Vietnam<br/> <sup>2</sup>Food Structure &amp; Function Research group, Ghent University (Belgium)</p>                                                                                                                                                 | 133 |
| PP-15 | <p><b>Morphological Methods for Diagnosis and Identification of Fungi</b></p> <p>Le Tai The, Phan Huy Hao, Tran Thai Tu, Tran Danh Nhan, Tuong Phi Vuong</p> <p>69 Institute, The Command of the Ho Chi Minh Mausoleum, Vietnam</p>                                                                                                                                                                                                                                                                                                                                    | 134 |
| PP-16 | <p><b>Microstructural Study on Microwave-processed Pure Cu vs Commercial Cu</b></p> <p>Khalid Bashir, Dheeraj Gupta, Vivek Jain</p> <p>Surface Engineering and Tribology Research Laboratory, Department of Mechanical Engineering, Thapar Institute of Engineering and Technology, Patiala, Punjab, India</p>                                                                                                                                                                                                                                                         | 135 |
| PP-17 | <p><b>Influence of Loading Methods on Physicochemical Properties and Antibacterial Activity of Curcumin-Loaded Nanostructured Lipid Carrier</b></p> <p>Nguyen Thi Bich, Tran Quang Huy, Nguyen Thi Thu Thuy, Nguyen Thi Hue</p>                                                                                                                                                                                                                                                                                                                                        | 139 |

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |     |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
|            | Phenikaa University Nano Institute, Phenikaa School of Engineering, Phenikaa University, Vietnam                                                                                                                                                                                                                                                                                                                                                                                                              |     |
| PP-18      | <b>Synthesis of Au@ZIF-8 Nanocomposites for Enhanced Antibacterial Activity</b><br>Vu Gia Nghi Phan <sup>1,2,3</sup> , Kieu The Loan Trinh <sup>2,3</sup> , Lan Thi My Nguyen <sup>1,3</sup><br><sup>1</sup> Faculty of Biology and Biotechnology, University of Science, Ho Chi Minh City, Viet Nam<br><sup>2</sup> Advanced Materials Technology Institute Vietnam National University Ho Chi Minh City, Ho Chi Minh City, Viet Nam<br><sup>3</sup> Vietnam National University, Ho Chi Minh City, Viet Nam | 140 |
| <b>VI</b>  | <b>Sponsor Presentations</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |
| SP-01      | <b>Conventional specimen preparation for SEM and TEM</b><br>Michael Heng<br>Singapore Winner Scientific Instruments PTE. LTD                                                                                                                                                                                                                                                                                                                                                                                  | 142 |
| SP-02      | <b>Electron Microscopy for Life Sciences &amp; Materials analyses from Thermo Fisher Scientific</b><br>Minh Khang Technical Service & Trading Co., Ltd                                                                                                                                                                                                                                                                                                                                                        | 143 |
| <b>VII</b> | <b>Workshop &amp; Training Lectures</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |     |
| TL-01      | <b>Scanning electron microscopy in biology: 3D analysis of biological specimens</b><br>Ivan Vorobyev<br>Nazarbayev University, Kazakhstan                                                                                                                                                                                                                                                                                                                                                                     | 144 |
| TL-02      | <b>Atomic Force Microscope for probing the structure and mechanical properties</b><br>Nguyen Anh Dung<br>Le Mans Université, France                                                                                                                                                                                                                                                                                                                                                                           | 145 |
| TL-03      | <b>Optical microscopy in life sciences: Time-lapse imaging of living cells</b><br>Pham Thanh Tri<br>Nazarbayev University, Kazakhstan                                                                                                                                                                                                                                                                                                                                                                         | 146 |

## PLENARY LECTURES

### **PL-01** Visualizing Life Across Biological Length Scales with Emerging Technologies

**Teng Leong Chew**

*HHMI's Janelia Research Campus, USA*

*Correspondence: [chewt@janelia.hhmi.org](mailto:chewt@janelia.hhmi.org)*

The first lecture discusses the strategy to remove conventional academic silos that has stifled interdisciplinary science. Unlocking complex biological processes increasingly demands the integrated efforts of biologists, chemists, and physicists. Operating strategically at the interface of engineering and biological applications, the Advanced Imaging Center (AIC) at HHMI Janelia Research Campus is uniquely positioned to drastically reduce the time between microscope development and widespread adoption for the increasingly technology-intensive field of biology. Recent findings will demonstrate how advanced microscopy has been leveraged to propel discoveries in life sciences.

## **PL-02** Frontiers in atomic force microscopy: Interfacial water and cell mechanobiology

**Ricardo Garcia**

*Instituto de Ciencia de Materiales de Madrid, Madrid, Spain*

*Correspondence: r.garcia@csic.es*

This contribution is focused on describing the challenges and the opportunities of atomic force microscopy to map at the molecular-scale the properties of solid-liquid interfaces and soft matter. The presentation is divided into three sections. The first section is devoted to introduce the capabilities of 3D-AFM to image with atomic-scale resolution the three-dimensional structure of solid-liquid interfaces [1-3]. The second section shows new developments in force volume and bimodal AFM to map in real-time the nanomechanical properties of biological processes [4-5]. The third section discusses some fundamental issues involving the imaging and mechanical characterization of live cells and tissues with the AFM [4, 6].



**Figure 1.** Mechanical touch analogue of AFM imaging and mechanical property mapping

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## KEYNOTE LECTURES

### **K-01** Networking for Diagnostic Electron Microscopy in Infectious Diseases

**Hing, H.L.<sup>1</sup>, Muranaka, Y.<sup>2</sup>, Kurth, A.<sup>3</sup>, Gelderbloms, H., Sahalan, A.Z, Kaswandi, M.A, & Hyatt, A.**

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The discovery of many local viruses and other infectious diseases agents such as Cocksackie virus (1997), Nipah virus (2001), Tioman virus (2000), Melaka virus (2006), Kampar virus (2006) and animal-borne viruses such as H5N1 (Avian Influenza). Together with worldwide emergence of, H1N1 (Influenza A) in 2009, monkeypox (2021,2022), \*Ebola (1976, 2023), SARS (2003), MERS-CoV (Middle east respiratory syndrome coronavirus) (2012), Zika virus (2015) and Covid-19 (2019) underlines the need for rapid and safe electron microscopy diagnostics of infectious agents (1). The ability to reveal all agents contained in a sample on a grid from the smallest virus to bacteria/fungal/minute particles in less than 15 minutes enhanced the importance of diagnostic EM as “front-line” diagnosis. Micrograph of unknown obtained can then be shared for quick diagnosis among experts for confirmation and further research via networking through national infectious diseases centres/laboratories throughout the region. Thus, sharing and expertise discussions will facilitate expedition of diagnosis within a very short time reducing the impact of the infectious outbreak. Further research work such as understanding structure and function, agent-host interaction, manifestation & treatment of diseases can then be undertaken (2).

For example, UKM and *Sarawak Infectious Diseases Centre (SIDC)* together with other diagnostic centre in ASEAN and the Asia Pacific region can act as a centre or network which will contribute towards the rapid, accurate identification and characterization of the new pathogens through taxonomy, preparation and interpretation of results. Other activities that can also be initiated include techniques development, database and virtual network development, workshops and training of diagnostic personnel.

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## **K-02 Nanoscopic Gateways: Reconciling Protocell Transport and Peptide-Mediated Endosomal Escape**

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The biological membrane is a masterpiece of evolutionary engineering, a dynamic gatekeeper tasked with the paradoxical challenge of maintaining structural integrity while facilitating the vital exchange of matter. For biophysicists, capturing the nanoscopic, transient "flickers" of membrane poration has remained a formidable frontier. In this keynote, we explore how the fundamental membrane instabilities that once permitted the survival of primordial life now hold the key to overcoming the "endosomal entrapment" bottleneck in modern medicine.

We first address a pivotal mystery in the origin of life: how did primitive cells facilitate molecular transport before the emergence of complex protein machineries? While fatty acid-based membranes are inherently permeable, this efficiency vanished as membranes evolved toward robust phospholipid bilayers. By utilizing giant unilamellar vesicles (GUVs) coupled with high-temporal resolution (2 ms) confocal detection, we have bridged the "resolution gap" to directly observe these stochastic gateways. Our quantitative analysis identifies spontaneous, hydrophilic pores, spanning approximately 20 nm in radius with a 14 ms lifespan, suggesting they are sufficiently large and long-lived to serve as the original nutrient conduits for the first cellular entities [1].

This ancestral lipid pathway offers more than a window into the past; it provides a blueprint for the future of drug delivery. Today, "endosomal entrapment" remains the primary barrier preventing therapeutic biologics from reaching their cytosolic targets [2]. We focus on the TAT peptide, a gold standard for intracellular delivery [3], whose clinical utility has been long-stalled by a lack of mechanistic clarity regarding endosomal escape.

We demonstrate that TAT peptides exhibit profound selectivity for bis(monoacylglycero)phosphate (BMP), the hallmark lipid of the late endosomal pathway. Through single-vesicle kinetic analysis, we reveal that TAT triggers a sophisticated, bifurcated response: an initial phase of rapid, transient bursts that matures into long-lived ( $>10$  s), stable pores. These openings are functionally robust, permitting the translocation of macromolecular cargo such as FITC-BSA and 250 kDa dextran. Our findings resolve the "rim-stabilization" mechanism, where TAT peptides preferentially accumulate along the edges of membrane defects to lower the energetic barrier for pore formation. By integrating these dual kinetics with visual evidence of TAT-mediated lipid fusion, we propose a multifaceted biophysical framework: TAT facilitates escape through a synergistic combination of pore translocation and intraluminal vesicle (ILV) fusion.

Ultimately, this research suggests that the same fundamental membrane instabilities that permitted primordial survival continue to play a pivotal role in modern biotechnology. By reconciling the transient dynamics of early life with the peptide-mediated stabilization required for therapeutic delivery, we move closer to a comprehensive understanding of biological barriers and the rational design of organelle-targeted systems.

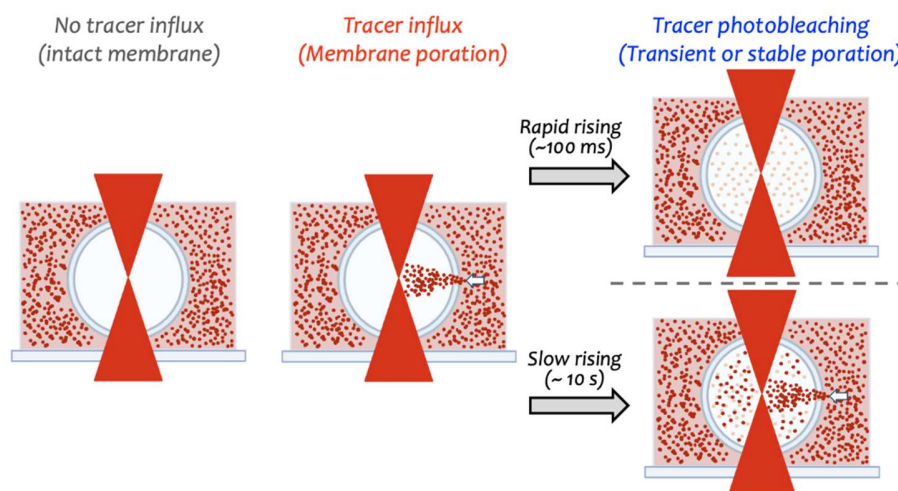


**Figure 1.** Schematic illustration of the tracer influx sequence: (Left) intact membrane with no permeation; (Middle) pore opening allowing tracer entry and fluorescence increase; and (Right) pore enclosure (transient poration; upper panel) or remain open (stable poration; lower panel) accompanied by gradual fluorescence decay owing to photobleaching.

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## **K-03** AFM Nanomechanics to Connect Macro- and Nanoscopic World

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Atomic force microscope (AFM) nanomechanics is a useful tool for linking the nanoscale world inside rubber with the macroscopic properties of rubber <sup>1)</sup>. Using AFM nanomechanics, which can visualize various nano-mechanical properties such as elastic modulus, our group has clarified various unsolved problems related to rubber. In this presentation, I will introduce the latest developments in this field.

### **Results and Discussion**

#### **1. Non-affine deformation of crosslinked rubber**

An understanding of the microscopic deformation behavior of crosslinked rubber is key to gaining insight into the mechanisms of the mechanical properties of rubber materials. In this study, we measured isoprene rubber (IR) under uniaxial tensile strain using AFM nanomechanics to track the microscopic deformation of the IR rubber and to visualize the stress distribution at the nanoscale <sup>2)</sup>. The results showed that affine deformation, a classical theory in rubber deformation, did not occur at the microscopic scale, and interesting nanoscale heterogeneous deformation behavior was observed as shown in Figure 1(a)-(d). Based on the AFM experimental results, we proposed a microscopic elongation behavior model that takes into account the heterogeneity of the crosslink density shown in Figure 1(e). In addition, we observed microcrystalline structures at the 10 nm scale at high strain, which is believed to be the first time that strain-induced crystallization (SIC) has been visualized in real space. The direct observation of SIC provides an important reference for the investigation of the self-reinforcing mechanisms of crystalline rubber.

#### **2. Interplay between AFM nanomechanics and FEM**

An *in-situ* AFM nanomechanical technique can be utilized to directly visualize the micromechanical behaviors of polymer nanocomposites during compressive <sup>3)</sup> or tensile <sup>4)</sup> strain. We obtained a stress distribution image of carbon black (CB)-filled IR at the nanoscale, with tracing the microscopic

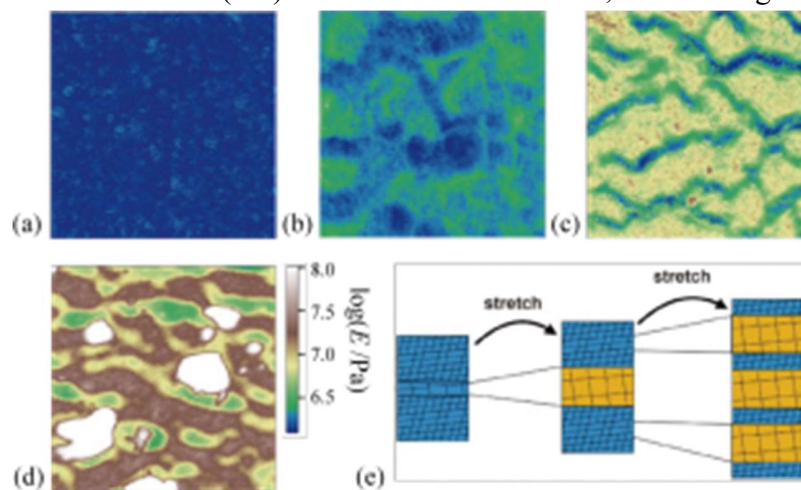


**Figure 1.** Elastic modulus mappings of IR vulcanizates (a) unstretched; (b) stretched to  $\lambda = 100\%$ ; (c) stretched to  $\lambda = 300\%$  (d) stretched to  $\lambda = 500\%$ . The scan sizes are  $1.0\ \mu\text{m} \times 1.0\ \mu\text{m}$ . (e) Schematic diagram of the microscopic deformation behavior based on this transformation process.

deformation behaviors of CB particles. CB filled rubbers exhibited heterogeneous local microscopic deformations, which were related to the dispersion of CB particles in rubber matrices. The local stress distributions of the rubber composites showed heterogeneity, and the stresses were concentrated in the regions near the CB particles during compression as shown in Figure 2(a)-(d). The area of stress concentration gradually expanded with increasing strain and eventually formed a stress network structure as schematically shown in Figure 2(e). This stress network bore most of the macroscopic stress and was considered the key reinforcement mechanism of CB-filled rubber. Based on the image data from the AFM experiments, we used finite-element method (FEM) simulations to reproduce the microscopic deformation process of CB-filled rubber. The stress distribution images simulated by FEM showed heterogeneity consistent with AFM.

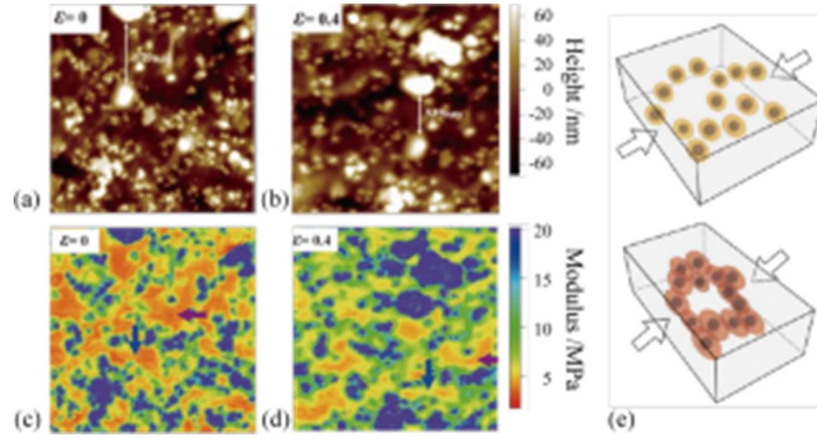


**Figure 2.** *In-situ* AFM height images of CB-filled IR at macroscopic compressive strains  $\epsilon =$  (a) 0 and (b) 0.4. (c) (d) The corresponding modulus images. The scan size is  $3.0\ \mu\text{m}$ . (e) Schematic diagram of the formation of stress network.

### 3. Competition between crosslinking and entanglement

This study investigates the changes in crosslinked structures of vulcanized butadiene rubber (BR) under uniaxial elongation using AFM nanomechanics. Crosslinked polydimethylsiloxane (PDMS) was employed as a model sample to elucidate the physical significance of the JKR modulus obtained under elongation. In PDMS, the increase in JKR modulus with elongation was found to match the macroscopic true stress as shown in Figure 3(a). However, this relationship was not observed in BR in Figure 3(b). This discrepancy suggests that the elastic modulus changes with elongation. AFM results support this hypothesis, showing that the elastic modulus decreases with elongation due to reduced topological constraints from the dissolution of molecular chain entanglements. This method enables experimental determination of the local elastic modulus at any elongation ratio, advancing the understanding of structure-property relationships in rubber materials.

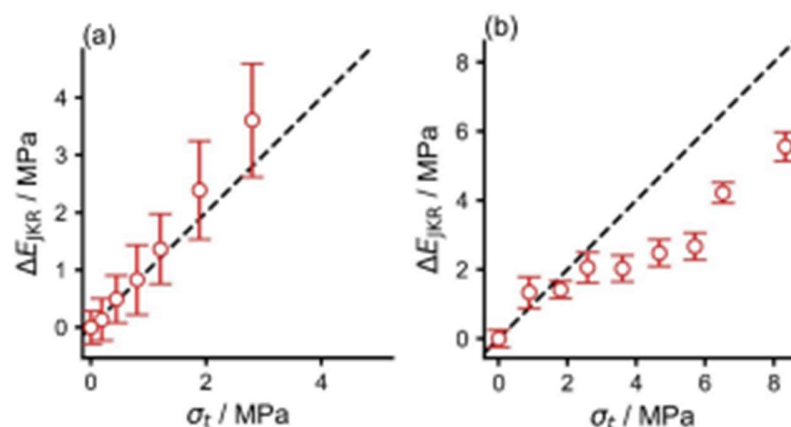


**Figure 3.** Relationship between  $\Delta E_{JKR}$  and true stress,  $\sigma_t$  in (a) PDMS and (b) BR. The dashed line indicates the relationship  $\Delta E_{JKR} = \sigma_t$ .

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## **K-04 Recent Advances in AI-Driven Visual Data Science for HS-AFM and Cryo-EM Analysis**

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High-speed atomic force microscopy (HS-AFM)[1] and cryo-electron microscopy (Cryo-EM)[2] are two complementary nano-scale imaging modalities that play central roles in modern structural biology. HS-AFM enables direct visualization of biomolecular surfaces at nanometer spatial and millisecond temporal resolution, with three-dimensional topographic information encoded in two-dimensional height maps, making it uniquely suited for capturing dynamic processes such as molecular motion, assembly, and conformational transitions in real time. In contrast, Cryo-EM provides atomic spatial resolution through three-dimensional reconstruction of vitrified specimens, offering detailed structural information but typically limited temporal information.

Their complementary strengths create both opportunities and challenges for computational analysis. In HS-AFM, key tasks include denoising and super-resolution, instance segmentation, object tracking, three-dimensional reconstruction, and frame interpolation for enhanced temporal continuity. Similarly, Cryo-EM analysis relies on robust micrograph denoising, accurate particle picking, two-dimensional classification and reliable three-dimensional reconstruction. These tasks are fundamental bottlenecks that directly affect the accuracy and interpretability of downstream structural analysis.

Recent advances in visual data science—encompassing computer graphics, image and video processing, and computer vision—have driven substantial progress in addressing these challenges. Data-driven models based on deep learning have enabled more accurate, automated, and scalable analysis pipelines for both HS-AFM and Cryo-EM. This article reviews recent advances in AI-driven techniques for HS-AFM and Cryo-EM analysis, highlighting methodological trends and emerging opportunities at the intersection of structural biology and visual data science.

### **Methodological Overview and Representative Approaches**

This section outlines representative tasks with methodologies, organized by core problems, highlights state-of-the-art approaches and key studies that exemplify recent advances in visual data science for HS-AFM and Cryo-EM analysis:

**Table 1.** Core Tasks for HS-AFM Analysis

| Core Task        | Problem Description                                                             | Representative Approaches                                                                                                                     |
|------------------|---------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Denoising</b> | HS-AFM images suffer from point, stripe noise and scanning artifacts, requiring | Self-supervised denoising strategies, including Noise2Noise [3] and Noise2Void, are preferred for HS-AFM due to the lack of clean references, |

| Core Task                            | Problem Description                                                                                                                                | Representative Approaches                                                                                                                                                                                                                                                                                                                    |
|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                      | noise reduction while preserving nanoscale details.                                                                                                | enabling geometry-preserving noise suppression. According to [4], Restormer is the most effective, while HINet is the most efficient for denoising AFM images.                                                                                                                                                                               |
| <b>Super-Resolution</b>              | Limited lateral resolution and scanning speed constrain the spatial detail observable in HS-AFM images.                                            | Super-resolution methods learn correlations between low-resolution features and high-resolution structural details, with CNN and Transformer models using depth-wise convolution showing strong performance in HS-AFM [5-8]                                                                                                                  |
| <b>Segmentation (Instance-level)</b> | Nanoscale objects exhibit weak contrast and complex topologies, including touching instances and internal cavities.                                | Geometry-aware instance segmentation incorporates height information and spatial derivatives instead of treating HS-AFM images as natural images. Hybrid visual-geometric feature representations enable robust boundary delineation. [9]                                                                                                    |
| <b>Temporal Object Tracking</b>      | Time-resolved HS-AFM sequences capture molecular motion and interactions but suffer from noise, deformation, and intermittent visibility.          | Tracking pipelines typically integrate segmentation with temporal association or motion estimation to ensure frame-to-frame consistency, enabling quantitative analysis of molecular dynamics. [10]                                                                                                                                          |
| <b>3D Reconstruction</b>             | Although represented as 2D images, HS-AFM data encode 3D surface topography, requiring reconstruction from partial and noisy surface observations. | Model-fitting approaches iteratively transform and deform candidate PDB structures, generate corresponding pseudo-AFM images via simulation, and compare them with experimental AFM images to solve an inverse geometry-matching problem. [11-19]                                                                                            |
| <b>Frame Interpolation</b>           | Limited scanning speed and hardware constraints lead to sparse temporal sampling, hindering continuous visualization of molecular dynamics.        | Although latent diffusion models are effective for frame interpolation, their application to HS-AFM is limited by the absence of force-field constraints, potentially yielding unrealistic molecular dynamics. Integrating molecular dynamics simulations is therefore essential for physically consistent generative interpolation. [20-21] |

**Table 2.** Core Tasks for Cryo-EM Analysis

| Core Task                   | Problem Description                                             | Representative Approaches                                             |
|-----------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------------|
| <b>Micrograph Denoising</b> | Cryo-EM micrographs exhibit extremely low signal-to-noise (SRN) | Topaz-Denoise for generalizable SNR enhancement [22], diffusion-based |

| Core Task                | Problem Description                                                                                                                                                                                                                                                                                       | Representative Approaches                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                          | ratios due to low electron dose and ice contamination.                                                                                                                                                                                                                                                    | denoising for structural noise removal [23], and noise-model-aware learning to guide signal restoration [24].                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Particle Picking</b>  | Particle picking aims to automatically identify individual macromolecular particles from cryo-EM micrographs but is challenging due to low contrast, structural heterogeneity, non-globular or asymmetric shapes, and high false-positive rates, making manual curation time-consuming and error-prone.   | Traditional methods rely on heuristics or templates with extensive post-processing. Deep-learning approaches now dominate: Topaz [25] uses positive-unlabeled learning to enable accurate picking with sparse labels and robustness to atypical particle shapes. crYOLO [26] applies single-shot object detection (YOLO) for fast, high-precision, and fully automated particle picking with strong generalization to unseen datasets.                                                                                                                                         |
| <b>2D Classification</b> | 2D classification groups and aligns noisy cryo-EM particle projections into homogeneous classes to enhance signal by averaging. Low SNR, random projection orientations, particle heterogeneity, and the lack of labels make accurate clustering difficult and directly affect 3D reconstruction quality. | Traditional 2D classification relies on iterative alignment and statistically robust clustering, such as RE2DC, which improves scalability via tree-based approximations while resisting attractor effects [27]. Recent learning-based methods emphasize representation learning under low SNR: SimCryoCluster adopts contrastive learning to extract discriminative particle features without labels [28], while DeepSLICEM integrates common-line similarity graphs with CNN- and GNN-based representations to effectively separate heterogeneous particle populations [29]. |
| <b>3D Reconstruction</b> | Cryo-EM 3D reconstruction is challenged by severe conformational and compositional heterogeneity, low SNR, and the need for accurate pose estimation from unordered 2D projections, particularly in ab initio settings without reliable initial models.                                                   | Deep neural representations are increasingly used to model continuous structural heterogeneity. CryoDRGN and CryoDRGN-AI learn latent conformational spaces for heterogeneous and ab initio reconstruction [30-31]. CryoNeRF adopts NeRF-based volumetric modeling [32], while CryoFastAR accelerates reconstruction via direct pose prediction using geometric foundation models [33].                                                                                                                                                                                        |

## Discussion

**Table 3.** Overview of AFMnanoX modules and their development status

| Module              | Primary Task                                                                                                                                                                                                       | Development Status             |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| <b>AFMnanoSALQ</b>  | Standalone instance segmentation and quantitative morphological analysis of HS-AFM data, supporting semi-automatic annotation to accelerate labeled dataset construction without requiring annotated training data | Completed                      |
| <b>AFMnanoSeg</b>   | Learning-based instance segmentation of HS-AFM images, built upon Mask2Former and adapted to incorporate geometry-aware representations                                                                            | Completed (public preparation) |
| <b>AFMnano3DR-G</b> | 3D surface reconstruction and generative modeling of nanoscale structures by integrating HS-AFM images with PDB-based structural priors                                                                            | In development                 |
| <b>AFMnanoAnim</b>  | Spatiotemporal modeling and frame interpolation for HS-AFM image sequences, enabling 2D and 3D animation                                                                                                           | In development                 |
| <b>AFMnanoPre</b>   | Deep learning-based denoising and super-resolution to enhance HS-AFM image quality while preserving nanoscale structural features                                                                                  | In development                 |

This article presents a concise review of recent advances in AI-driven visual data science for HS-AFM and Cryo-EM analysis, highlighting key computational challenges and methodological trends in nanoscale structural biology. By examining core tasks across both modalities, we emphasize the growing role of geometry-aware, data-driven approaches in transforming complex imaging data into quantitative structural and dynamic insights. In parallel with these developments, our research group has progressively developed analysis methods for HS-AFM (**Table 3**) and Cryo-EM that align with current trends in automated, learning-based data processing. Despite substantial progress, challenges remain in robustness, interpretability, and multimodal integration. Nevertheless, the synergy between visual data science and nano-biophysics offers significant opportunities for interdisciplinary collaboration and future innovation.

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## **K-05 Cellular asymmetry and asymmetric cell division**

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How do cells acquire a unique fate, a specific function or a particular molecular identity? How is cellular identity regulating cell behavior and how does it inform the formation, maintenance and function of tissues, organs and organisms? These questions are at the intersection of cell, developmental and mechanobiology and are the focus of my research program.

My lab is addressing these questions in the context of asymmetric cell division (ACD), an evolutionary conserved mechanism that creates cellular diversity. ACD is often preceded by different forms of cellular and subcellular asymmetry but the underlying mechanisms and contributions to binary cell fate decisions are mostly unknown.

In my presentation, I will outline two research projects from my lab, detailing how different imaging methods reveal new conceptual and mechanistic insight into asymmetric cell division during development.

### **Experimental methods (theoretical/simulation models) and materials**

We are using advanced imaging methods, including confocal, electron, spinning disc and superresolution microscopy, to investigate the dynamics and mechanisms underlying cellular and subcellular asymmetry and its potential impact on cell fate decisions in developing *Drosophila melanogaster* brains. We combine these imaging methods with molecular approaches such as gene expression profiling and molecular genetic manipulations.

### **Results and Discussion**

Project 1: Asymmetric centromere and gene locus positioning in *Drosophila* neural stem cells

In this project, we used *Drosophila* neuroblasts (NBs) to define the mechanisms and function of centromere positioning in the developing larval brain. Using live cell imaging in the intact larval brain and detailed quantitative image analysis, we show that non-random, polarized centromere positioning is retained in NBs and their early, but not late, progeny. We further show that, unlike in *S. pombe* and *A. thaliana*, the LINC complex is dispensable for asymmetric centromere positioning. In contrast, we find that in NBs, the nucleoporins Nup54, Nup62, and Nup98-96 are required for asymmetric centromere positioning, as well as cytoplasmic heavy chain Dynein, the Nuclear Mitotic Apparatus (NuMA)-like protein Mushroom body defect (Mud), and Lamin. Finally, we show that the developmentally regulated gene loci *hunchback* (*hb*) and *pendulin* (*pen*) occupy specific areas within the nucleus relative to the apical polarity axis and that this organization requires polarized centromere localization. We propose a model whereby polarized centromere positioning is established and

maintained by connecting MTs from the apical MTOC to apically facing NPCs, using Dynein and Mud as a force-generating machinery. On the intranuclear side, NPCs either connect to centromeres directly or via Lamin. Collectively, this study suggests that polarized fly neural stem cells translate their intrinsic polarity into stereotypic chromatin organization, possibly regulating cell fate decisions and stem cell behavior <sup>1</sup>.

Project 2: Cell size asymmetry regulates neural stem cell proliferation and lineage expansion in *Drosophila*

In this project, we use asymmetrically dividing *Drosophila* neuroblasts to investigate how altered Cell size asymmetry (CSA) impacts neurogenesis and brain development. We employ two complementary approaches to change CSA of dividing neuroblasts and find that cell positioning, and cell size regulate the neuroblast's proliferation and differentiation potential. Surprisingly, live cell imaging, detailed lineage analysis, and gene expression profiling show that changing CSA increases the neural stem cell pool, without increasing the number of differentiating siblings. Using iterative mathematical modeling, we show that volume-based growth regulation and neuroblast self-repression are possible mechanisms to constrain neuroblast lineage expansion. We conclude that the size and placement of the neuroblast are necessary to maintain a proliferative stem cell pool to produce the correct number of differentiating siblings. This finding could inform our current understanding of neurodevelopmental disorders, such as primary microcephaly <sup>2</sup>.

*Acknowledgements:*

These projects are supported by the American Cancer Society and the National Institutes of Health.

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## **K-06 Unconventional Approach by Electron Microscopy to Visualize Structural-Changes of Rapidly Moving Targets**

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Quick-freeze deep-etch (QFDE) replication was the first cryo-electron-microscopy technique capable of capturing various biological events within 1 msec, providing high-contrast views of rapid physiological processes *in situ* (Heuser *et al.*, 1979). When I began investigating the molecular mechanisms of skeletal-muscle contraction 45 years ago, ATP-hydrolysis by actomyosin was already established, but the accompanying structural changes remained poorly understood due to limited materials, techniques, and equipment. Because the power-stroke of myosin cross-bridges begins with re-attachment after complete dissociation from actin, visualizing the structural-change of myosin during sliding was particularly challenging. To overcome this, I applied QFDE to capture *in vitro* sliding of acto-heavy meromyosin using “mica-flakes as substrate” (Heuser, 1983).

The skeletal muscle myosin-head consists of three regions: the catalytic domain, the lever-arm, and the hinge connecting them. Within the hinge, two cysteinyl-residues contain reactive thiol-groups, SH-1 and SH-2. Actin-associated heavy-meromyosin observed during *in vitro* sliding appeared rounded, in contrast to the elongated shape under the rigor-state (Katayama, 1996), consistent with my earlier findings (Katayama, 1989). Since subtle surface patterns were detected on the myosin-head, we developed novel image-analysis methods to correlate rotary-shadowed images with simulated surfaces of crystal structures (Kimori *et al.*, 2007). While rigor-actomyosin images matched simulations, nucleotide-bound myosin did not correspond to sliding structures with ATP. Reactive thiols are known to cross-link only in the presence of nucleotides. Although the crystal structure of scallop myosin cross-linked in this manner was determined, it resembled ADP/Vi-bound species, and the cross-link occurred between SH-2 (Cys-693) and Lys-705 rather than SH-1 (Cys-703) (Himmel *et al.*, 2002). Thus, we observed SH1–SH2 cross-linked myosin by our methods and inferred the rough configuration of such molecular species, whose crystal-structure remains unavailable even now, probably due to its structural instability.

Using our approach, we proposed that the lever-arm portion of this configuration may rotate to the opposite side, not only in this new configuration but also during sliding, allowing the myosin-head to embrace actin (Kimori *et al.*, 2013). This was consistent with the rounded appearance of S1 previously observed in the presence of ATP. Incorporating this novel configuration, we could explain the images of myosin during sliding and the full sequence of structural changes in the cross-bridge cycle (Katayama, 2014). There, two sets of actin–myosin attachment sites were shown to bind sequentially, in agreement with time-resolved chemical cross-linking studies (Andreev & Reshetnyak, 2007). While the structural basis of the much later discovered processive myosin-V walking has recently been clarified (Klebl *et al.*, 2025), the detailed molecular processes underlying classical non-processive type myosin-2 movements still remain enigmatic.

Although spatial-resolution is limited, high-speed Atomic-Force-Microscopy (Ando, 2019) provides sequential movie-like views of QFDE-like surface profiles of moving targets, whereas Cryo-Electron-Microscopy in vitreous-ice (McMillan & Scarff, 2022) now approaches the spatial-resolution of X-ray crystallography. The effective combination of these microscopy techniques offers a powerful means to investigate molecular mechanisms of diverse biological machines from a structural perspective. In this lecture, I will present further applications of QFDE to visualize complex biological architectures and discuss how they contribute to our understanding of dynamic molecular machinery.

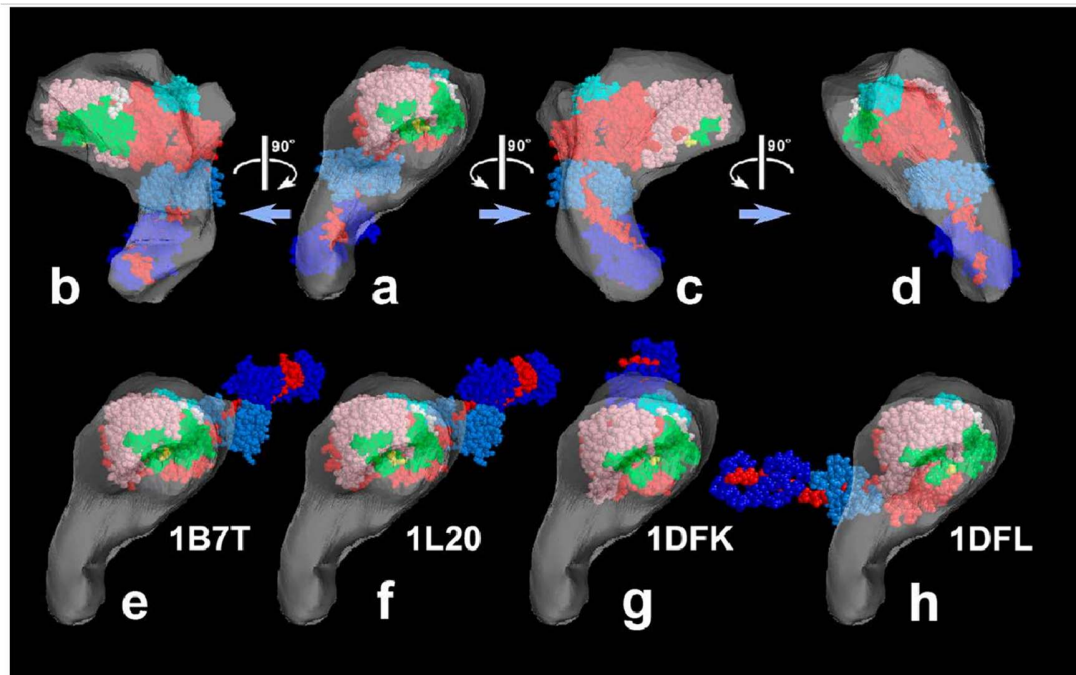


Figure 1. Reconstructed shell to present 3-D envelope of the SH1–SH2 cross-linked myosin head [modified from Figure 7 of our paper: reference 7]. a)–d); Its tentative model was fit to the shell and viewed from four different angles. e)–h); Four known crystal structures of scallop-S1 whose catalytic domains are snugly placed in the shell of the novel structure. Note that the orientation of the lever-arm in the novel structure is directed quite differently from the others. The atomic models are, e) ADP-bound form, f) ADP-bound Lys705-Cys693 cross-linked form, g) nucleotide-free near-rigor form, h) ADP/Vi-bound form.

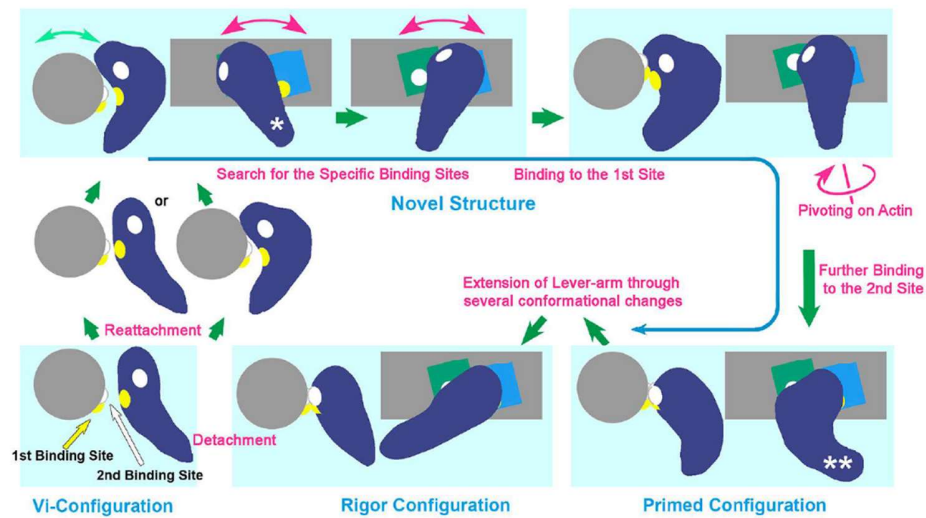


Figure 2. Schematic drawing of revised cross-bridge-cycle of skeletal actomyosin including the new conformer (taken from Fig. 8 of the reference 7). The cycle starts from the dissociation of rigor myosin from actin by the binding of ATP, which eventually re-associates with actin through several conformational states mostly involving the new configuration. The structural states placed in light-bluish panels are presented as the side- and the barbed-end views of the actomyosin complex. Violet; myosin head, blue and green; actin-monomers along actin-filament (gray). There, the behavior of two pairs of actomyosin interaction sites (presented by yellow and white patches in the reaction sequence), are indicated according to the time-sequence of the structural change from conventionally-bent ADP/Pi-structure (similar to the ADP/Vi-bound form) right after dissociation from actin, to the final rigor structure [N.B.; The third actin-binding site is located close to the yellow patch and might concomitantly operate with the second site to start lever-arm swinging]. Hence, the new conformer plays a crucial role as the reaction intermediate, throughout those states. The configurations marked by a single and double asterisk in the drawing correspond to the views (d) and (c) in Figure 1, respectively.

**Keywords:** skeletal muscle contraction, myosin-2, in-vitro acto-myosin sliding, quick-freeze deep-etch replica electron-microscopy, in situ structural-change, myosin cross-bridges, molecular mechanisms, simulated surface-profiles, image-analysis

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## **K-07** Role of cytoskeletal components in epithelial-to-mesenchymal transition

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Epithelial cells undergoing EMT experience significant alterations at transcriptional and morphological levels. However, changes in the cytoskeleton, especially cytoskeleton dynamics are poorly described. Addressing the question we induced EMT in three cell lines (MCF-7, HaCaT and A-549) and analyzed morphological and cytoskeletal changes there using immunostaining and live cell imaging of cells transfected with microtubule and focal adhesion markers. In all cell lines studied, cell area after EMT increased. We next analyzed three components of the cytoskeleton namely microtubules, actin fibers and focal adhesions. The following changes were observed after EMT in cultured cells: (i) Organization of microtubules becomes more radial; and growth rate of microtubule plus ends was accelerated; (ii) Actin stress fibers become co-aligned forming the longitudinal cell axis; and (iii) Focal adhesions had decreased area in all cancer cell lines studied, and became more numerous in HaCaT cells. We conclude that among dynamic components of the cytoskeleton the most significant changes during EMT happen in the regulation of microtubules.

## **K-08 From Molecules to the Globe - Putting Microscopy in the Hands of Scientists Worldwide**

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The second lecture “From Molecules to the Globe - Putting Microscopy in the Hands of Scientists Worldwide” will explore the various barriers to gaining access to advanced technologies, even with the availability of open access programs. Equal accessibility to technologies rarely translate into equitable access. In fact, such well-intentioned efforts often inadvertently bias against the scientific communities in lower-and medium-income countries. This talk will focus on the AIC’s international outreach programs aimed at capacity-building as well as community-empowering efforts to bridge this gap, especially recent progress made in Africa and Southeast Asia. Open access and collaborative infrastructure models in other parts of the world will also be discussed.

## **K-09** Multicolor Variants and Applications for Life Science

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Proteins Bioluminescence imaging has become an indispensable technology in modern biological research, offering high sensitivity, a wide dynamic range, and the ability to visualize cellular processes in living systems with minimal phototoxicity and negligible excitation-induced background. Yet conventional approaches are fundamentally constrained by their reliance on exogenously supplied substrates such as luciferin. Because these substrates are gradually consumed and can distribute unevenly in tissues, signal intensities decay over time and spatial uniformity is compromised, complicating long-term, quantitative imaging—particularly in three-dimensional samples and extended time-lapse experiments.

To address these limitations, genetically encoded autonomous bioluminescence systems have emerged. Two natural paradigms, the bacterial *lux* system and the fungal *luz* system, comprise gene clusters that encode both the light-emitting proteins and the biosynthetic enzymes required to produce the luminescent substrate in situ. When the complete set of essential genes is introduced into host cells, tissues, or organisms, the engineered system becomes self-sustained: samples glow continuously without exogenous luciferin, enabling stable imaging over long durations with inherently low background.

In this symposium, I will introduce our recent achievement regarding successful development of multi-color variants of autoluminescent proteins as well as their application to subcellular localization tags, multiple gene reporters, and  $\text{Ca}^{2+}$  dynamics at the single-cell level.

**Keywords:** *Autonomous bioluminescence, Multicolor imaging, Bioluminescent proteins, Gene reporters, Lux system, Luz system*

## **K-10** The Frozen Architecture of Life: Visualizing Biology at Atomic Resolution

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For decades, our understanding of the molecular world was limited to static models and blurred approximations. The advent of cryogenic Electron Microscopy (Cryo-EM) has fundamentally shifted this paradigm, enabling scientists to observe the machinery of life in its near-native state and at near-atomic detail. In this talk, I will review the core principles of single particle analysis (Cryo-EM)—a technique that captures thousands of snapshots of individual proteins to digitally reconstruct their 3D shapes. I will then expand into cryo-Electron Tomography (Cryo-ET), a method that allows us to look inside an intact cell to see how these components interact within their crowded, natural environment. Finally, I will highlight recent technological breakthroughs that are pushing the boundaries of these methods, transforming them from niche imaging tools into a unified platform for the future of precision medicine and cellular discovery.

## **K-11** Integrated Electron, Scanning Probe, and Optical Spectroscopic Characterization of Metal–Organic Frameworks

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Metal–organic frameworks (MOFs) are an important class of crystalline porous materials with tunable structures and physicochemical properties, enabling broad applications in catalysis, gas storage, sensing, and biomedicine. Understanding the structure–property relationships of MOFs requires comprehensive characterization techniques capable of probing morphology, crystallinity, surface features, and chemical bonding across multiple length scales. In this context, the combined use of advanced microscopy and optical spectroscopic methods provides a powerful and complementary characterization platform. This presentation focuses on the integrated application of electron microscopy (SEM and TEM), atomic force microscopy (AFM), and optical spectroscopy techniques—including UV, UV–Vis absorption, Fourier-transform infrared (FT-IR), and Raman spectroscopy—for the detailed characterization of MOFs. SEM and TEM are employed to elucidate particle morphology, size distribution, crystal habit, and internal structural features, while AFM offers nanoscale insights into surface topography, roughness, and local mechanical characteristics. Together, these microscopy techniques enable direct visualization of structural heterogeneity and defects that critically influence MOF performance. Optical spectroscopic methods play a central role in probing the electronic structure and chemical environment of MOFs. UV and UV–Vis spectroscopy provide information on ligand-centered and metal–ligand charge transfer transitions, band gap features, and framework functionalization. FT-IR and Raman spectroscopy enable the identification of coordination modes, functional groups, framework integrity, and guest–host interactions through vibrational fingerprints. Correlating spectroscopic signatures with microscopy-derived structural information allows for a more complete understanding of framework formation, modification, and stability. By highlighting representative case studies, this work demonstrates how the synergistic use of SEM, TEM, AFM, and optical spectroscopy advances the structural and functional characterization of MOFs. The approach supports the development and application of advanced microscopy techniques in materials science

**Keywords:** *Optical spectroscopy; Light scattering; Photonic response; Metal-organic frameworks; Characterization*

## INVITED & ORAL PRESENTATIONS

### **IL-01 High-Speed Atomic Force Microscopy Visualizes Target DNA Search Dynamics of a Transcription Factor**

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Transcription factors (TFs) are essential DNA-binding proteins that regulate gene expression and thereby control diverse cellular functions such as differentiation, homeostasis, and immune responses. Gene expression is initiated when TFs bind to short target DNA sequences of only 6–8 base pairs. To ensure proper gene regulation, TFs must rapidly locate these targets and bind with high specificity. However, how TFs efficiently find their target sites within vast genomic DNA remains unclear. Facilitated diffusion models have been proposed, in which TFs search DNA through one-dimensional sliding and intermittent jumping [1]. In addition, TF dimerization is thought to enhance target recognition specificity and binding affinity. Directly visualizing TF oligomeric states and their dynamic behavior on DNA at high resolution, however, has been technically challenging.

#### **Experimental methods and materials**

High-speed atomic force microscopy (HS-AFM) enables real-time visualization of biomolecular dynamics under aqueous conditions. This technique allows direct observation of structural changes, including conformational transitions, and molecular interactions at nanometer spatial and sub-second temporal resolution [2].

Photozipper (PZ), a light-controllable transcription factor derived from algae, enables reversible control of monomeric and dimeric states and serves as a useful model system [3]. We visualized intramolecular conformational changes and dimerization of purified PZ at nanometer resolution using high-speed atomic force microscopy (HS-AFM) (Figure 1) [4]. Furthermore, we applied HS-AFM to directly observe the dynamics of PZ on DNA and investigate its target-search mechanism.

#### **Results and Discussion**

Using HS-AFM, we captured single-molecule dynamics of PZ during its one-dimensional diffusion along DNA. By comparing PZ dynamics on DNA with and without target sequences and by controlling its oligomeric state using light and mutants, we analyzed the distinct behaviors of monomeric and dimeric PZ. In addition, HS-AFM observations of the monomeric transcription factor Dof revealed highly specific binding to tandem repeated target sequences (Figure 2) [5]. These results provide new insights into transcription factor target-search mechanisms.

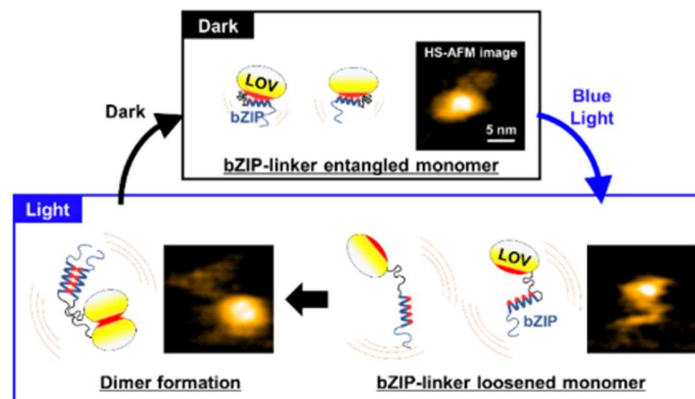


**Figure 1.** Light-induced dimerization of the transcription factor Photozipper. Adapted from Ref. [4].

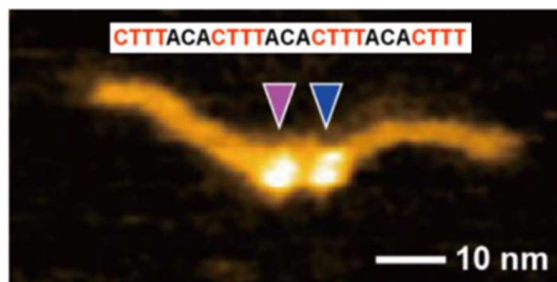


**Figure 2.** High-speed atomic force microscopy (HS-AFM) images of the transcription factor Dof bound to DNA. Adapted from Ref. [5].

*Acknowledgements:* We thank Dr. Miyagawa (Kyoto University) for collaboration on the Dof study reported in Ref. [5]. This work was supported by JSPS KAKENHI Grant Number 22K18945, 23H03073, 25K09580 (H.Y.), 24KJ1579 (A.T.).

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## **IM-01 Electron Microscopy as a Central Tool for Understanding Growth Mechanisms in ALD Nanocoatings and Stabilization Mechanisms in Nanowire Networks**

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The interaction between energetic electrons and nanostructured materials generates a rich variety of signals, enabling simultaneous investigation of nanoscale structure, chemical contrast, and elemental composition. These complementary information channels make electron microscopy a central tool in advanced nanomaterial research, where morphology and interfaces critically govern material properties.

In this talk, I will discuss the role of field-emission scanning electron microscopy (FE-SEM) and transmission electron microscopy (TEM) in understanding growth mechanisms and morphology evolution in ALD nanocoatings and nanowire-based systems. Representative studies on oxide thin films, including ZnO,[1] Al-doped ZnO,[2] SnO<sub>2</sub>, and CuO[3] deposited by atmospheric-pressure spatial atomic layer deposition (AP-SALD), will be presented. Combined FE-SEM and other advanced characterizations provide insights into nucleation behavior, grain development, and substrate- and surface-dependent growth mechanisms.

The talk will further address transparent electrodes based on Ag nanowire networks,[4] where SEM, EDS mapping, and TEM are essential to elucidate coating mechanisms and morphological stabilization induced by ultrathin oxide layers deposited via atmospheric-pressure ALD.

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## **IL-02 Conformational dynamics of actin filaments crosslinked with alpha-actinin and their roles in suppressing cofilin-induced helical shortening and cluster formation**

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Actin is one of the most conserved eukaryotic proteins and, in filament form, underlies essential processes such as cell morphogenesis, motility, division, transport, and membrane remodeling. Beyond the cytosol, actin filaments also participate in nuclear events including transcription regulation, chromatin remodeling, and DNA repair<sup>1,2</sup>. Understanding how actin filaments acquire specialized functions remains a major challenge.

Actin filaments form right-handed helices with two pitches: a long pitch, or half helical pitch (HHP), of ~36 nm (~13 subunits), and a short pitch defined by the ~5.5 nm axial distance (AD) between adjacent protomers<sup>3–8</sup>. These features determine filament mechanics and stability.

Alpha-actinin, a major actin crosslinker, is Ca<sup>2+</sup> insensitive in muscle (isoforms 2 and 3)<sup>9</sup> but Ca<sup>2+</sup> sensitive in non-muscle cells (isoforms 1 and 4)<sup>10</sup>. Although structures of these isoforms are known, their influence on actin filament conformational dynamics is unclear. Alpha-actinin crosslinks actin at each HHP and organizes bipolar bundles in stress fibers and sarcomeres, as well as unipolar arrays in protrusive structures.

Cofilin binds actin at 1:1 stoichiometry, generating supertwisted cofilactin with a ~25% shorter HHP (~11 subunits)<sup>11,12</sup>. Cryo-EM shows that internal and barbed-end subunits flatten, whereas pointed-end subunits twist and impede pointed-end elongation<sup>13</sup>. We previously found that bare HHPs near cofilin clusters shorten and show larger mean axial distance (MAD) values between adjacent protomers, but it is unknown whether transitions from flattened to twisted protomers are required for cooperative cofilin binding<sup>14</sup>.

Here, using high-speed atomic force microscopy (HS-AFM), all-atom molecular dynamics (MD) simulations, and principal component analysis (PCA), we examine how alpha-actinin modulates actin architecture, helical parameters, protomer geometries, and the cooperative binding of cofilin.

HS-AFM shows that alpha-actinin preserves canonical HHP and MAD values even in the presence of cofilin. MD simulations confirm that alpha-actinin stabilizes rises, ADs, and protomer dihedral angles, maintaining flattened F-actin-like conformations. These stabilized, flattened states suppress cooperative cofilin binding and clustering but likely allow myosin II S1 binding. Bare filaments, in contrast, undergo cofilin-induced helical shortening and cooperative clustering.

Cofilin and S1 bind distinct filament regions—cofilin to shortened HHPs and S1 to normal HHPs—allowing their coexistence on the same filament. We show that cooperative cofilin binding begins at

shortened ADP-HHPs that promote protomer twisting and further HHP shortening; when these steps do not occur, cooperativity is blocked.

Overall, alpha-actinin regulates filament architecture by maintaining canonical helical features and restricting cofilin-driven structural transitions, implicating a structural mechanism for spatial and temporal control of actin-binding protein interactions in cells (**Figure 1**).

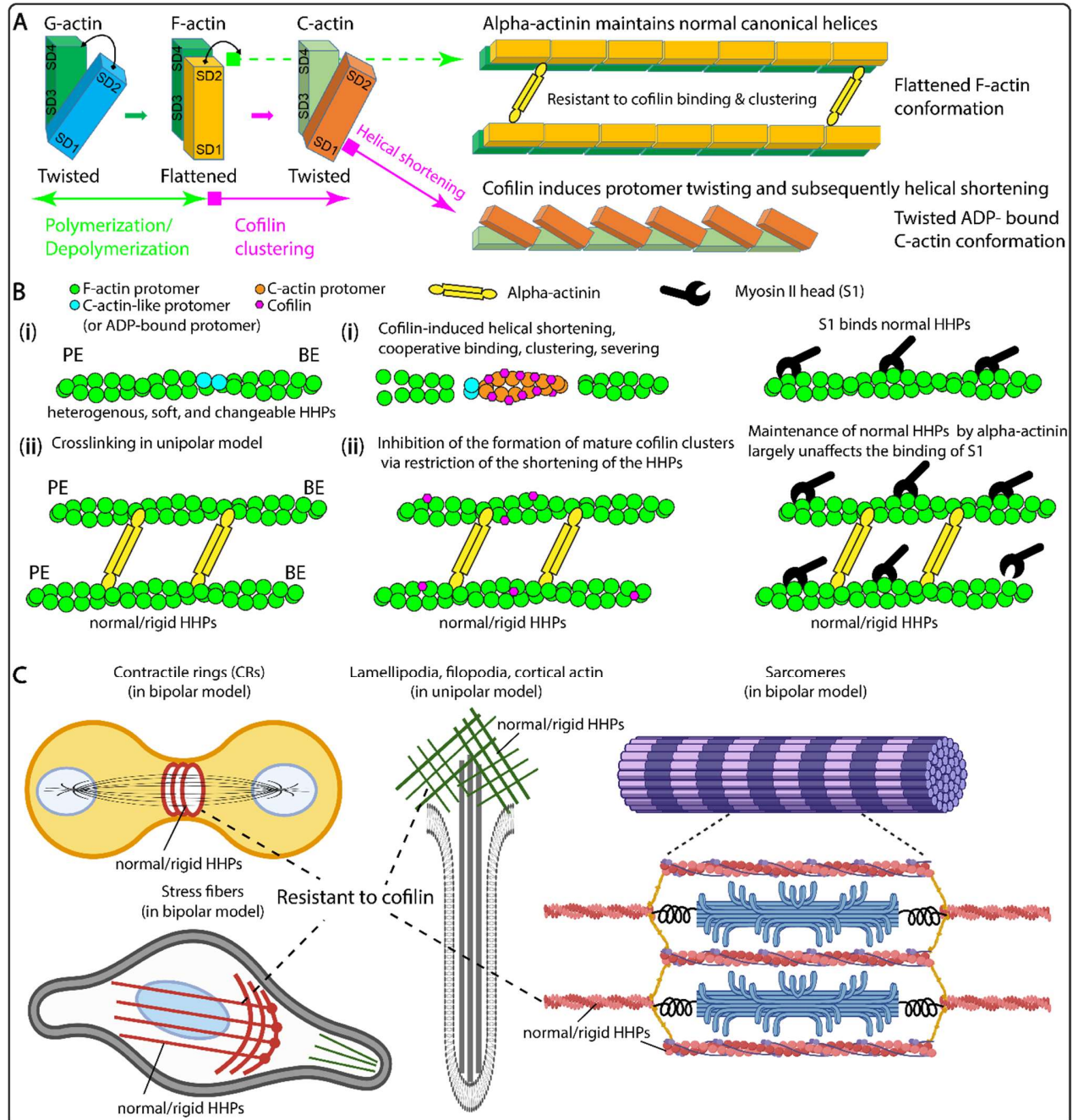


**Figure 1.** A hypothesis proposing actin conformation-dependent cooperative binding and clustering of cofilin on actin filaments, utilizing a short helical structure, in contrast to the normal helical structure employed by the myosin II head motor (S1).

## HS-AFM analysis

We employed high-speed atomic force microscopy (HS-AFM), as previously described<sup>14–16</sup>, to capture the dynamic conformations of actin filament-crosslinked with alpha-actinin under various conditions, providing high-speed imaging and three-dimensional (3D) surface structure of the protein at nanometer resolution. Alpha-actinin was diluted to a desired concentration in F-buffer containing 20 mM KCl, 10 mM PIPES-KOH (pH 6.8), 0.5 mM MgCl<sub>2</sub>, 0.25 mM EGTA, 0.25 mM DTT, and 0.5 mM ATP, as similarly done<sup>17</sup>. We used F-buffer at pH 6.8 to study cooperative cofilin binding and clustering on actin filaments while minimizing cofilin-induced severing and depolymerization, which are known to increase at higher pH (~7.8)<sup>18,19</sup>. To investigate the dynamic conformational changes in actin filaments crosslinked solely by alpha-actinin, actin filaments were gently immobilized on a lipid membrane and similar F-buffer consisting of 0.5 mM MgCl<sub>2</sub>, 0.5 mM ATP, and 50 nM alpha-actinin, but without CaCl<sub>2</sub>, was employed for HS-AFM imaging.

### Main Results

Our results suggest that (i) alpha-actinin more effectively stabilizes flattened protomer conformations and normal HHPs in crosslinked filaments than in bare filaments when cofilin is present; (ii) these flattened protomers and normal HHPs strongly suppress cooperative cofilin binding and clustering while leaving S1 binding and clustering largely unaffected; and (iii) cofilin binding and cluster expansion proceed through an initial association with shortened ADP-bound HHPs, followed by protomer twisting and further HHP shortening, which together drive cooperative growth. In the absence of these steps, cooperative binding and clustering are inhibited. However, we do not rule out the possibility that crosslinking may limit helical twist changes, impede cofilin cluster maturation, and thus maintain the flattened conformation even in the presence of cofilin. These findings uncover a previously unrecognized atomic mechanism by which alpha-actinin regulates actin filament dynamics and structure-dependent interactions with other ABPs critical for cytoskeletal organization.

**Acknowledgements:** The authors also acknowledge the financial support from KAKENHI (Japan Society for the Promotion of Science) (19K06581, 23K05713, 23H02452-01).

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## **IM-02** Microscopy in analysis of TiO<sub>2</sub> nanotubes-cell interactions

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Cell-surface interactions play an important role in osseointegration, immune response and implant lifetime, thereby influencing the application of titanium (Ti) implants. This study focuses on microscopy in analysis of TiO<sub>2</sub> nanotubes-cell interactions using confocal laser scanning microscope (CLSM), scanning electron microscope (SEM) and atomic force microscopy (AFM). Mouse baby hamster kidney (BHK) cells were used as models and the cells were cultured on the surface for 48 h and 72 h of incubations and the results of different microscopy analysis were compared. In vitro cell tests revealed that TiO<sub>2</sub> nanotubes with highly hydrophilic properties promoted better cell attachment as indicated by expanded cell shape and dense cell density in relation to the bare titanium substrates. The better cell attachment on TiO<sub>2</sub> nanotubes was attributed to higher hydrophilic properties compared to that of the Ti substrates. These results suggest that the microscopy is useful for TiO<sub>2</sub> nanotubes-cell interactions in biomedical implants.

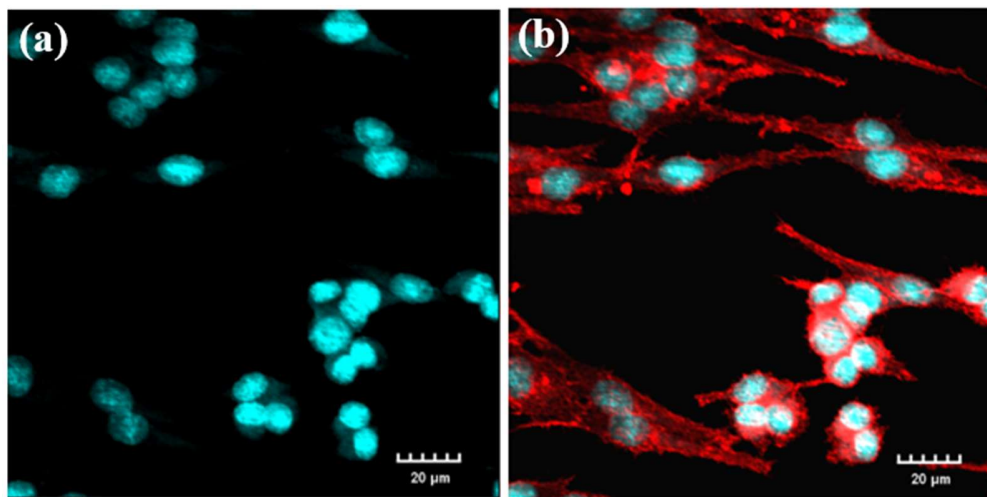


**Figure 1.** Cell attachment on TiO<sub>2</sub> nanotubes after 48h of culturing. (a) DAPI and (b) Phalloidin 555 staining.

## **IL-03** Advanced biosynthesis to boost the production of natural antibiotics for medicinal and food industries

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The emergence and rapid spread of multidrug-resistant (MDR) bacterial strains is a public health concern. This issue arises primarily from the misuse and abuse of antibiotics, fostering the development of antibiotic-resistant strains. Furthermore, the rise of biofilm-associated infections and antibiotic resistance requires innovative strategies that go beyond traditional medicines. Due to a growing number of nosocomial and community-acquired infections caused by MDR pathogens, nanoparticles (NPs) with enhanced antibacterial activity have recently been proposed as an alternative to antibiotics. However, the influence of NPs on bacterial growth inhibition and cell survival has not been thoroughly studied to realize their full potential.

In this study, a multi-modal method including individual and co-culture analysis, electrochemical stimulation, and nanoparticle-based enhancement is used to examine the antibacterial efficacy of *Lactobacillus plantarum* against several bacterial strains. To accomplish this, we first identified the *Lactobacillus* species that most successfully limit the growth of *S. aureus*, a well-known pathogenic bacterium frequently encountered in hospitals. Three distinct *Lactobacillus* species were co-cultured with *S. aureus* in a compound medium (CM) that was designed to mimic competitive polymicrobial environments and satisfy both organisms' metabolic needs. The most potent inhibitory effect was shown by *L. plantarum*, which dramatically reduced *S. aureus* planktonic growth and biofilm development in both aerobic and anaerobic settings. In anaerobic, unadjusted pH conditions, cell-free supernatants (CFS) from *L. plantarum* demonstrated strong antimicrobial activity, with zone of inhibition (ZOI) values as high as  $11.5 \pm 1.5$  mm. Antimicrobial activity was significantly decreased with pH neutralization, demonstrating the significant contribution of acidification and organic acid metabolites. In addition, the inhibitory impact of *L. plantarum* on *S. aureus* was enhanced by electrochemical stimulation, particularly in co-culture biofilms grown on conductive screen-printed electrodes. This was demonstrated by fluorescence microscopy and verified by image analysis, which revealed a 70% decrease in biofilm coverage.

To investigate the effect of NPs on bacterial growth inhibition, we measured bacterial growth over 24 hours at various NP concentrations and identified concentrations that inhibited as well as boosted bacterial growth. The identified enhanced NPs concentration was then applied to both the classical and electro fermentation procedures to increase the production of natural antibiotics. The efficacy of these organically produced compounds was then tested using the cell-free supernatant from the fermentation products. Preliminary studies show that the CFS derived from this fermentation setting has strong antibacterial action against numerous facultatively anaerobic bacteria. Pilot tests using this CFS to produce carboxymethyl cellulose thin films also demonstrate that they exhibit strong antibacterial properties against a variety of potentially harmful bacterial species.

These results highlight the possibility of combining nanoparticles and electrochemical stimulations to enhance the production of natural antibiotics and show that *L. plantarum* is a strong natural antimicrobial, particularly in acidic and anaerobic environments. This integrative strategy shows promise for developing advanced probiotic-nanomaterial hybrid therapies to combat biofilm-forming, drug-resistant pathogens on biomedical surfaces.

**Keywords:** *Lactobacillus plantarum*, *Staphylococcus aureus*, antimicrobial resistance, co-culture, electrofermentation, nanoparticles, biofilm inhibition, cell-free supernatant

## **IM-03 Imaging techniques for semiconducting industry: from front-end to back-end**

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Adapting the production demands of the semiconductor industry processes on a national scale, from front-end to back-end, the roles of imaging techniques are extremely important. The requirement criteria of the semiconductor industry will drive the training programs of the educational institutions at the domestic level, particularly selecting a specific process in the entire of the semiconductor chip productions that is suitable for the current situations of Vietnam, aiming at finding a rational approach to training human resources to meet the direct demands of this attractive labor market. This talk thus will provide an overview of some practical issues at the SAMSUNG company of South Korea in recent years, from which we can identify existing challenges aiming at aiding the high-quality human resource training programs in Vietnam is better, based on the actual conditions. Understanding the current challenges, the training programs of the educational institutions in Vietnam need to be integrated with foundation and hi-tech knowledge to achieve the strategic goals of Vietnam: *providing at least 50k peoples successfully trained at the level adapting for the semiconductor industry before 2030, especially focusing on design, packaging, testing, and mastering semiconductor chip manufacturing technology*. Recognizing the specific challenges and actual situations of Vietnam, teaching and learning activities should select appropriate subjects and prepare necessary skills during specialized internship workloads related to semiconductor-chip technology training, *i.e.*, engineering physics, materials science engineering, chip design engineering, etc.

Based on the experiences of higher education activities and the semiconductor chip manufacturing market in Korea, such actual challenges will affect the trends in human resource training and the labor market in the semiconductor industry in Vietnam in the very near future. Due to the given situations, we can suggest the following tips which should be integrated into the training programs of the education institutions in VN: (i) defining the scope/segment of training to guide learners in choosing appropriate specializations to serve a specific stage of semiconductor chip production; (ii) understanding the specific features of the chip production market and the critical soft skills to meet the stringent requirements of the domestic and international semiconductor industry markets as we are aiming for; (iii) since a reasonable training segment is identified, the appropriate internship modules or course work syllabus will be selected in well preparing for the learning outcomes in combining with student internships at domestic/international semiconductor corporations/companies; (iv) open issues behind university/ college training programs, forwarding a higher education level in the field of semiconductor chip production on the national scale.

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## **IL-04 Multi-scale Structural Characterization and Physicochemical Profiling of *Tor douronensis* Muscle for Cultivated Fish Meat**

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### **Introduction**

The Mahseer (*Tor douronensis*), locally known as Pla Phluang Chomphu, is a premium freshwater fish endemic to Southern Thailand, commanding market prices as high as \$100/kg. Due to its high economic value and status as a threatened species, it has been selected as a case study for Thailand's BCG economy model to develop high-value cultivated meat alternatives. A primary challenge in cellular agriculture is the "bionic design"—finely simulating the complex, multi-scale hierarchical organization of natural fish muscle to replicate its unique mouthfeel and nutritional function. Replicating this organization requires a precise structural blueprint. This study presents a comprehensive characterization of *Tor douronensis* muscle architecture, bridging the gap between microscopic morphology and macroscopic food properties to provide target data for AI-driven scaffold design.

### **Experimental methods (theoretical/simulation models) and materials**

Samples of *Tor douronensis* were analyzed to establish a multi-scale data profile. Surface morphology and micro-topography were investigated using Scanning Electron Microscopy (SEM) following formaldehyde, osmium tetroxide (OsO<sub>4</sub>) fixation and critical point drying (CPD). For internal 3D architecture, high-resolution X-ray Computed Tomography (micro-CT) was employed using a Waygate Vtomex-M system. To enhance contrast in soft tissue, samples were stained with an optimized 3.75% IKI solution, a method refined to allow the distinct separation of muscle fiber bundles from fat and connective tissues.

Physical properties were quantified via Texture Profile Analysis (TPA) using a Texture Analyzer to measure hardness, springiness, and chewiness across different fillet regions (back, belly, and tail). Simultaneously, the nutritional fingerprint was established through proximate analysis (AOAC methods) and high-performance liquid chromatography (HPLC) to determine amino acid and fatty

acid profiles. This integrated approach allows for the correlation of 3D structural data with mechanical food performance.

### Expected Analyzed Results

As we are currently analyzing the data, we are expecting the multi-scale analysis to reveal a sophisticated spatial distribution of muscle bundles (myotomes) and connective tissue (myocommata). In addition, we are anticipating that our 3D micro-CT reconstruction provides quantitative insights into the arrangement of muscle fibers and the distribution of marbling fat, which is particularly prominent in the belly region and contributes to a fatty mouthfeel. These structural parameters, including fiber diameter and spacing, are critical for engineering edible scaffolds that can support cell alignment and growth in 3D.

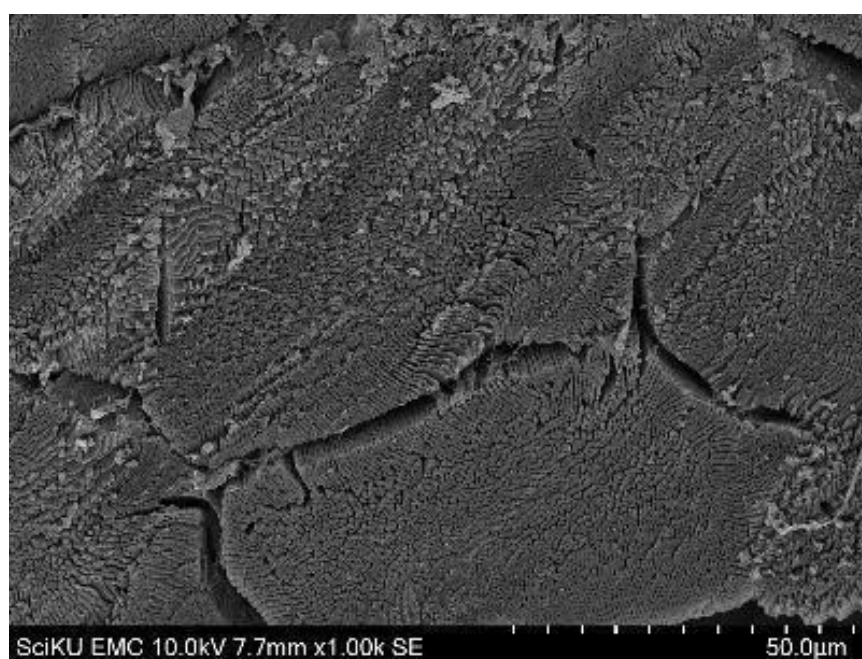


**Figure 1.** Examples of SEM data of *Tor douronensis*'s tail being analyzed at various magnifications

In the texture profile analysis, we expect to observe a significant correlation between structural width (myocommata) and hardness. We also anticipate that the tail region exhibited the highest firmness and adhesiveness, likely due to shorter, denser muscle fibers and increased collagen content. Nutritional profiles would confirm *Tor douronensis* as a high-protein source rich in essential minerals and good fatty acids. By combining these structural and physicochemical datasets, the resulting cultivated fish analogs not only replicate the nutritional value but also the distinct multi-scale texture of the natural Mahseer in Thailand.

**Acknowledgements:** This work has received funding support from the National Science, Research and Innovation Fund (NSRF) via the Program Management Unit for Human Resources & Institutional Development, Research and Innovation grant number B36G660006 and via Kasetsart University (KU)'s Fundamental Fund grant number FF17.68.

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**Keywords:** *Cultivated meat, Tor douronensis, Micro-CT, Scanning electron microscopy, Texture profile analysis*

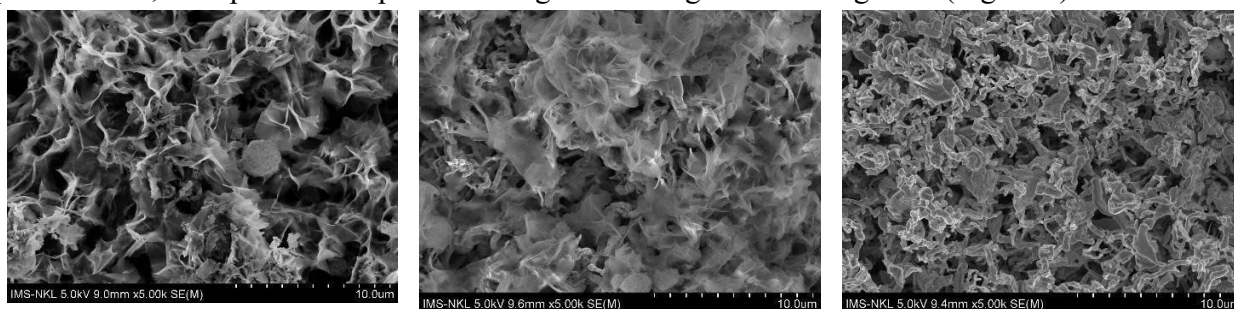
## **IM-04** An excellent non-paraffin-stick coating achieved by silicone microfilament deposition on a micro- and nanostructured ZnO-coated CT3 steel surface

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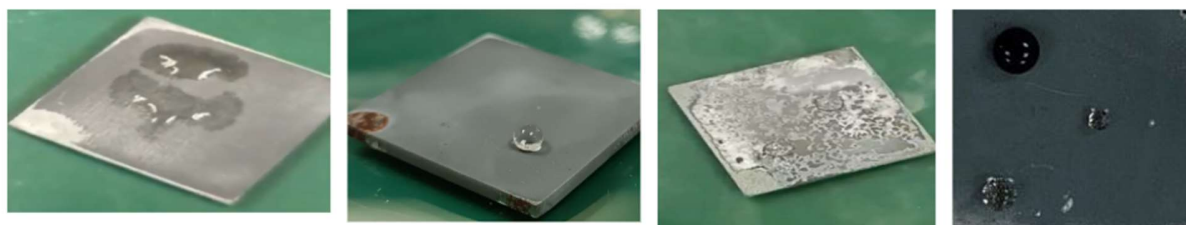
The prevention of paraffin deposition on surfaces remains a critical challenge. Inspired by superomniphobic coatings which integrate micro/nanostructured roughness with low surface energy through chemical modification, we developed a straightforward method to deposit silicon microfilaments on ZnO-coated CT3 steel. The process involves mixing methyltriethoxysilane, hydrochloric acid, and toluene, offering a less toxic and more economical alternative to trichloromethylsilane used in conventional microfilament synthesis (Figure 1). Microfilament growth is regulated by the HCl concentration in the precursor solution, followed by surface modification with 1H,1H,2H,2H-perfluorooctyltriethoxysilane. The resulting surface exhibits excellent anti-paraffin performance, with paraffin droplets showing contact angles exceeding 150° (Figure 2)



(A) Without adding HCl 0.01M (B) Adding 50  $\mu\text{L}$  HCl 0.01M (C) Adding 90  $\mu\text{L}$  HCl 0.01M

**Figure 1.** SEM images of ZnO-coated CT3 steel after microfilament deposition with and without HCl. (A) Without HCl; (B) 50  $\mu\text{L}$  of 0.01 M HCl; (C) 90  $\mu\text{L}$  of 0.01 M HCl.

Crude oil (dark) and paraffin (white) droplets on the microfilament ZnO-coated CT3 steel surface



(A) Without 0.01 M HCl

(B) With 0–90  $\mu\text{L}$  of 0.01 M HCl

(C) With more than 90  $\mu\text{L}$  of 0.01 M HCl.

(D) Crude oil (dark) and paraffin (white) droplets on the microfilament ZnO-coated CT3 steel surface.

**Figure 2.** Water droplet behavior on ZnO-coated steel surfaces modified with MTES: (A) Without 0.01 M HCl; (B) With 0–90  $\mu\text{L}$  of 0.01 M HCl; (C) With more than 90  $\mu\text{L}$  of 0.01 M HCl; (D) Crude oil (dark) and paraffin (white) droplets on the microfilament ZnO-coated CT3 steel surface

## **IL-05 Structural Basis of Tigecycline bound Mitochondrial Ribosome revealed by Cryo-Electron Microscopy**

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### **Introduction**

Antibiotics that target bacterial ribosomes have been essential for the treatment of infectious diseases; however, their potential off-target effects on eukaryotic mitochondrial ribosomes remain insufficiently understood. Hypothetically, mitochondria evolved from bacterial ancestors, subsequently, mitochondria have their own DNA (mtDNA) and their own ribosome (mitoribosome). Thirteen proteins encoded by mtDNA mostly belong to oxidative phosphorylation (OXPHOS) complexes that respond to ATP production within mitochondria. Disruption of mitochondrial protein synthesis can profoundly impair OXPHOS complex affecting cellular metabolism, particularly in immune cells such as T lymphocytes that require mitochondrial remodeling upon activation. Tigecycline, a third-generation tetracycline antibiotic, has been reported to exert immunosuppressive effects, yet the molecular basis underlying its mitochondrial toxicity remains unclear. Here, we combine high-resolution cryogenic electron microscopy (cryo-EM) with complementary cellular and biochemical assays to elucidate how tigecycline directly interacts with the human mitoribosome and disrupts mitochondrial translation.

### **Experimental methods**

Human mitochondrial ribosomes (55S mitoribosomes) were isolated from Jurkat T cells. Purified mitoribosomes were incubated with tigecycline and vitrified for single-particle cryo-EM analysis. Cryo-EM data were collected using a 300-kV transmission electron microscope. Image processing, particle classification, and three-dimensional reconstructions were performed to resolve tigecycline-bound mitoribosome structures at near-atomic resolution, enabling unambiguous identification of antibiotic binding sites.

To contextualize the structural findings, complementary biochemical and cellular assays were performed. Mitochondrial and cytosolic protein synthesis were assessed by metabolic labeling and immunoblotting.

### **Results**

Cryo-EM reconstructions reveal that tigecycline binds directly to the human mitoribosome at multiple distinct sites. A conserved binding site was identified within the mitochondrial small ribosomal subunit (mtSSU) A-site, analogous to tetracycline interactions observed in bacterial ribosomes, providing a structural explanation for inhibition of mitochondrial decoding. In addition, two previously uncharacterized tigecycline binding sites were discovered on the mitochondrial large subunit (mtLSU). One site (mtLSU-1) identified at the region of mtLSU helices 69 and 71 which has not previously been recognized for any antibiotic binding sites in bacterial ribosomes. The third binding site (mtLSU-2) is located at the catalytic peptidyl transferase center (PTC) which has been reported for other tetracycline derivatives such as sarecycline.

Consistent with these structural observations, biochemical assays show selective inhibition of mtDNA encoded protein synthesis following tigecycline treatment, but not cytosolic ones. Cellular analyses further reveal compromised mitochondrial respiration and impaired proliferation and activation of T cells at clinically relevant concentrations. Together, these data support a direct structural mechanism linking tigecycline binding to mitoribosome dysfunction and downstream cellular toxicity.

## Discussion

This study provides a structural framework for understanding mitochondrial toxicity associated with tigecycline by revealing its direct and multivalent engagement with the human mitoribosome. The identification of multiple binding sites—spanning both conserved and mitochondria-specific ribosomal features—demonstrates that mitoribosomes are not merely passive off-targets but possess structural elements that actively accommodate antibiotic binding. These findings underscore the importance of cryo-EM in capturing drug–ribosome interactions that are inaccessible through biochemical approaches alone.

Beyond elucidating tigecycline’s mechanism of action, the structural insights presented here have broader implications for antibiotic development and mitochondrial biology. These findings open up opportunities for the development of new antibiotics with increased efficacy and reduced side effects and suggest a potential therapeutic application for tigecycline in cancer and immuno-diseases treatment.

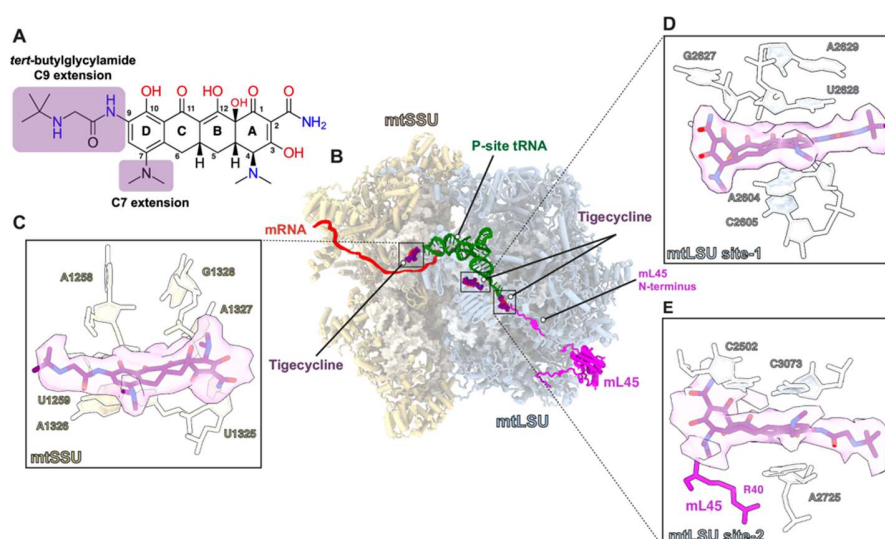


Figure 1: Overview of the interactions of tigecycline with the human mitoribosome

**Keywords:** *Cryo-Electron Microscopy, 3D structural determination, mitochondria, mitoribosome, antibiotic*

## **IM-05** Electron Backscatter Diffraction helps observe the initiation of stress corrosion cracking phenomenon in pipeline steels

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This presents a microscopic study on the behavior of stress corrosion cracking (SCC) phenomenon in pipeline steels using electron backscatter diffraction (EBSD) technique. Stress corrosion cracking tests were performed in planar steel samples using a Cortest proof-ring coupled with a fabricated cell containing near-neutral pH solution as a corrosive medium, simulating the soil conditions, to observe the cracking initiation stage. Surface characterizations of the steel samples using advanced techniques such as FESEM, EDS, and EBSD provided experimental evidence of microcrack formations (initiation), where nonmetallic inclusions could take place as pitting sites (to form corrosion pits), which constitute the most susceptible sites for SCC crack initiation. SEM and EBSD maps taken on the steel sample surfaces have verified the presence of both SCC transgranular and intergranular crack types in near-neutral solutions. The results have also proven the capability of EBSD in revealing insights into the relationship between microstructural features and SCC behavior.

**Keywords:** *pipeline steel, stress corrosion cracking, crack nucleation, EBSD.*

## **IL-06 Engineering Protein–Lipid Interfaces on Giant Unilamellar Vesicles as a Platform for Membrane Mechanobiology**

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Cellular membranes are active mechanical interfaces that integrate lipid composition, protein organization, and cytoskeletal coupling to regulate cell shape and signaling [1]. Understanding these interactions requires minimal models like Giant Unilamellar Vesicles (GUVs) to reduce biological complexity. While GUVs effectively mimic cell-like dimensions, establishing programmable connections between artificial membranes and living cells remains a significant challenge [2]. This work develops modular connector strategies using the evectin-2 pleckstrin homology (PH) domain to investigate membrane–membrane and membrane–cytoskeleton interfaces.

### **Experimental methods and materials**

GUVs containing phosphatidylcholine (DOPC) and phosphatidylserine (DOPS) were prepared via water-in-oil emulsion transfer. Two connector strategies were engineered based on the evectin-2 PH domain [3]:

1. Multi-component GUV Bridge: Evectin PH domains fused to GFP were bound to PS on GUV surfaces. These were linked using biotinylated anti-GFP antibodies and a NeutrAvidin core to create a stable physical tether.
2. Actin-Coupled Connector: An evectin-PWA fusion protein containing a WASP family–related actin-binding domain (PWA) and a PH domain was used to link membranes directly to extracellular actin structures.

Imaging was performed using Highly Inclined and Laminated Optical sheet (HiLo) microscopy to selectively visualize near-membrane regions with reduced background fluorescence [4].

### **Results and Discussion**

Experimental results confirmed specific GUV coupling for both connector types, with HiLo–TIRF imaging revealing clear fluorescent localization at the contact interfaces. Notably, the connectors failed to bind to viable biological cells. This confirms the high exclusionary specificity of the PH-domain; in healthy cells, PS is sequestered in the inner leaflet and is inaccessible.

Rather than a limitation, this specificity positions the platform as a powerful tool for pathological mechanobiology. PS exposure on the outer leaflet is a hallmark of early-stage cellular stress and degeneration. Our findings suggest that these GUV-linkers can serve as autonomous sensors targeting compromised cells. Future applications include utilizing these GUVs as "mechanical splints" or delivery vehicles, providing localized regenerative signals to stressed cells before they reach irreversible apoptosis. This dual-modality approach, which combines structural support with targeted signaling, offers a new frontier in cell rescue and regenerative medicine.

*Acknowledgements: This work was supported by JSPS KAKENHI Grant Numbers JP25K00059 and JP25H01791 to DI. This work was also supported in part by Grants from Kakiyama Research Foundation and Naito Research Foundation to DI.*

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## **IM-06 Insights into the Structure and Mechanics of Polymer-Based Lightweight Materials through AFM and Complementary Microscopy Techniques**

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The growing challenges related to improving fuel economy and reducing greenhouse gas emissions have driven various industries to develop and adopt lightweight materials as alternatives to traditional metal-based components. In this context, polymer composites have become indispensable materials with the potential to revolutionize and enable technological breakthroughs across a wide range of modern industries, including aerospace, automotive, wind energy, and electronics.<sup>1</sup> Among polymeric materials, epoxy resins offer particularly attractive opportunities for these applications, as they can serve not only as matrices in structural composites, such as fiber-reinforced polymers, but also as adhesive bonding materials that can replace conventional mechanical joining techniques, owing to their excellent adhesion, high mechanical strength, thermal stability, and chemical resistance.<sup>2</sup>

To enhance the stiffness and fracture toughness of epoxy materials, various types of nanoparticles, such as silica, alumina, and carbon nanotubes have been incorporated into epoxy matrices. Although many studies have provided increasing evidence that the toughening effect in these nanocomposite systems is largely governed by the nanoscale interfacial layer formed between the nanoparticles and the epoxy matrix, direct observation of structural and mechanical changes at this interface remains highly challenging.<sup>3</sup> Experimental validation of this critical mechanism has only recently seen significant advances through the use of various advanced microscopy techniques. For example, *in situ* TEM studies by Wang and co-workers have directly revealed the nucleation and growth of

nanovoids surrounding nanoparticles during tensile deformation, strongly supporting the concept related to the debonding process occurring at the interface as the prominent mechanism underlying the toughness enhancement in epoxy nanocomposites.<sup>4,5</sup> Notably, using various atomic force microscopy (AFM) modes enabled us to directly quantify reduced elastic and adhesive responses at the nanoparticle/epoxy interface compared to the matrix region, providing important insights into the physical origin behind the debonding mechanism at the interface.<sup>6,7</sup>

### **Experimental methods and materials**

Hydrogenated bisphenol A diglycidyl ether (HDGEBA) was used as an epoxy base, whereas 1,4-Cyclohexanebis(methylamine) (CBMA) was used as a curing agent. Silica nanoparticles with nominal diameters of 50 nm and surfaces treated with phenyl-type silane were used as nanofiller. Silica nanoparticles were first thoroughly dispersed in CBMA to achieve a good dispersion system, which was then mixed with HDGEBA at a molar ratio of 1:2. This ratio is equivalent to the stoichiometry of the epoxy and amino groups.<sup>6</sup> Neat epoxy and epoxy nanocomposites with silica weight fractions of 5, 10, and 15 wt% were prepared in this study. The mixtures were then cured at 373 K for ~24 h to

obtain epoxy-amine systems with a network conversion of nearly 100%. A bimodal AFM mode, namely amplitude- and frequency-modulation (AM-FM), was employed for measuring elastic modulus of epoxy resins at high-spatial resolution. AM-FM experiments were performed via a Cypher-ES AFM (Asylum Research, Oxford Instruments, USA) instrument equipped with blueDrive photothermal excitation. A detailed description of the working principle of the AM-FM method has been reported elsewhere.<sup>6</sup> Another AFM mode, namely nanoscale dynamic mechanical analysis (nDMA), was performed via Bruker Dimension Icon AFM with a Nanoscope 6 controller (Bruker, USA). This mode has been recently proven capable of measuring the dynamic mechanical properties of polymers, such as the dynamic storage ( $E'$ ) and loss ( $E''$ ) moduli and loss tangent ( $\tan\delta$ ), over broad temperature and frequency ranges in both linear and nonlinear deformation regimes.<sup>7</sup>

### Main Results

The incorporation of a small fraction of rigid nanoparticles into epoxy resins can simultaneously enhance multiple macroscopic properties, including the fracture toughness. This improvement is largely attributed to the formation of an interfacial polymer layer surrounding the nanoparticles, which exhibits structural and mechanical properties distinct from those of the bulk matrix.<sup>3</sup> To gain deeper insight into this toughening mechanism, characterization techniques that enable direct observation of nanoscale changes at nanoparticle/polymer interfaces are strongly demanded. In this study, we combine two recently developed AFM-based modes, AM-FM and nDMA, to characterize the local mechanical properties of the interfacial layer surrounding well-dispersed in HDGEBA/CBMA matrix. While the AM-FM method allows simultaneous high-resolution mapping of elastic modulus and energy dissipation,<sup>6</sup> the nDMA provides access to the dynamic mechanical responses of both the epoxy matrix and the interfacial layer over a broad temperature range.<sup>7</sup>

As a result, both methods provide clear evidence for the existence of an interfacial layer with a thickness of  $\sim 20$  nm, stiffness and adhesive properties of which are significantly altered relative to those of the bulk matrix. As illustrated by AM-FM results in Fig. 1, the glassy modulus of this interfacial layer is reduced by several-fold compared to the matrix value, while the adhesive response of the epoxy network became weaker upon approaching close to the nanosilica interface.<sup>6</sup> In this talk, I will present our AFM results detailing changes in both structure and mechanics of the interfacial layer compared to the matrix region. In addition, I will compare these findings with results obtained using other microscopy techniques, such as TEM and SEM, on the same epoxy nanocomposite systems.

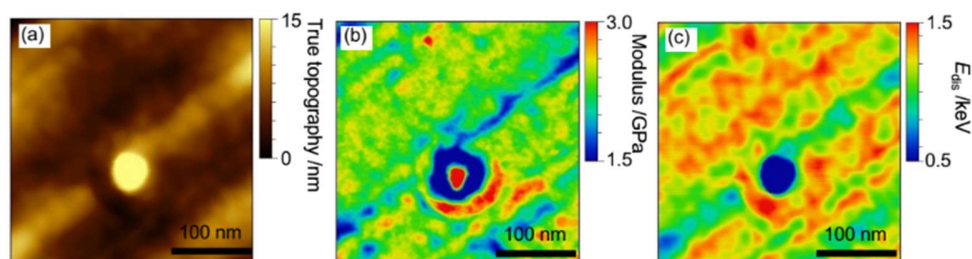


**Figure 1.** (a) True topography, (b) elastic modulus and (c) dissipated energy images captured surrounding a nanosilica in epoxy nanocomposites using AM-FM AFM method.

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## **IL-07 Bacterial cell - nanoparticle interactions through transmission electron microscopy**

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Elucidating the interactions between engineered nanoparticles (NPs) and biological systems, including their biomolecules and ability to associate with or disrupt bacterial cell membranes is fundamental to understanding both the antibacterial activity and diagnostic potential of nanomaterials. Transmission electron microscopy (TEM) has emerged as a powerful platform for directly visualizing these interactions at high spatial resolution. In this presentation, we report TEM-based investigations of nanoparticle–bacteria interactions, with emphasis on both inorganic and organic nanomaterials that adsorb onto and adhere to bacterial surfaces. High-resolution imaging reveals the localization of magnetic and gold nanoparticles on bacterial cell walls, underscoring their promise for the detection, capture, and isolation of pathogenic bacteria in complex biological matrices. In contrast, silver and zinc oxide nanoparticles demonstrate strong interactions with the bacterial envelope, resulting in membrane damage, loss of cellular integrity, and consequent inhibition of bacterial proliferation or cell death. In addition, recent advanced electron microscopy applied to the study of nanoparticle–bacterial interactions are briefly reviewed, highlighting emerging insights into nanoscale mechanisms that underpin antimicrobial efficacy and biosensing applications.

**Keywords:** *nanoparticles, TEM, advanced electron microscopy, bacterial cells*

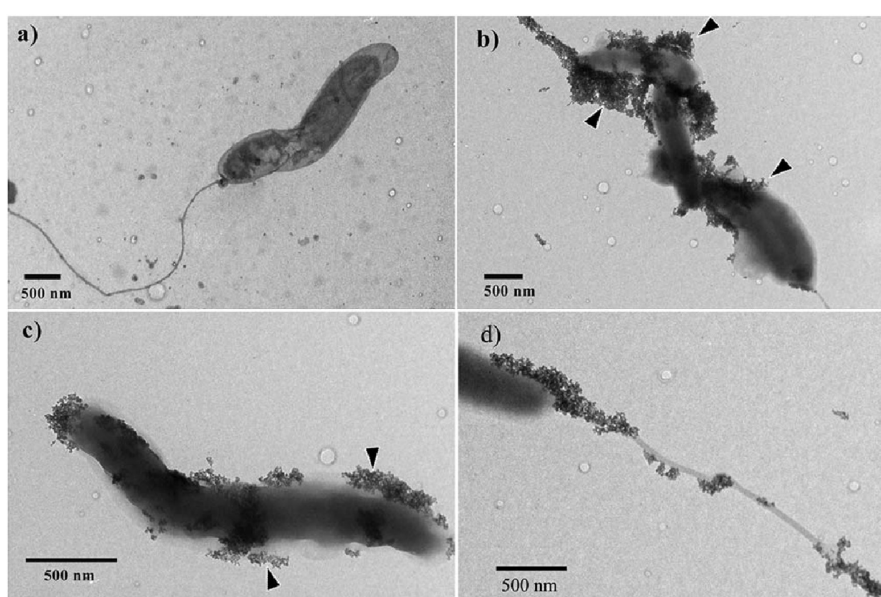


**Figure:** TEM images of *V. cholerae* bacteria (a) before interaction with the complex of IONP@CHI@GA@PrA@Ab, (b) aggregated and bound by IONPs, (c) IONPs bound to the cell wall, and (d) IONPs bound to the bacterial flagellum.

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## **IM-07 Strain-Induced Crystallization Near a Crack Tip: Micro-Scale Insights from Unfilled and Filled Elastomers**

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Strain-induced crystallization (SIC) represents a distinctive molecular-scale toughening mechanism in elastomeric materials, where localized crystalline domains form under mechanical deformation to create autonomous reinforcement networks. This self-reinforcing phenomenon is particularly critical in high stress/strain regions near crack tips, where it dissipates strain energy and significantly increases crack-propagation resistance. While extensive research has illuminated SIC behavior under uniform deformation conditions, the interplay between local strain fields and crystallization near crack tips—especially in nanofiller-reinforced systems—remains poorly understood due to confined and heterogeneous characteristics. This study aims to elucidate the mechanically modulated SIC mechanisms in both pure and carbon black-filled natural rubber (CB-filled NR) by integrating high-resolution microscale digital image correlation (DIC) with scanning wide-angle X-ray diffraction (WAXD), thereby revealing the spatial correlations between extreme local deformation and crystallinity distributions.

### **Experimental methods**

We employed a complementary analytical approach combining micro-beam WAXD (10  $\mu\text{m}$  square beam) and microscale DIC techniques to characterize thin NR specimens (80 mm  $\times$  10 mm  $\times$  0.25 mm) with a 10 mm single-edge notch. For pure NR, WAXD mapping was conducted at 40  $\mu\text{m}$  intervals over an approximately 3 mm  $\times$  1 mm area, while filled NR specimens were scanned at 30  $\mu\text{m}$  intervals over 3 mm  $\times$  5 mm regions around stabilized crack tips. By analyzing over 15000 diffraction patterns in filled systems, we simultaneously mapped local strain tensor properties and crystallinity fields. DIC analysis was performed on surfaces patterned with approximately 20  $\mu\text{m}$  random speckles, imaged at approximately 4  $\mu\text{m}/\text{pixel}$  resolution. All characterizations were conducted at a macroscopic true strain of 0.62 after stress equilibration, following multiple loading-unloading cycles to ensure crack tip stability and eliminate strain-hysteresis effects.

### **Results and Discussion**

Our micro-scale analysis reveals profound insights into SIC-driven toughening mechanisms. In pure NR (Figure 1), the maximum tensile component in the local principal strain tensor predominantly dictates crystallinity distribution, with the SIC zone extending approximately 160  $\mu\text{m}$  along the crack centerline and 1600  $\mu\text{m}$  perpendicular to it. Notably, shear strain plays a significant role in determining crystal orientation, as evidenced by the linear correlation between principal strain axis deviation and crystallographic c-axis tilting in peripheral zones.<sup>1</sup>

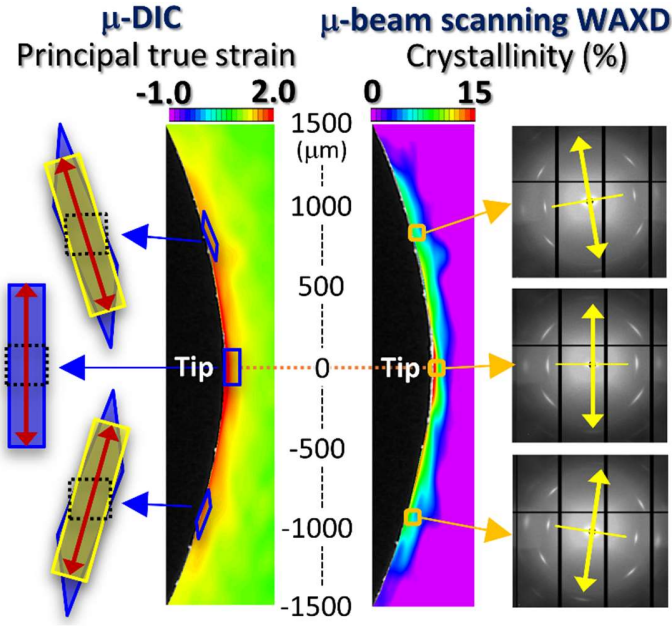


**Figure 1.** 2D distributions of principal true strain and crystallinity around a crack tip for unfilled NR

In nanofiller-reinforced elastomers (Figure 2), carbon black incorporation dramatically expands the SIC-active zone by nearly an order of magnitude and considerably reduces the crystallization onset strain from 130% to 65%. However, the strain amplification typically induced by fillers diminishes as the crack tip is approached, indicating a mechanical compensation effect. This spatial modulation reflects a dynamic balance among local crystallinity, deformation, and filler-mediated stress transfer. We identify a dual-slope strain singularity linked to crystallinity gradients and quantify an empirical correlation between crystallinity and major principal strain throughout the SIC-active region. These findings demonstrate that SIC-generated crystallites serve as in situ reinforcements, mitigating strain concentrations and enhancing damage tolerance. Our results provide mechanistic insights into the interplay between nanofiller-induced reinforcement and localized SIC behavior, offering guiding principles for designing soft materials with superior mechanical robustness and paving the way for predicting crystallinity distributions using solely strain field data.<sup>2</sup>

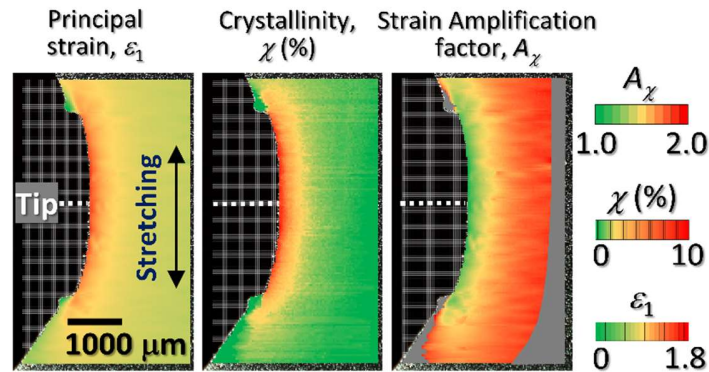


**Figure 2.** 2D distributions of principal true strain, crystallinity, and strain amplification factor around a crack tip for CB-filled NR

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## **IL-08 Reduced cell wall stiffness is partially responsible for reduced shape robustness in the Arabidopsis mutant *vip3***

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Organisms produce organs with highly conserved shapes and sizes, a phenomenon called robustness. How they achieve that is an active field of study. In recent years, the sepal – the outer organ protecting the flower bud – has been used as a model to study organ shape robustness because of several reasons such as their conserved shape, their heterogeneous population of cells, and their accessibility [1]. The control of cell and organ growth in plants largely happens at the cell wall (CW), where softer CWs promote and stiffer CWs restrict growth. The CW is a complex material consisting of cellulose microfibrils embedded in a matrix of polysaccharides (pectins and hemicelluloses such as xyloglucans) [2]. The stiff cellulose fibrils are generally considered the load bearing component, largely determining overall CW stiffness. They are synthesized by the cellulose synthase complex, which in turn is guided by cortical microtubules at the cell membranes. Disrupting microtubule dynamics leads to significant reduction in CW stiffness and various developmental phenotypes [3]. In this study, we work on the *vip3* mutant that has reduced shape robustness (i.e. increased shape variability) [4], and attempt to explain the phenotype through the lens of microtubule dynamics and CW stiffness.

We used advanced live cell imaging to measure microtubule dynamics and found that although microtubule density was increased in the mutant, microtubule dynamics was not significantly different compared to the WT. Consistent with that, when we used genetic tools to reduce microtubule dynamics in the mutant, although the growth and development of the mutant were severely affected, organ shape robustness was not significantly altered. We then used AFM and other techniques to probe CW stiffness in the mutant, and found that it was significantly reduced in the mutant compared to the WT. Using genetic tools to increase general stiffness of the CW in the mutant, we found that the overall development of the mutant was improved. More importantly, organ shape robustness of the mutant was significantly increased as well. The results suggest that reduced CW stiffness is partially responsible for the reduced shape robustness observed in the mutant.

*Acknowledgements:* We thank the PLATIM platform (Simone Bovio and Claire Lionnet, RDP Lyon, France) for their help in using the microscopes and the AFM.

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## **IM-08 Three-dimensional reconstruction and quantitative analysis of confocal microscopy z-stack images**

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Confocal microscopy enables optical sectioning of thick biological samples, providing volumetric information that cannot be fully captured by conventional two-dimensional imaging. However, in many studies, confocal datasets are still presented mainly as maximum intensity projections, which may obscure important three-dimensional structural features. In this work, we present a systematic approach for three-dimensional reconstruction and quantitative analysis of confocal microscopy z-stack images using publicly available datasets.

Confocal z-stack image sequences acquired from murine ventricular wall tissue were obtained from an open-access Zenodo repository. The image stacks were processed using open-source image analysis tools to perform noise reduction, intensity normalization, and threshold-based segmentation. Three-dimensional reconstruction was achieved through volume rendering and surface extraction, enabling visualization of tissue microarchitecture across the axial dimension.

Quantitative metrics, including layer thickness, signal volume fraction, and surface morphology descriptors, were extracted directly from the reconstructed 3D volumes. These measurements reveal structural heterogeneity along the z-axis that is not apparent in two-dimensional projections. The results demonstrate that 3D reconstruction from confocal z-stacks provides enhanced structural insight and enables reproducible quantitative characterization of microscopic tissue features.

This study highlights the value of open confocal microscopy datasets for three-dimensional structural analysis and underscores the importance of integrating image-based reconstruction with quantitative measurement. The proposed workflow is broadly applicable to confocal datasets and may serve as a foundation for further modeling or transport simulations informed by experimentally derived 3D geometries.

## **IL-09 Label-free Full-Spectrum Cytometry of Autofluorescence**

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The autofluorescence of cell populations is heterogeneous and, in traditional flow cytometry, is often considered a hindrance to analysis and is excluded as an artifact. Using the 7-laser full-spectrum cytometer and extended ‘virtual filtering’ approach, we examined cellular autofluorescence at multiple excitation and emission wavelengths, and demonstrated how the distinct autofluorescent signatures can be applied to the characterization of cellular populations spanning from nine major phytoplankton groups to human monocyte-derived macrophages at different states of M1/M2 polarization. Algal assemblages can be characterized by highly heterogeneous autofluorescence signals, resulting from differences between main photosynthetic and accessory pigments, particularly between phycobiliprotein and non-phycobiliprotein taxa, whereas autofluorescent profiles of monocyte-derived macrophages change in different metabolic states and under M1/M2 polarization. In full-spectrum cytometry, we suggest going beyond fluorescent intensity as a critical parameter and including other spectral characteristics in the analysis. Translation of findings requires reporting spectral parameters and a greater focus on autofluorescence dynamics. We conclude that autofluorescence can be used as a sensitive tool for assessing cellular characteristics and metabolic states with applications from taxonomy to cell phenotyping.

## **IM-09 Redox Controlled Nanopatterning of Graphene Surface by Electro-Active Molecules**

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Graphene, a single-atom-thick layer of  $sp^2$ -hybridized carbon atoms arranged in a honeycomb lattice, has attracted tremendous attention since its isolation due to its exceptional properties. However, despite these remarkable qualities, pristine graphene faces several intrinsic limitations. Its zero bandgap hinders its use in digital electronics where high on/off ratios are essential. In addition, graphene is insoluble in common solvents, complicating solution-based processing and large-scale integration. These disadvantages necessitate surface functionalization to tailor its electronic, chemical, and processing properties.

Surface modification via ordered organic adlayers is considered a potentially useful technique for tuning the electronic properties of graphene layers. Due to its delocalized  $\pi$  electrons, graphene is highly susceptible to adsorbates on the surface. Therefore, organic molecules with the highest occupied molecular orbital (HOMO) and lowest unoccupied molecular orbital (LUMO) at a suitable position with respect to the Fermi level of graphene have been employed to dope graphene. Among all  $\pi$ -conjugated molecules, viologens (V) that are redox-active and almost ideally reversible in electron-transfer reactions in combination with their low-lying LUMOs have emerged as promising candidates to address the intrinsic challenges of graphene. Reduced viologen is also known as an  $n$ -type dopant for 2D and carbon-based materials due to its lower reduction potential. However, implementing a single-step approach for precise spatial control of the nanopatterning on graphene surface *at the molecular level*, is still a challenge.

In this contribution, we address this challenge by introducing such novel experimental protocols for controlled and reproducible functionalization of HOPG (a model multi-layered graphene) as well as single-layered graphene via viologen-based nanopatterning employing both non-covalent and covalent approaches. The efficiency of this grafting approach was revealed by employing a state-of-the-art toolbox of characterization techniques, including cyclic voltammetry (CV), electrochemical impedance spectroscopy (EIS), Raman microscopy and spectroscopy, X-ray photoelectron spectroscopy (XPS), atomic force microscopy (AFM), and scanning tunneling microscopy (STM). Triggering the redox states of the V under electrochemical control enables functionalization of graphitic surfaces by either random ( $V^{2+}$ ), dimer phase ( $V^+$ ), or stripe ( $V^0$ ) patterns. Importantly, the  $V^0$  striped graphene surface reveals  $n$ -doping caused by the charge transfer from the electron-rich uncharged  $V^0$  species to graphene. This finding opens a new way to nanopatterned functionalization and doping of graphene and other 2D substrates by electrochromic molecules.

## **OL-01 Optimizing and real-time monitoring the formation of neurospheres on 3D microarray plates**

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### **1. Introduction**

Three-dimensional (3D) culture systems offer a physiologically relevant environment for neuronal modeling, providing better mimicry of the in vivo microenvironment compared to traditional 2D systems. However, longitudinal monitoring of these neurospheres remains labor-intensive and poses significant risks of microbial contamination and cellular stress due to repeated exposure to ambient air. To overcome these challenges, we utilized microarray-based PAMCELL plates featuring 350 precision-engineered micropads (100  $\mu\text{m}$  in diameter) per well to facilitate the assembly of uniform neural spheroids. The integration of a Cyclic Olefin Polymer (COP) thin film bottom enables high-resolution, in-situ live-cell imaging directly within the incubator, eliminating the need for sample transfer while maintaining a stable microenvironment. By leveraging this platform, we aimed to optimize the culture and differentiation of SH-SY5Y and human iPSC-derived neurons, to establish a robust, non-invasive workflow for high-throughput drug monitoring and high-fidelity pathological modeling.

### **2. Experimental methods and materials**

#### *2.1 Cell culture and differentiation*

SHSY-5Y was obtained from ATCC. The cells were proliferated in EMEM with penicillin and streptomycin and 15% heat-inactivated fetal bovine serum (hiFBS; Thermo Fisher, Waltham, MA, USA). The cells were incubated at 37 °C, 5% CO<sub>2</sub>, and 95% humidity.

SH-SY5Y cells were differentiated and matured in 96-well PAMCELL™ R100 plates. 40,000 cells per well were seeded onto 96-well PAMCELL™ R100 plates, which were pre-coated with iMatrix-511 (1:1000 in PBS) for 1 h. The cells were cultured in EMEM supplemented with various ranges of hiFBS (2.5%, 5%, 10%, 15%), 1× penicillin/streptomycin, and 10  $\mu\text{M}$  retinoic acid. On day 6, the culture medium was replaced with 2 types of maturation media, 1% B27, 20 mM KCl, 1% Penicillin, 2mM Glutamax, 0.05 ng/ $\mu\text{L}$  Brain-derived neurotrophic factor: RA-free and RA treated (10  $\mu\text{M}$ ) media, and half the medium was changed every day until day 12

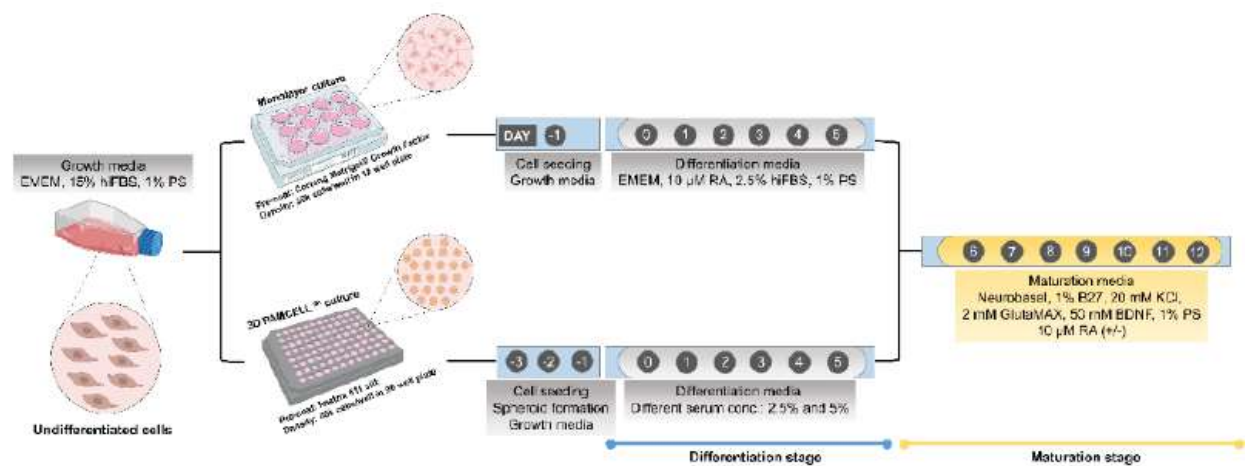


**Figure 1.** Culture and differentiation scheme of SHSY-5Y 3D culture

iPSC-derived neurons were purchased from NEXCEL (Seoul, South Korea). For spheroid culture,  $8 \times 10^5$  of viable hiPSC-neurons were diluted in 300  $\mu$ L CAMM and seeded into 96-well PAMCELL™ R100 coated with iMatrix-511 silk (NIPPI Corp., Kanagawa, Japan) in cell incubator for at least an hour. The media was half changed every day.

### 2.2. Real-time monitoring

iPSC-derived neurons were seeded for at least an hour. Then, the plate was moved into CO<sub>2</sub>-injected Cytation C10 and monitored for 24 hours.

### 2.3. Immunocytochemistry

The spheroids were fixed and permeabilized. Samples were washed and then soaked in a blocking solution for one hour with 1% bovine serum albumin. The permeable cells were incubated with primary antibodies for an overnight period at 4 °C. After washing with a blocking buffer, secondary antibodies were treated for 30 min at room temperature. DAPI was incubated for 20 min. The stain must be removed by washing thoroughly three times or more with PBS. To avoid being dried and detached from plates, spheroids are not exposed to air for every single step.

Fluorescent images were taken using a confocal microscope (Leica Stellaris 5, Leica Camera AG, Germany).

## 3. Results and Discussion

We differentiated SH-SY5Y cells into mature glutamatergic-like neurons and optimized hiFBS concentrations within the 3D culture system. The resulting spheroids displayed highly uniform morphology and strong expression of TUJ1, MAP2, and Synapsin, suggesting the establishment of intra-neurosphere synaptic connectivity. Furthermore, neurite outgrowth observed between spheroids confirmed inter-spheroid communication, effectively forming a complex neural network. Finally, the differential expression profile favoring VGLUT1 over TH confirmed that the spheroids predominantly maintained a glutamatergic phenotype.

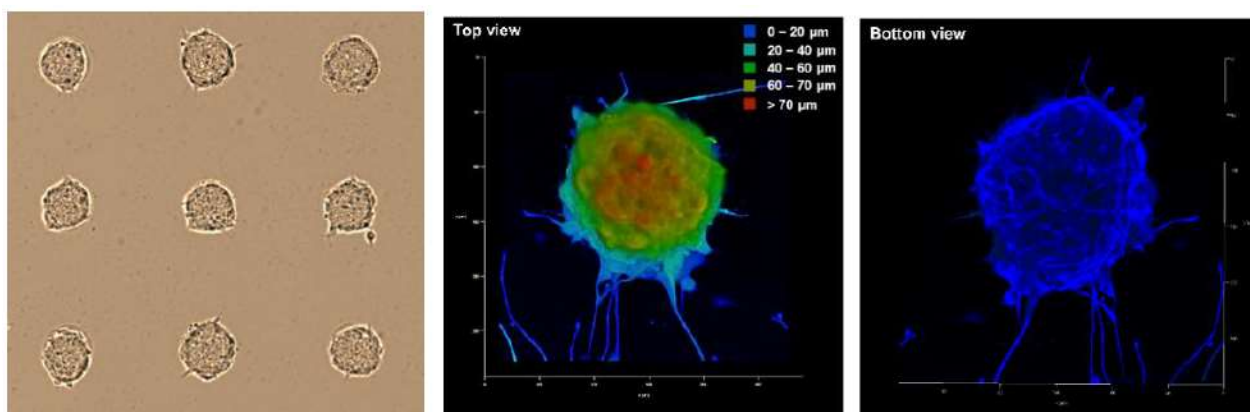


**Figure 2.** Spheroids formation of SHSY-5Y (left). Depth-coded color image of glutamatergic mature-like neural spheroid

For iPSC-derived neuron models, we successfully monitored the real-time formation of cellular aggregates during the first 24 hours, which subsequently differentiated into neurospheres displaying characteristic neural rosette architectures

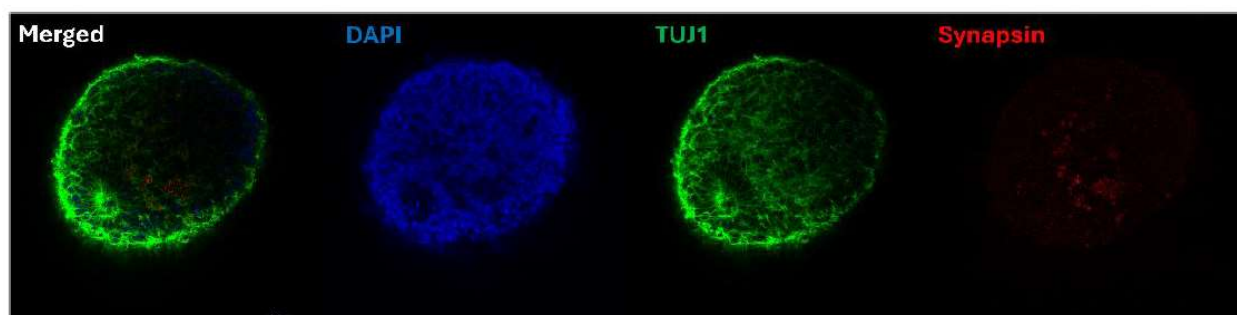


**Figure 3.** Neural Rosettes of iPSC-derived neurons.

#### 4. Conclusion

By leveraging the PAMCELL platform, we successfully optimized the protocol for neural differentiation and enabled the real-time monitoring of functional SH-SY5Y and iPSC-derived neurospheres, providing a powerful platform for next-generation drug screening

**Keywords:** 3D cultures, neurospheres, real-time monitoring, iPSC-derived neurons

## **OM-01 Effect of Tool Geometry on Microchannel Fabrication in Micro Ultrasonic Machining**

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Microchannels form the core structural elements of microfluidic applications, where two or more fluid streams can be manipulated for mixing, separation, and analytical purposes [1,2]. The fabrication of microchannels on hard and brittle materials such as glass, silicon, and ceramics further restricts the applicability of conventional techniques [3-4]. As a result, non-conventional and advanced manufacturing processes have gained attention for microchannel fabrication. Among these, micro ultrasonic machining (micro-USM) has emerged as a promising technique due to its non-thermal nature and low machining forces.

Micro-USM operates on the principle of material removal through the impact of abrasive particles energized by a high-frequency vibrating tool. The process typically employs frequencies above 20 kHz with vibration amplitudes in the range of 10–50  $\mu\text{m}$ . It is particularly effective for machining hard and brittle materials that are otherwise difficult to process. One of the critical challenges in micro-USM is the design and fabrication of suitable micro-scale tools. This work focuses on studying the influence of tool geometry on the quality and characteristics of microchannels fabricated using micro-USM.

### **Experimental Methods and Materials**

Austenitic stainless steel was selected as the tool material due to its adequate strength and machinability. The micro tools were attached to the tool holder using soft soldering to avoid thermal damage or alteration of material properties. The length-to-diameter (L/D) ratio of the tools was selected based on machine constraints, and the total tool assembly weight was maintained below 53 g to ensure effective machining performance. Two different tool geometries were employed (a) Solid cylindrical micro tool and (b) Straight-edge micro tool.

The Solid cylindrical micro tool was fabricated using wire electric discharge grinding (WEDG). In this process, a continuously traveling conductive wire is used to shape a rotating cylindrical workpiece under controlled spark erosion.



**Figure 1:** The WEDG-based fabrication process of micro tools

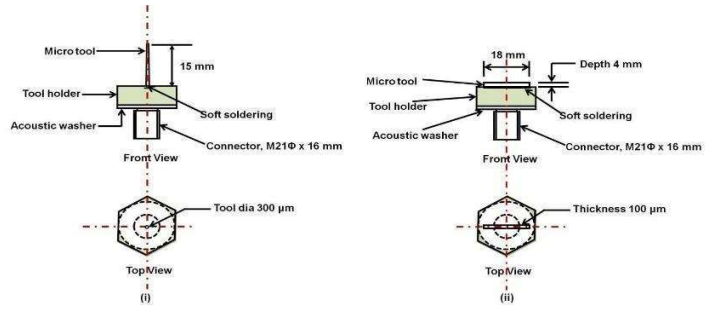


**Figure 2:** The two tool geometries used in the study along with their dimensions

## Results and Discussion

Initial experiments were carried out using the solid cylindrical micro tool, where microchannels were fabricated using a layer-by-layer machining approach. Commercial borosilicate glass slides with a thickness of 2 mm were used as the workpiece material.

Due to the tool motion along the X-direction, a deeper cavity formed at the center of the channel. This phenomenon is attributed to the higher probability of abrasive particle impact beneath the vibrating bottom edge of the tool. Scanning electron microscopy (SEM) images (**Figure 3**) reveal significant out-of-straightness (OOS) and non-uniform channel width along the channel length.

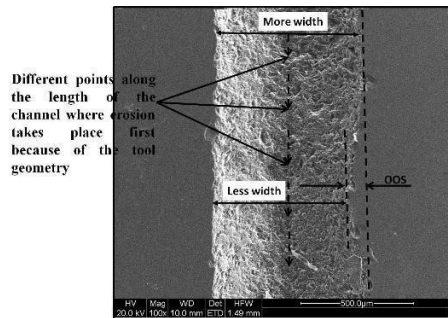


**Figure 3:** A glass  $\mu$ -channel fabricated using Solid Cylindrical Tool

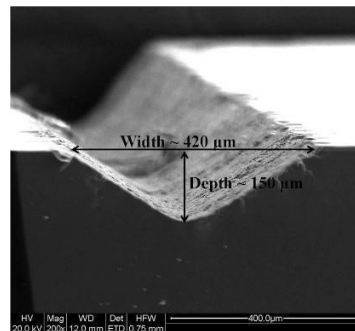


**Figure 4:** A V-Type Channel

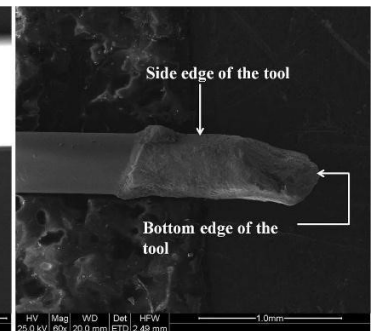


**Figure 5:** Worn Out Micro Tool

Side cutting due to abrasive entrapment between the tool sidewalls and channel walls resulted in tapered channel profiles, leading to the formation of V-shaped microchannels, as shown in **Figure 4**. The approximate channel width and depth were found to be 420  $\mu\text{m}$  and 150  $\mu\text{m}$ , respectively. Tool wear was significant in this case due to the involvement of both bottom and side edges in material removal. SEM micrographs of the worn tool are presented in **Figure 5**.

To overcome the limitations associated with the cylindrical tool, a straight-edge micro tool was employed. This tool geometry enabled contour (die-sinking) machining, allowing the desired channel dimensions to be achieved in a single pass.

Microchannels fabricated using this method exhibited improved dimensional accuracy, smoother kerf surfaces, and the absence of internal cracks. Cross-sectional views of microchannels fabricated on glass and silicon substrates are shown in **Figure 6**. The channels exhibit a cusp-shaped bottom profile, attributed to the rounded edges of abrasive particles. The cusp radius was measured to be

approximately 65  $\mu\text{m}$  for glass and 50  $\mu\text{m}$  for silicon. Variations in cusp geometry are influenced by abrasive size, particle shape, and the number of active abrasive particles involved in machining. Such tapered microchannels can be advantageous for applications involving liquid trapping, lubrication, sensing, and micro heat pipes.

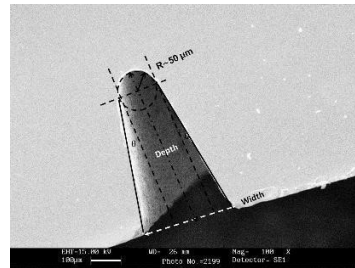
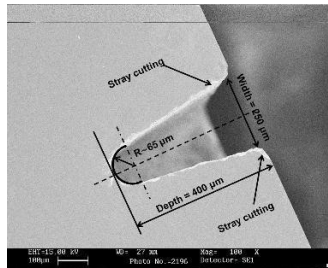


**Figure 6:** Cross-sectional views of microchannels fabricated on (a) glass and (b) silicon using straight-edge tool

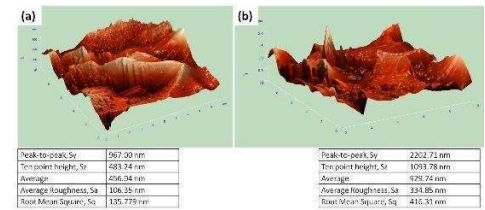


**Figure 7:** 3D surface contour plots of glass microchannels using (a) 1  $\mu\text{m}$  and (b) 10  $\mu\text{m}$  abrasives

Three-dimensional surface topography of machined glass microchannels was analyzed for different abrasive sizes. **Figure 7** shows 3D surface contour plots obtained using fine (1  $\mu\text{m}$ ) and coarse (10  $\mu\text{m}$ ) boron carbide abrasives. The average surface roughness values were found to be 106.35 nm and 334.85 nm, respectively, indicating a significant improvement in surface finish with finer abrasives. Solid cylindrical tools result in layer-by-layer machining with higher tool wear, dimensional inaccuracies, and tapered channel profiles. In contrast, straight-edge micro tools enable single-pass machining with superior dimensional control, improved surface quality, and reduced tool wear.

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## **OL-02 AFMnanoX: Geometry-Aware Analysis of HS-AFM Data Using Intensity and Height Cues**

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### **Introduction**

High-Speed Atomic Force Microscopy (HS-AFM) [1] captures biomolecular structures and dynamics at nanometer spatial and millisecond temporal resolution, producing two-dimensional images in which pixel intensity corresponds to surface height, thereby encoding three-dimensional topography. However, most existing analysis approaches treat HS-AFM data as conventional grayscale images and primarily rely on visual appearance, thereby overlooking the underlying geometric information critical for quantitative structural interpretation. In this study, we introduce AFMnanoX series, an analysis framework that jointly exploits visual intensity and height-derived geometric cues from HS-AFM images. By integrating these complementary cues, AFMnanoX provides a unified pipeline for HS-AFM analysis, supporting preprocessing, robust structural segmentation, and a wide range of downstream tasks, including quantitative measurement, three-dimensional structural reconstruction, object tracking over time, and 3D animation from HS-AFM data sequences.

Visual Data Science, encompassing computer graphics, image and video processing, and computer vision, plays an important role in the biology data analysis, including AFM[1], and cryo-electron microscopy (Cryo-EM)[2]. While Cryo-EM offers high-resolution static structural determination, AFM—particularly HS-AFM—enables high temporal resolution analysis of dynamic biomolecular processes. As AFM data typically contains multiple structures within a single frame, reliable segmentation is a fundamental requirement for downstream tasks. Although deep learning approaches achieve strong performance, they rely on large-annotated datasets, which are rarely available for laboratory-acquired AFM data. To address this limitation, AFMnanoX integrates two complementary pipelines within a unified framework: a traditional, label-free pipeline for fast analysis—such as boundary detection, segmentation, and coarse classification—serves semi-automatic annotation tool, and a deep learning pipeline trained on generated labels to improve accuracy.

Due to conference presentation time limitations, we focused on two representative components of AFMnanoX series: AFMnanoSALQ [3], which supports semi-automatic labeling and quantitative measurement, and AFMnanoSeg, which provides robust segmentation of HS-AFM images. The presented results demonstrate the effectiveness of combining intensity and height-derived geometric cues for reliable object separation and quantitative analysis. Other components are beyond the scope of this presentation and therefore not discussed in detail.

## Experimental methods and materials

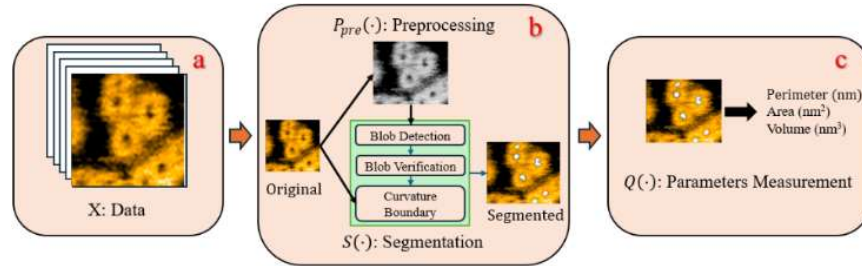
This section describes the AFMnanoSALQ and AFMnanoSeg components evaluated on HS-AFM datasets from [4, 5].

### 1. AFMnanoSALQ:

AFMnanoSALQ [3] is designed as a practical framework for rapid inspection of HS-AFM data, enabling standalone instance boundary detection and quantitative morphological analysis without reliance on labeled datasets. It supports semi-automatic annotation workflows that significantly reduce the effort required to construct labeled datasets. By bridging feature-based analysis and learning-based modeling, AFMnanoSALQ establishes a reliable basis for dataset generation and subsequent validation in deep learning-oriented studies.

$\alpha$ -hemolysin ( $\alpha$ HL)[6-9], a pore-forming toxin from *Staphylococcus aureus* (PDB: 7AHL) [10], is selected as a representative and challenging case. Its characteristic mushroom-like structure makes it well suited for feature-based analysis. While AFMnanoSALQ is tailored to the analysis of  $\alpha$ HL HS-AFM images, the proposed framework remains generalizable and can be readily adapted to other biomolecular systems through appropriate modification of the feature-extraction strategy.

**Figure 1.** Overview of AFMnanoSALQ for  $\alpha$ HL HS-AFM analysis. **(a)** Dataset  $X$  comprises HS-AFM images capturing



$\alpha$ HL dynamics over time. **(b)**  $P_{pre}(\cdot)$  performs preprocessing (e.g., smoothing, grayscale converting, denoising) and  $S(\cdot)$  detects instance boundary of “kernel” in conformations (e.g., oligomers, mushroom-shaped pre-pores, pores). **(c)**  $Q(\cdot)$  computes morphological parameters (e.g., perimeter, area, volume, height). Together, these components form a comprehensive pipeline for quantitative analysis of  $\alpha$ HL developmental stages in HS-AFM data (Copyright © Springer Nature Singapore Pte Ltd 2026).

### 2. AFMnanoSeg:

AFMnanoSeg is the learning-based segmentation component of the AFMnanoX series, built upon Mask2Former and adapted to better capture geometric characteristics of HS-AFM data. Each HS-AFM image is reformulated into a three-channel input  $[\mathbf{dx} = \partial z / \partial x, \mathbf{dy} = \partial z / \partial y, \text{gray-height}]$ , where  $dx$  and  $dy$  denote first-order derivatives that encode local surface gradients, and the gray-height represents surface height. This representation provides complementary information on height magnitude and local geometric variation. To further enhance geometric consistency, the standard Mask2Former loss is extended with additional constraints, including a **SoftIoU Loss** for improved boundary quality and a height based **Pairwise 3D Coherence Loss** that enforces local geometric

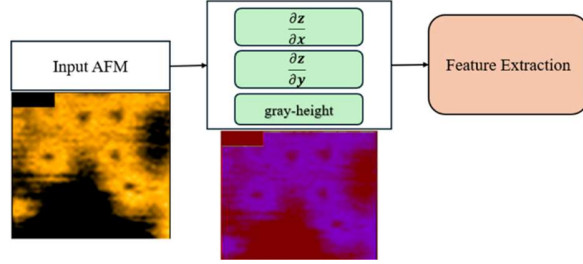
continuity within individual objects. While this study focuses on input and loss-level adaptations, future work will investigate geometry-aware modifications to the attention backbone.

**Figure 2.** Input representation pipeline. The AFM image is transformed into a three-channel input  $[\frac{\partial z}{\partial x} \quad \frac{\partial z}{\partial y} \quad h]$  by computing first-order derivatives gradients and combining them with the gray-height intensity for feature extraction.

### 3. Quantitative Measurement:

Given ordered boundary points  $\{(x_i, y_i)\}_{i=1}^n$ , the perimeter  $P$  is computed by summing Euclidean distances between successive points:

$$P = \sum_{i=1}^n \sqrt{(x_{i+1} - x_i)^2 + (y_{i+1} - y_i)^2}, \quad \#(1)$$



The enclosed area  $A$  is estimated from the boundary using Green's theorem [11]:

$$A = \frac{1}{2} \sum_{i=1}^n (x_i y_{i+1} - x_{i+1} y_i), \quad \#(2)$$

The volume  $V$  is computed by integrating height differences within the segmented region  $D$ :

$$V \approx \sum_{(x,y) \in D} [|h_0 - h(x,y)|] \Delta x \Delta y, \quad \#(3)$$

where  $h(x, y)$  is the local height and  $h_0$  is the boundary baseline.

To convert pixel-based measurements to physical units, the embedded scale bar is automatically detected and extracted text information via OCR.

## Results and Discussion

We prepared a dedicated HS-AFM dataset of  $\alpha$ HL to systematically evaluate AFMnanoSALQ, AFMnanoSeg with UNet, YOLOv8-Seg and Mask2Former.

**Table 1.** Segmentation evaluation averaged over subsets from individual  $\alpha$ HL conformations

| Method             | Intensity Based | Height Based | Detected TP | Miss FN     | Wrong FP    | Precision TP/(TP+FP) | Recall TP/(TP+FN) | F1-score     | IoU        |
|--------------------|-----------------|--------------|-------------|-------------|-------------|----------------------|-------------------|--------------|------------|
| <b>AFMnanoSALQ</b> | <b>Yes</b>      | <b>Yes</b>   | <b>6.26</b> | <b>0.84</b> | <b>0.09</b> | <b>0.986</b>         | <b>0.882</b>      | <b>0.931</b> | <b>90%</b> |
| UNet               | Yes             | No           | 6.55        | 0.17        | 0.47        | 0.933                | 0.975             | 0.954        | 94%        |
| YOLOv8-Seg         | Yes             | No           | <b>6.97</b> | <b>0.08</b> | 0.14        | 0.980                | <b>0.989</b>      | <b>0.984</b> | 89%        |
| Mask2Former        | Yes             | No           | 7.00        | 0.08        | 0.11        | 0.985                | 0.989             | 0.987        | 94%        |
| <b>AFMnanoSeg</b>  | Yes             | Yes          | <b>7.04</b> | <b>0.06</b> | 0.09        | 0.987                | <b>0.992</b>      | <b>0.989</b> | <b>94%</b> |
| Valid_GT           | -               | -            | 7.19        | 0.00        | 0.00        | 1.000                | 1.000             | 1.000        | 100%       |

As shown in **Table 1**, AFMnanoSeg achieves the highest F1-score and IoU, validating the advantage of explicitly modeling intensity–height cues in HS-AFM segmentation. Notably, AFMnanoSALQ, despite being a non-deep learning approach, delivers competitive performance relative to UNet and YOLOv8-Seg, underscoring its practicality for fast analysis and semi-automatic labeling.

**Table 2.**  $\alpha$ HL Pore Measurement Evaluation

| Method                | Num of Sample | Average Perimeter (nm) | Average Area (nm <sup>2</sup> ) |
|-----------------------|---------------|------------------------|---------------------------------|
| Manual by UMEX Viewer | 1109          | 11.58 ± 1.14           | 9.31 ± 1.82                     |
| <b>AFMnanoSALQ</b>    | 1686          | 12.68 ± 2.11           | 10.56 ± 3.58                    |
| PDB, [6-8]            | -             | 9.425 ± 5.03           | 9.08 ± 7.54                     |

Notably, AFMnanoSALQ measured  $\alpha$ HL heights of ~9.94 nm (pre-pore) and ~6.46 nm (pore), in close agreement with reported values [19,35]. Due to imaging artifacts limiting direct volume estimation, the internal pore volume was indirectly estimated from averaged area and height measurements, yielding ~70 nm<sup>3</sup>, consistent with prior studies [6–8]. (**Table 2**)

In conclusion, this study introduces the **AFMnanoX series**, a unified analysis framework that jointly exploits visual intensity and height-derived geometric cues inherent to HS-AFM data. Within this framework, **AFMnanoSALQ** enables rapid, label-free quantitative analysis and semi-automatic annotation, while **AFMnanoSeg** integrates geometry-aware inputs and loss design to achieve state-of-the-art segmentation performance. Beyond the scope of this presentation, several components are already completed or under active development, including **AFMnano3DR-G** for 3D structural reconstruction, **AFMnanoOT** for object tracking, and **AFMnanoAnim**, which integrates molecular dynamics simulations to interpolate HS-AFM frames into continuous time-resolved animations, paving the way toward comprehensive spatiotemporal analysis of biomolecular dynamics.

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## **OM-02** Microstructural Study on Microwave-processed Pure Cu vs Commercial Cu

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In the current study, a comparison is made between microwave-processed pure copper and commercial copper. The domestic microwave oven was used to melt pure Cu at 2.45 GHz and a power level of 900W, with charcoal serving as a susceptor for additional heat development. The microwave-processed pure Cu was melted in 7 minutes. Following this, microstructural characterisation was performed using Field Emission Scanning Electron Microscopy (FESEM) on both microwave-processed pure Cu and commercial Cu. Microstructural analysis revealed a homogeneous hexagonal cellular structure in the microwave-processed pure copper, indicating minimal temperature differences during solidification, while the microstructure of commercial copper shows coarse, equiaxed grains. Porosity analysis of the microwave cast sample shows  $0.81 \pm 0.06$ , whereas commercially cast copper shows  $7.71 \pm 2.89$ .

**Keywords:** *Pure Cu powder, Commercial Cu, Microwave hybrid heating, Microstructural Characterisation*

## **OL-03** Characterization of SARS-CoV-2 Circulated in Viet Nam, 2020-2025

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The emergence of SARS-CoV-2 in late 2019 resulted in a global pandemic with substantial public health impact. Viet Nam initially achieved effective control COVID-19 outbreak through early intervention measures; however, the emergence of novel variants led to four waves of transmission between 2020 and 2022. After a one-year delay, from 2024 to 2025, SARS-CoV-2 was monitored by integrated sentinel surveillance. Throughout these periods, comprehensive laboratory surveillance played a central role in monitoring viral circulation. To examine the characterization of SARS-CoV-2, virus isolation and electron microscopy provided virological characterization and confirmation of viral morphology. In parallel, next-generation sequencing (NGS) enabled genomic surveillance to track viral evolution, variant emergence, and transmission dynamics over time. Integrating epidemiological data with multi-platform laboratory approaches offers critical insights into the circulation patterns of SARS-CoV-2 in Viet Nam and informs ongoing surveillance strategies and preparedness for future emerging respiratory pathogens.

Experimental methods (theoretical/simulation models) and materials

### *Electron microscopy*

SARS-CoV-2 positive samples which successfully isolated on the Vero-E6 cell were selected to prepare for viral morphology by electron microscopy. Transmission electron microscopy was used to visualize viral particles following sample concentration and negative staining. Specimens were examined to assess viral morphology and size by JEM 1010 (JEOL-Japan) in the National Institute of Hygiene and Epidemiology.

### *Next-generation sequencing*

Illumina next-generation sequencing was applied for clinical SARS-CoV-2 with realtime Ct value under 30. Reagents for nucleotide sequencing include RNA extraction kit (Qiagen, USA); SARS-CoV-2 specific primers (Biosearch) and Superfi green master mix (Invitrogen) for DNA amplification, Ampure XP bead for DNA purification; DNA nextra XT for library preparation; MiSeq Reagent Kits v2 (Cartridge and Flowcell) for MiSeq machine.

## **Results and Discussion**

### *Electron microscopy*

The specimens positive for SARS-CoV-2 using realtime RT-PCR were isolated from Vero E6. CPE was monitored daily, and supernatant samples were examined using realtime RT-PCR every two days for verification.

The first two positive samples in February 2020 were subjected to gold-linked grid technique and viral imaging using transmission electron microscopy (TEM) at the National Institute of Hygiene and

Epidemiology. The results confirmed that the isolated virus was a coronavirus, measuring 97-100 nm, with a round shape and surrounding spikes (Figure 1).

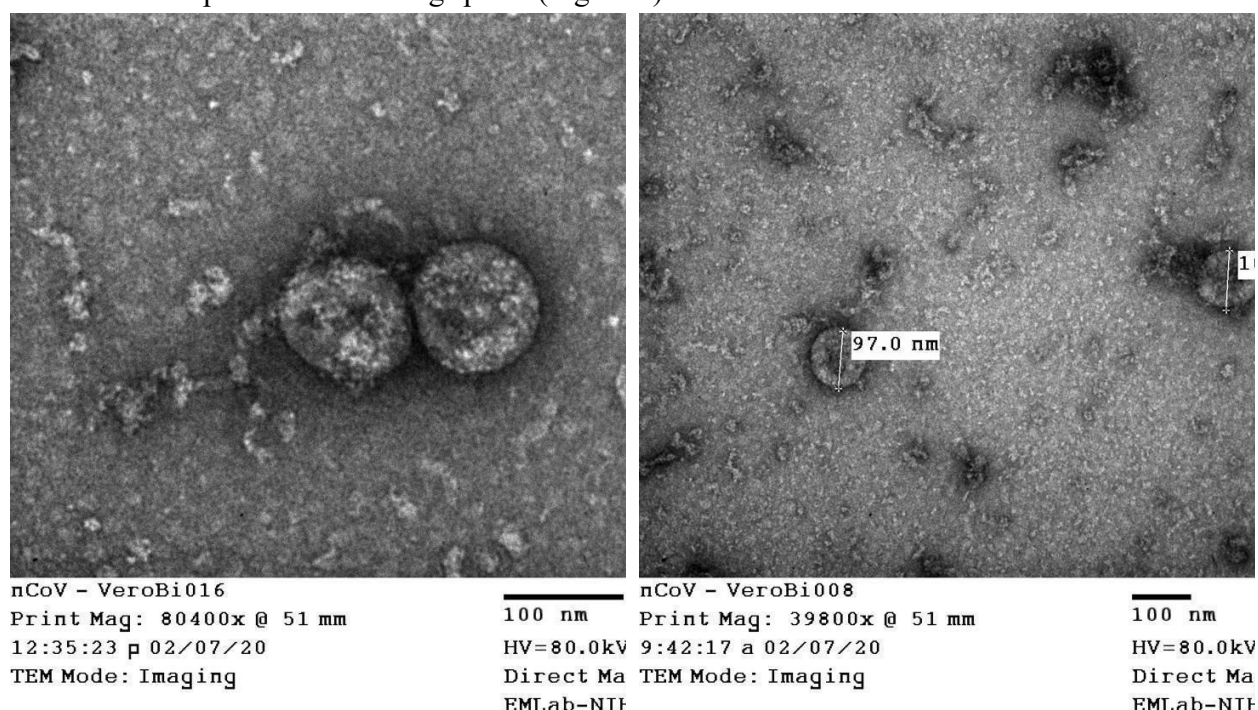


**Figure 1.** Image of SARS-CoV-2 in cell culture supernatant using transmission electron microscopy

Although real-time RT-PCR remains the gold standard for SARS-CoV-2 detection due to its high sensitivity and specificity, TEM offers unique advantages by enabling direct observation of viral particles. This is particularly valuable for verifying viral integrity, assessing sample quality, and supporting virus isolation efforts. In our study, successful visualization by TEM suggests a sufficient viral load and effective sample preparation, highlighting the importance of specimen selection and concentration procedures.

#### *Next-generation sequencing*

The results of analyzing the SARS-CoV-2 virus genome (188 samples) in Northern Vietnam from January 2020 to March 2021 recorded 9 clades of SARS-CoV-2 virus detected in that 5 clades were detected in the community: B; B.1.1; B.1.1.351 and B.1.1.7. The mutation recorded at NSP9 (A 12772C) of clade B.1.1 is a mutation characteristic of virus originating from the outbreak in Da Nang in July 2020 (1). In 2021, a total of 538 samples were processed, showed 92 samples belonged to clade B.1.1.7 (Alpha); 429 samples belonged to clade B.1.617.2 (Delta); and 17 samples belonged to clade BA (Omicron). From January to April 2022, a total of 303 samples were subjected to genomic surveillance in which clade B.1.617.2 (Delta) was decreased sharply (6 samples) and 242 samples belonging to clade BA (Omicron). The Delta variant (B.1.617.2) circulating in Vietnam is divided into 6 sub-clades: AY.1; AY.29; AY.57; AY.75; AY.79; AY.85 and the Omicron variant (BA) has 2 sub-clades: BA1 and BA2 when it first appeared in Viet Nam (2). From this time, the SARS-CoV-2 Omicron variant dominated in community in the world (3). SARS-CoV-2 in 2024 (15 samples) showed that Omicron variant has been varied in 5 sub-clades: JN.1, JN.1.11.1, KP.3, LF.7 and NB.1.8.1 (2 cases). Samples positive with SARS-CoV-2 posed 83,6% (56/67) were in sub-clade

NB.1.8.1; the remains were in 7 sub-clade including JN.1, KP.3.1.1, XEC, LF.7, MV.1, LP.8.1, XPG, shared with 2024 2 sub-variants (JN.1 and LF.7). The number of amino acid substitution was increased significantly and differed among sub-variants, from average 16,7 changes in 2024 to 33,3 changes in 2025 (Figure 2).

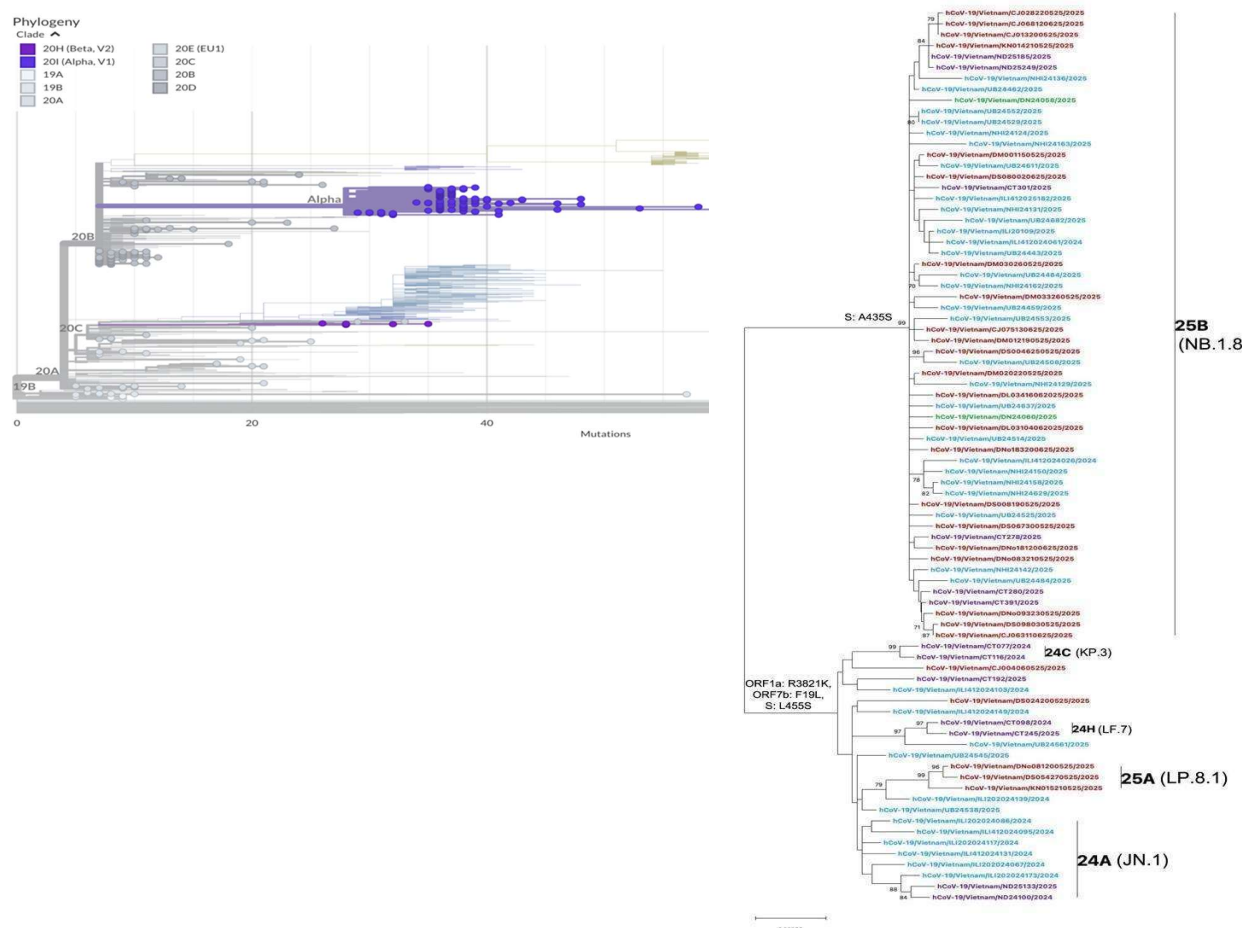


**Figure 2.** A) Phylogenetic tree of SARS-CoV-2 Alpha-2020 B) Phylogenetic tree of SARS-CoV-2 Delta 2021-2022 C) Phylogenetic tree of SARS-CoV-2 Omicron 2024-2025

**Acknowledgements:** We acknowledge the Ultrastructure laboratory-NIHE to have the SARS-CoV-2 image; US-CDC for supporting NGS reagents period of 2020-2022; Program for Research in Epidemic Preparedness and REsponse (PREPARE) Strategic Research Funding - Singapore in partnership with Bill and Melinda Gates, Reference No. PREPARE-SF-2023-006 for NGS surveillance in 2024-2025.

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## **OL-04 Probing structure and mechanical properties of human skin by atomic force microscopy**

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Skin mechanical properties are commonly evaluated at the macroscopic scale, while nanoscale structural and mechanical changes within individual skin layers remain poorly understood [1]. Collagen, the primary structural component of the dermal extracellular matrix, plays a central role in these processes [2]. In this study, we investigated the structure and mechanics of dermal collagen with a particular focus on ageing effects using atomic force microscopy (AFM). Human skin samples spanning five age groups, from young to elderly, were prepared as vertical cross-sections to preserve the native epidermis–dermis architecture. AFM imaging was performed in contact mode to simultaneously acquire high-resolution topography and friction force maps of collagen fibers within the papillary dermis. Collagen ultrastructure was characterized through fiber morphology and D-periodicity analysis. Depth-resolved mechanical properties were obtained using circular mode AFM at controlled distances from the epidermal–dermal junction. In addition, the impact of UV radiation and cream treatments on collagen structure and mechanics was evaluated. The results reveal age-dependent remodeling of dermal collagen, characterized by changes in fiber thickness, D-periodicity, and stiffness. Across all age groups, stiffness increases with increasing depth within the papillary dermis. These findings demonstrate the capability of AFM to provide depth-resolved, nanoscale insights into collagen structure and skin ageing.

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## POSTER PRESENTATIONS

### **PP-01** Contribution of Xyloglucans to Growth and Development at the Cell Level in *Arabidopsis thaliana*

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Plant cells are enclosed by a stiff cell wall (CW), which not only protects the cell but also controls its growth and shape. Cellulose, pectin, and hemicellulose are known as the main components of the cell wall (CW). Among them, xyloglucan is a hemicellulose that plays an important role in maintaining the structure and mechanical properties of the CW by connecting cellulose microfibrils. The significant roles of xyloglucan in plant growth and development have been documented at the organ and whole plant level. For example, mutants lacking xyloglucan exhibit clear phenotypes such as slower growth and smaller overall size. In this study, we aim to understand how xyloglucan contributes to plant growth and development in greater detail. For that, we quantitatively compared growth and development at the cell level in the wild-type *Arabidopsis* and the mutant *xxt1 xxt2* lacking xyloglucan by analyzing a series of 3D confocal images taken over 7 days. The MorphoGraphX software was used to analyze and compare important aspects such as cell size, cell growth rate, growth pattern, directions of growth, and cell division rate. The results showed that the lack of xyloglucan synthesis reduces the rate of cell growth and division, and causes loss of growth direction, which eventually leads to more rounded and smaller organs in the mutant. Overall, this study combines advanced imaging and image analysis to give a better understanding of the roles of xyloglucan in plant development.

**Keywords:** *cell wall, xyloglucan, xxt1 xxt2, morphogenesis, plant development*

## PP-02 Self-assembly of DNA origami crystals

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DNA origami provides a bottom-up route to assemble three-dimensional nanoscale architectures with high geometric precision, overcoming the resolution limits of conventional nanofabrication [1]. In this work, I focus on the crystallization and silicification of simple cubic lattices formed from 18-helix-bundle cross-shaped DNA origami monomers with a unit cell size of about 50 nm. The monomers are folded from a long single-stranded scaffold by thermal annealing in Mg<sup>2+</sup> buffer, purified via PEG-based centrifugation, and then directed to crystallize into extended 3D cubic lattices by programming their blunt ends with either shape-complementary or shear connections mediated by flexible poly-T DNA adapters with reinforcing G-C pairs. Subsequent silicification conformally solidifies the DNA framework, preserving the cubic symmetry while significantly enhancing mechanical robustness [2]. These results show that DNA origami-derived cubic crystals can be reliably transformed into inorganic scaffolds, offering a versatile platform for future integration of plasmonic or other functional nanocomponents.

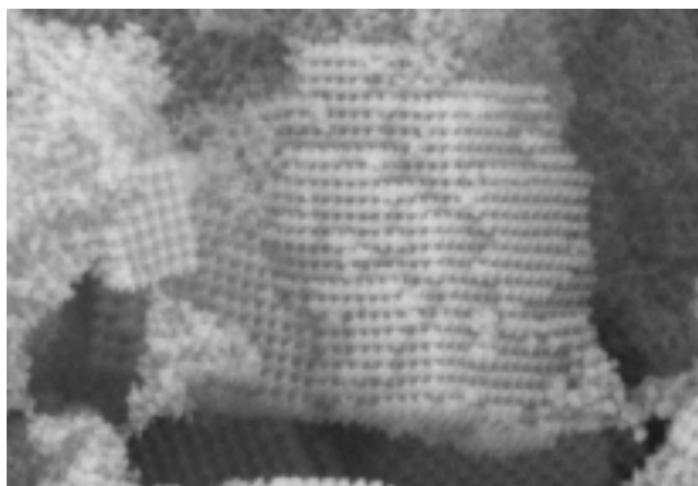


**Figure 1.** 3D DNA origami cubic crystal. (scalebar = 100 nm)

*Acknowledgements:* This work is supported by Mobility grant by University of Warsaw

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**Keywords:** *DNA origami, self-assembly, silicification*

## **PP-03 Applications of Transmission Electron Microscope in the Study on Morphology and Structure of Nanoparticles**

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Research on nanostructured materials plays a crucial role in the development of science and real-life applications. Transmission electron microscopy (TEM) is one of the most important and effective analytical techniques for investigating such materials. With angstrom-level resolution, TEM enables direct observation of the morphology, particle size, size distribution, and crystalline structure of nanoparticles. This article provides an overview of the principles and fundamental mechanisms of TEM in acquiring morphological and structural information from TEM images, and results in representative applications of TEM in the study of inorganic, organic, and biological nanoparticles at Institute 69. At the same time, it emphasizes that TEM is an indispensable tool in nanoscience and nanotechnology.

***Keywords:*** *Transmission electron microscopy, TEM, nanoparticles, morphology, crystal ultrastructure.*

## **PP-04 Optimization of Excitation Wavelength for SERS Detection of Dopamine Using Ag-Decorated ZnO Nanofibers**

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The rapid and sensitive detection of dopamine (DA) is critical for the early diagnosis of neurological disorders such as Parkinson's and Alzheimer's disease. In this work, we report the successful fabrication of a high-performance Surface-Enhanced Raman Spectroscopy (SERS) substrate based on Silver/Zinc Oxide (Ag/ZnO) nanocomposites. The substrate comprises ZnO nanofibers synthesized via electrospinning, which were subsequently decorated with Ag nanoparticles using a facile UV irradiation photoreduction method. This hierarchical structure combines the high surface area of ZnO nanofibers with the intense electromagnetic enhancement of Ag nanoparticles. A key focus of this study was investigating the influence of excitation wavelength on the SERS performance. We compared the Raman signal enhancement of dopamine under 532 nm and 638 nm laser excitations to determine the optimal resonance conditions. Furthermore, Raman mapping was employed to track the signal uniformity and verify the distribution of "hot spots" across the substrate. The results demonstrate that the Ag/ZnO nanofibers provide a stable and sensitive platform for dopamine detection, with signal intensity heavily dependent on the chosen excitation laser. This work offers a promising strategy for developing efficient, label-free biosensors for neurotransmitter monitoring.

## **PP- 05** Effect of synthesis time on the optical properties of Co-doped CdSSe Semiconductor quantum dots

Nguyen Thi Thu Hoan<sup>1,2</sup>, Giap Tung Duong<sup>1</sup>, Bui Thi Huyen Chang<sup>1</sup>, Nguyen Van Truong<sup>1</sup>, Nguyen Xuan Ca<sup>2</sup>, Do Thi Hue<sup>3</sup>, Vu Thi Kim Lien<sup>4</sup>, Nguyen Thi Hang Nga<sup>5</sup>, Pham Van Duong<sup>6</sup>, Pham Thanh Hieu<sup>7</sup> and Pham Minh Tan<sup>7\*</sup>

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Semiconductor quantum dots exhibit strong quantum confinement-induced optical and electronic properties, making them attractive for optoelectronic and energy-related applications. Ternary CdSSe QDs are particularly promising due to their tunable band gap, while transition-metal doping can further tailor optical, electronic, and magnetic properties. However, controlling dopant incorporation remains challenging, as synthesis parameters strongly affect material properties. This study investigates how synthesis time influences the structural and optical characteristics of Co-doped CdSSe quantum dots.

### **Experimental methods**

S and Se precursors were dissolved in ODE and TOP at 100 °C to generate S<sup>2-</sup> and Se<sup>2-</sup> solutions with a controlled S/Se ratio. CdO was reacted with OA and ODE at 200 °C for 50 min to form a Cd<sup>2+</sup> solution. Co(NO<sub>3</sub>)<sub>2</sub>·6H<sub>2</sub>O was dissolved in TOP and ODE at 100 °C for 60 min to prepare a Co<sup>2+</sup> solution with an adjusted Co/Cd ratio. The Co<sup>2+</sup> solution was mixed with the Cd<sup>2+</sup> solution, and the S<sup>2-</sup>/Se<sup>2-</sup> solution was swiftly injected at 280 °C. After 60 min of reaction, CdSSe:Co quantum dots were obtained..

### **Results and Discussion**

In this study, Co-doped CdSSe quantum dots (CdSSe:Co QDs) were successfully synthesized via a wet-chemical route, and the influence of reaction time (1–60 min) on their structural and optical properties was systematically investigated. Structural characterization confirmed the formation of ternary alloy CdSSe with a zinc-blende crystal structure, while Co<sup>2+</sup> ions were effectively incorporated into the host lattice rather than merely adsorbed on the surface.

XRD analysis revealed diffraction peaks corresponding to the (111), (220), and (311) planes of the zinc-blende phase, with the (111) peak located between those of CdS and CdSe, confirming alloy formation. Upon Co doping, a slight shift of diffraction peaks toward lower angles was observed, indicating lattice contraction due to the substitution of larger Cd<sup>2+</sup> ions by smaller Co<sup>2+</sup> ions. The average crystallite size, estimated using the Debye–Scherrer equation, remained in the ultrasmall regime (~2 nm), which is essential for strong quantum confinement effects.

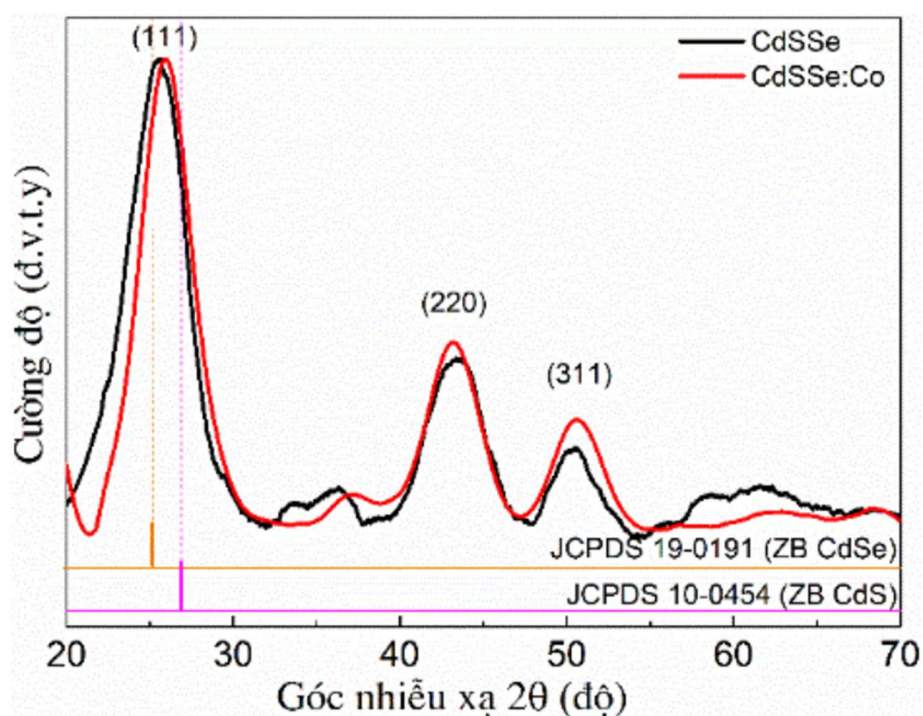


**Figure 3.** XRD patterns of CdSSe and Co-doped CdSSe quantum dots with a Co concentration of 8% synthesized at a reaction time of 30 mins.

Compositional analysis using EDX and EDX mapping demonstrated the presence and uniform distribution of Cd, S, Se, and Co throughout the samples. The experimentally determined Co content (~6.88 wt%) was slightly lower than the nominal doping level (8%), which can be attributed to limitations of EDX quantification and partial dopant incorporation during synthesis. FTIR spectra further confirmed the presence of residual organic ligands on the QD surface and, importantly, revealed a characteristic Co–S vibrational mode, providing strong evidence for Co incorporation into the CdSSe lattice.

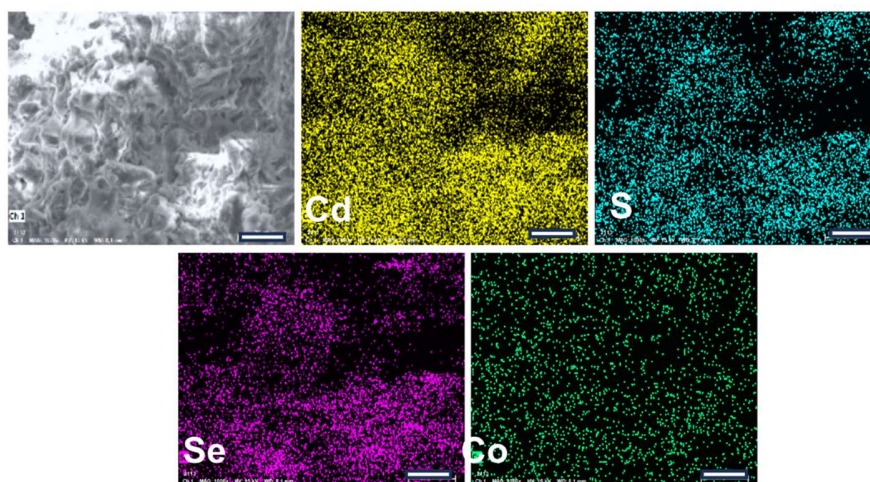


**Figure 5.** EDX mapping of QDs CdSSe doped Co

Optical measurements showed that reaction time plays a critical role in tuning the photophysical properties of CdSSe:Co QDs. UV–Vis absorption spectra exhibited a red shift of the excitonic absorption edge with increasing reaction time, indicating particle growth and a gradual reduction in quantum confinement. Correspondingly, photoluminescence (PL) spectra displayed a pronounced shift of excitonic emission from 408 nm to 516 nm, along with enhanced low-energy emission associated with defect-related or dopant-induced states.

Time-resolved photoluminescence measurements revealed a significant decrease in fluorescence lifetime from 26 ns to 8.38 ns as the reaction time increased. At the same time, the photoluminescence quantum yield dropped sharply from 46.29% to 0.53%. This behavior is attributed to several concurrent mechanisms: (i) an increased density of structural defects at longer reaction times, (ii) the introduction of mid-gap states associated with  $\text{Co}^{2+}$  ions that act as non-radiative recombination centers, and (iii) the weakening of quantum confinement effects and increased particle aggregation as QD size increases.

Overall, these findings demonstrate that synthesis time is a key parameter governing dopant incorporation, defect formation, and exciton dynamics in Co-doped CdSSe quantum dots. While Co doping introduces additional electronic states that can tailor emission characteristics, excessive reaction time leads to severe quenching of photoluminescence. This trade-off highlights the importance of precise kinetic control during synthesis to optimize optical performance. The results provide valuable insight into the design of transition-metal-doped ternary QDs for potential applications in optoelectronics, photocatalysis, and multifunctional nanomaterials.

**Acknowledgements:** This research was funded by the National Foundation for Science and Technology Development (NAFOSTED) Project Number: 103.02-2021.147.

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**Keywords:** *CdSSe, quantum dots, cobalt, optical properties*

## **PP-06** Synthesis and Surface Modification of Rice Husk-Derived Activated Carbon with Metal Oxide Nanoparticles for Enhanced H<sub>2</sub>S Removal

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The growing demand for sustainable environmental technologies has intensified research into biomass-derived carbon materials. Hydrogen sulfide (H<sub>2</sub>S), a toxic and corrosive gas prevalent in biogas, poses significant risks to human health and industrial infrastructure. This study investigates the development of efficient, low-cost adsorbents using rice husk, an abundant agricultural byproduct in Vietnam. Activated carbon (AC) was synthesized through carbonization at 450–650 °C, followed by chemical activation with 1 M KOH for 4 hours. To optimize H<sub>2</sub>S removal, the AC surface was modified with iron oxide and copper oxide nanoparticles, followed by calcination at 350 °C. The structural and elemental characteristics of the samples were systematically analyzed using scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDS), while the crystalline phases of the metal oxides were identified via X-ray diffraction (XRD). H<sub>2</sub>S removal performance was evaluated using a fixed-bed system under constant flow conditions, monitoring breakthrough concentrations over time. Preliminary results demonstrate that surface modification significantly enhances H<sub>2</sub>S removal capacity, revealing a synergistic effect between the metal oxide nanoparticles and the porous carbon framework. These findings suggest that the developed composite is a promising, sustainable, and cost-effective material for biogas purification, contributing to both environmental protection and the value-added utilization of agricultural waste.

***Keywords:*** Rice husk; activated carbon; biogas purification; FeO; CuO.

## **PP-07** Applying Electron Microscopy on the Studying of Photocatalysts

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### **Introduction**

Electron microscopy is now a fundamental method in modern materials science, enabling direct access to morphology and interface information at the nanoscale. In photocatalysis systems, the performance of catalysts is determined by morphological features, specific surface area, crystalline structure, and optical properties. Electron microscopy provides highly visual information about the structural configuration of materials, thereby combining spectroscopy methods and various analytical techniques to specifically determine the properties and characteristics of the materials.

In this work, we systematically employ field-emission scanning electron microscopy (FE-SEM) and high-resolution transmission electron microscopy (HRTEM) to evaluate the morphological and structural characteristics of photocatalytic nanomaterials. We observed the morphology of various materials including layered materials, granular materials, and nanocomposite materials.

FE-SEM analyses reveal hierarchical morphologies constructed from nanosheets and nanocrystals, which are highly favorable for increasing specific surface area and enhancing light absorption. Complementarily, HRTEM enables atomic-scale visualization of exposed crystal facets and well-defined heterojunction interfaces, offering direct evidence of lattice continuity, interfacial coherence, and defect distribution that critically influence charge separation and migration.

### **Experimental**

The fabrication methods of photocatalysts are described elsewhere with various method, including sol-gel (BiOCl, BiOBr), solvothermal (NiTiO<sub>3</sub>), thermally polymerizing (bulk graphitic carbon nitride g-C<sub>3</sub>N<sub>4</sub>), chemical oxidation (graphene oxide) [1-4]. Field-emission scanning electron microscopy (FE-SEM; JSM-600F JEOL or Regulus 8100, Hitachi) and high-resolution transmission electron microscopy (HRTEM, JEM-2100F, JEOL, Japan) were employed to analyze the morphologies of photocatalysts.

### **Results and Discussion**

#### ***Layered materials***

The layered morphology of sheet-like materials can be clearly observed by transmission electron microscopy (TEM), with graphene oxide serving as a representative example. TEM images reveal thin, transparent, and wrinkled nanosheets with lateral dimensions extending to several micrometers, indicating successful exfoliation into few-layer or single-layer structures. The contrast variations across the sheets suggest differences in thickness and local stacking of graphene oxide layers. In addition, folded edges and overlapping regions are frequently observed, further confirming the flexible and layered nature of the material. The TEM images observed in **Figure 1** provide direct evidence of the two-dimensional structure characteristic of graphene oxide.

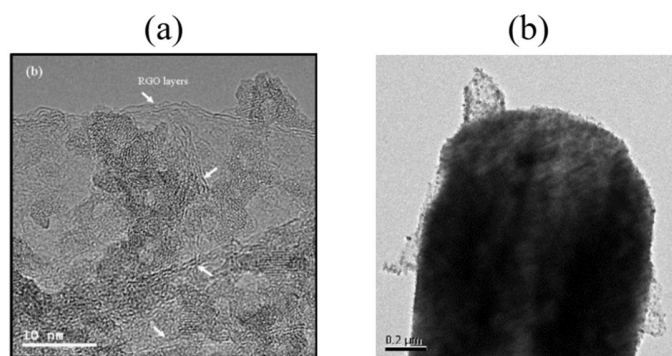


**Figure 1.** HR-TEM images of (a) rGO and (b) a thin layer of rGO encapsulated NiTiO<sub>3</sub> particles. [2]

### ***Sheet materials***

A representative example of layered materials is bismuth oxyhalide (BiOX, X = Cl, Br). Either BiOCl or BiOBr nanosheets have an average thickness of 15 nm and a surface area of approximately 100 nm. Interestingly, these individual sheets do not stand alone but often self-assemble into hierarchical flower-like structures with an overall size of about 0.7 μm, as can be seen in **Figure 2**. This 2D structure significantly increases the contact area and creates gaps (pores) that allow light to be scattered multidimensionally within the material, thereby enhancing light absorption efficiency.

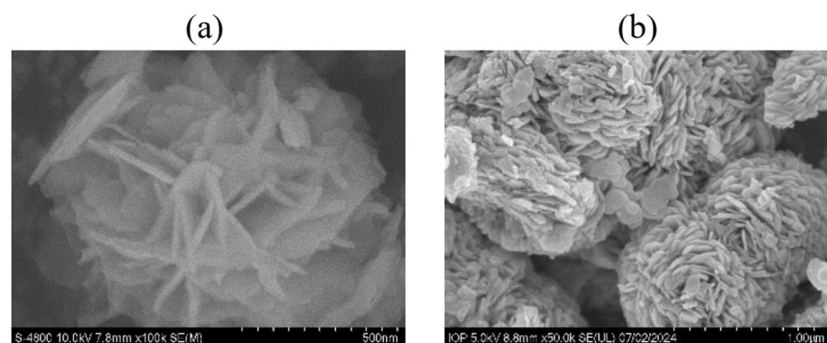


**Figure 2.** SEM images of (a) BiOCl and (b) BiOBr [1].

### ***Granular materials***

Granular/Nanocrystals such as NiTiO<sub>3</sub>, TiO<sub>2</sub> have uniform sizes ranging from 1 to 100 nm. In the field of photocatalysis, feature small particle size would optimize specific surface area, creating high active center density. Highly crystallized nanoparticles ensure rapid charge transport, minimizing electron-hole pair recombination. These characteristics can be studied via FE-SEM and HR-TEM, respectively (**Figure 3**).

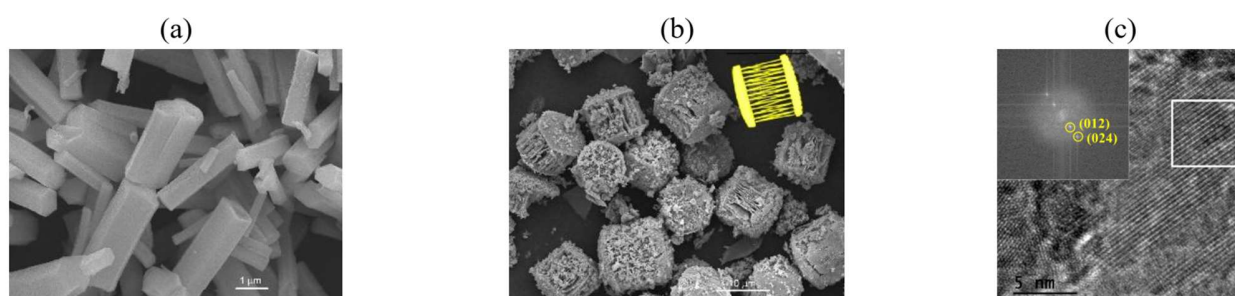


**Figure 3.** (a, b) FE-SEM images of NiTiO<sub>3</sub> synthesized under different conditions and (c) HRTEM images with FFT patterns (inset) of corresponded NiTiO<sub>3</sub> [2].

### Nanocomposites

**Figure 4** shows The morphology and microstructure of the BiOCl/g-C<sub>3</sub>N<sub>4</sub> and NiTiO<sub>3</sub>/rGO nanocomposites were investigated by scanning electron microscopy (SEM) and transmission electron microscopy (TEM). SEM images reveal a heterogeneous but well-integrated architecture, where BiOCl and NiTiO<sub>3</sub> particles are uniformly distributed on the layered g-C<sub>3</sub>N<sub>4</sub> and rGO substrates, respectively. TEM observations further confirm the intimate interfacial contact between the inorganic components and the two-dimensional supports, with no obvious agglomeration detected. Distinct contrast differences and clear particle boundaries in the TEM images indicate the successful anchoring of the nanophases onto the layered matrices. These combined SEM and TEM results demonstrate the effective construction of the nanocomposite structures with enhanced interfacial interactions.

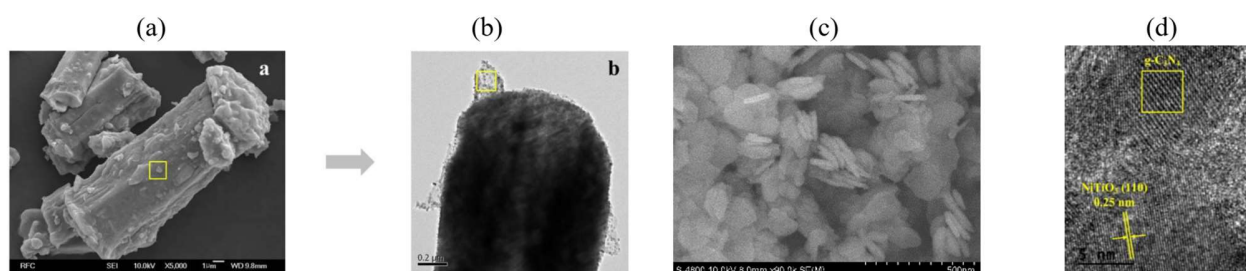


**Figure 4.** (a, b) FE-SEM and HR-TEM images of NiTiO<sub>3</sub>/rGO nanocomposite [2], respectively, (c) FE-SEM image of BiOCl/g-C<sub>3</sub>N<sub>4</sub> [3] and (d) HR-TEM image of NiTiO<sub>3</sub>/g-C<sub>3</sub>N<sub>4</sub> [4].

### Results and Discussion

Overall, this study underscores the critical role of electron microscopy techniques, including FE-SEM and HR-TEM, in elucidating the surface morphology and interfacial structures of photocatalytic materials. The detailed structural insights obtained provide a robust foundation for the rational design and optimization of next-generation photocatalysts aimed at sustainable energy conversion and environmental remediation.

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**Keywords:** photocatalyst, morphology, microscopy

## **PP-08 Preparation of an Oil-Absorbent Material from Recycled Cigarette Butts**

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### **Introduction:**

The rapid development of technology and population growth has caused serious environmental pollution issues [1, 2]. Discarded cigarette butts (CBs) are among the most pervasive forms of environmental litter. Although small, cigarette butts (CBs) are non-biodegradable and contain many toxic chemicals that can leach into water, causing solid waste and water pollution [3, 4]. Moreover, oil spills in oceans and waterways are one of the big problems in water pollution [5]. Lots of materials such as plastic foams, which are derived from polyolefins or polyurethane, are used to soak up oil, but this method creates more plastic waste [6]. Therefore, scientists have studied eco-friendly and renewable materials to solve problems related to waste CBs and oil spills. This study aims to recycle used CBs as new material using a simple and green approach.

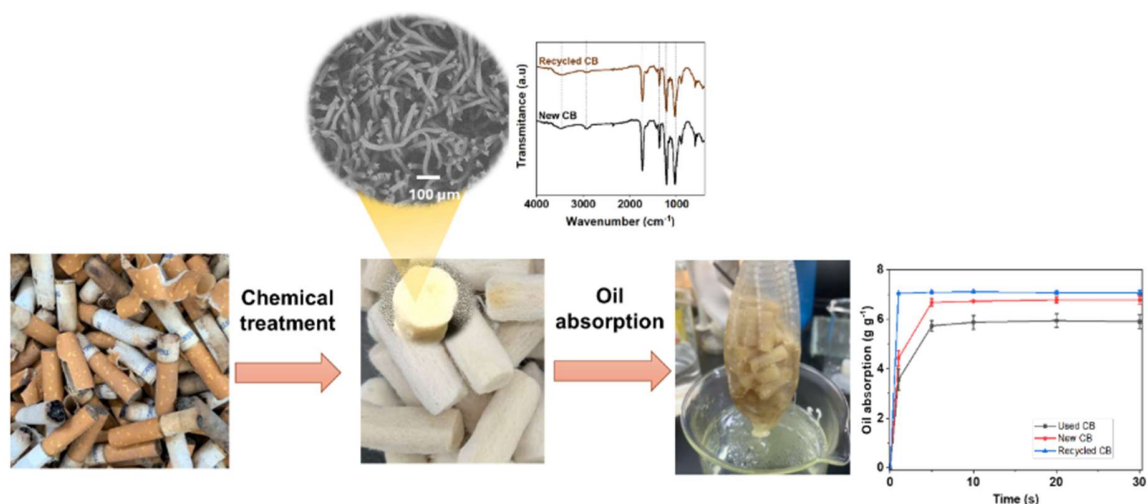
### **Experimental method and material:**

Used cigarette butts (CBs) were collected from various local restaurants and coffee shops in Ho Chi Minh city, Ethanol (99,5%) was purchased from Chemsol (Vietnam). Polydimethylsiloxane (PDMS) was supplied by Truong Thinh Saigon (Vietnam). Distilled water was provided by Ho Chi Minh city of Technology and Engineering (HCMUTE). The used CBs were treated several times with water and ethanol 99% to remove impurities and toxic chemicals and then dried thoroughly in an oven at  $45 \pm 3$  °C. To enhance the surface interaction with oil, the prepared CBs were modified by a dip-coating method using polydimethylsiloxane (PDMS). This modification improved the properties of material.

### **Results and discussion:**

The recycled cigarette butts (CBs) exhibited chemical functional groups similar to those of new CBs, indicating that the chemical composition, particularly for ethyl acetate, was preserved after the recycling process. Scanning electron microscopy revealed that the CBs possessed a highly porous structure. By utilizing the natural sponge-like structure of these cleaned filters, an effective oil-absorbent material was obtained. The results show that the recovered cigarette butt can absorb a large amount of oil ( $7.15 \text{ g g}^{-1}$ ) in a short time (5s). The material is lightweight, facilitating easy to collect after oil absorption. This research indicates the potential application of recycled cigarette butts as low-cost, sustainable, and effective materials for oil spill clean-up.

### **Graphic abstract**



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**Keywords:** cigarette butts, oil spill, oil-absorbent, chemical treatment.

## **PP-09** Design and microscopy-based characterization of sub-micrometer silica particles and liposomal nanostructures for functional material application

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Sub-micrometer carriers are pivotal in drug delivery and environmental remediation. This study presents a comparative investigation into the synthesis and multi-technique characterization of two distinct carrier systems: inorganic sub-micrometer silica particles (SiO<sub>2</sub>) derived from waste cigarette filters and organic Liposomal Nanostructures loaded with *Durio zebethinus* extract. Beyond morphological validation via microscopy, this work comprehensively evaluates the physicochemical properties, surface characteristics, and encapsulation capabilities of templates to optimize their functional applications.

Experimental methods (theoretical/simulation models) and materials

Sub-micrometer silica particles SiO<sub>2</sub> were fabricated via a hard-templating route: recycled cellulose acetate fibers were used as templates, coated with tetraethyl orthosilicate (TEOS), and calcined at 550°C to remove the core. In parallel, liposomes were engineered using the thin-film hydration method, followed by probe sonication to reduce particle size. The structural integrity and physicochemical properties were characterized using a multi-method approach:

Morphology: Field Emission Scanning Electron Microscopy (FE-SEM) and Transmission Electron Microscopy (TEM).

Chemical Structure: Fourier Transform Infrared Spectroscopy (FTIR) and X-Ray Diffraction (XRD).

Surface Properties: Brunauer-Emmett-Teller (BET) analysis for silica surface area. Colloidal

Stability & Efficiency: Dynamic Light Scattering (DLS) for Zeta potential/PDI, and UV Vis spectroscopy for Encapsulation Efficiency (EE%) and drug release profiling. Results and Discussion

Microscopy analysis revealed that the silica particles possessed a uniform spherical morphology (diameter ~ 480 nm) with a distinct hollow structure, resulting from the core removal. FTIR confirmed the formation of the siloxane (Si-O-Si) framework, while BET analysis indicated a mesoporous surface suitable for adsorption.

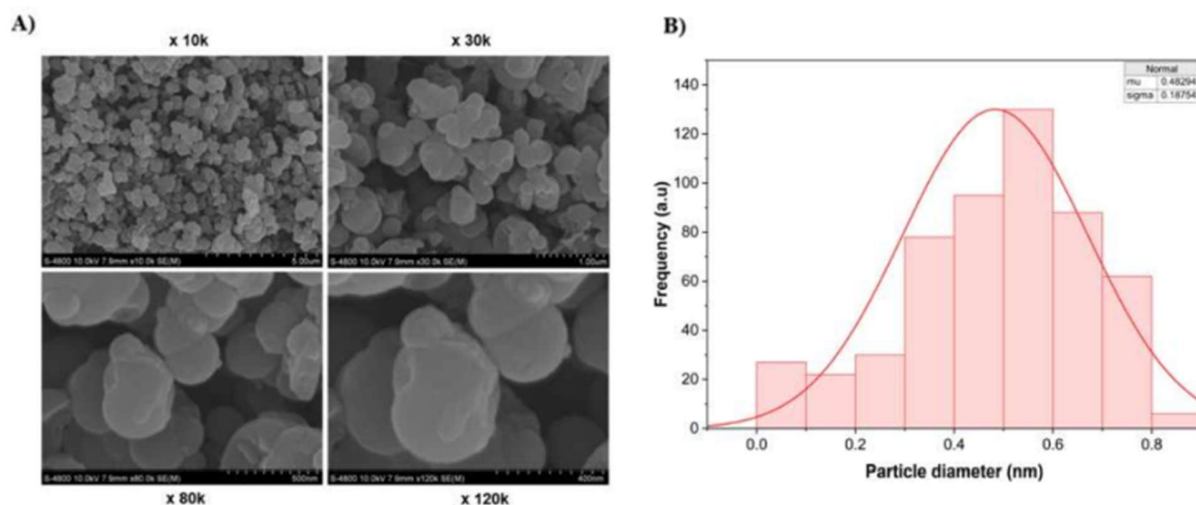


**Figure 1.** A) FE-SEM images of silica Sub-micrometer silica particles; B) Particle size distribution histogram

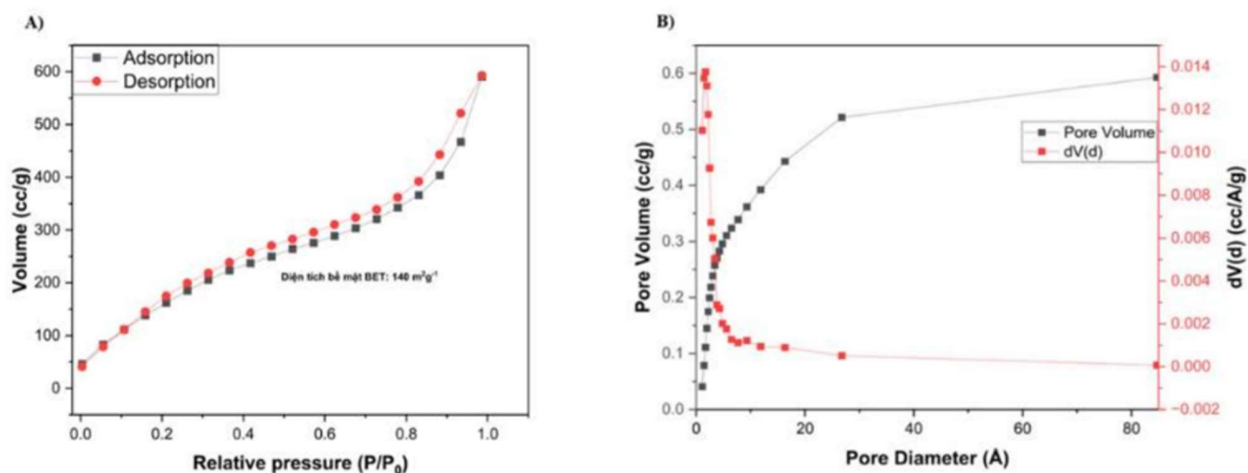


**Figure 2.** A) Nitrogen (N<sub>2</sub>) adsorption-desorption isotherms; B) BJH pore size distribution

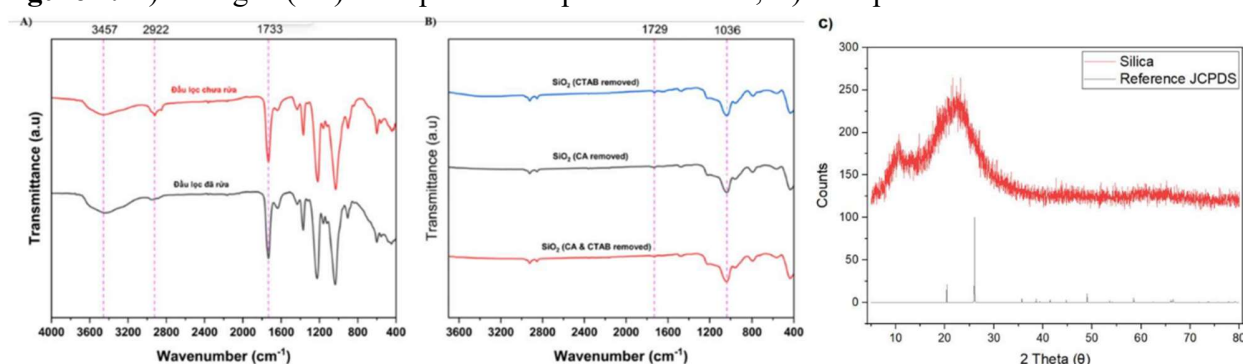


**Figure 3.** Comparative FTIR spectra: A) the waste cigarette filter precursor; B) the synthesized silica particles; C) X-ray diffraction (XRD) patterns.

Conversely, the liposomal nanostructures exhibited spherical vesicles (diameter ~ 106 nm) with high homogeneity (PDI < 0.3) and stability (Zeta potential -40 mV). UV-Vis spectroscopy confirmed high encapsulation efficiency (>80%) for bioactive compounds. These findings underscore the critical role

of microscopy combined with spectroscopic validation in optimizing carrier morphology for specific applications.

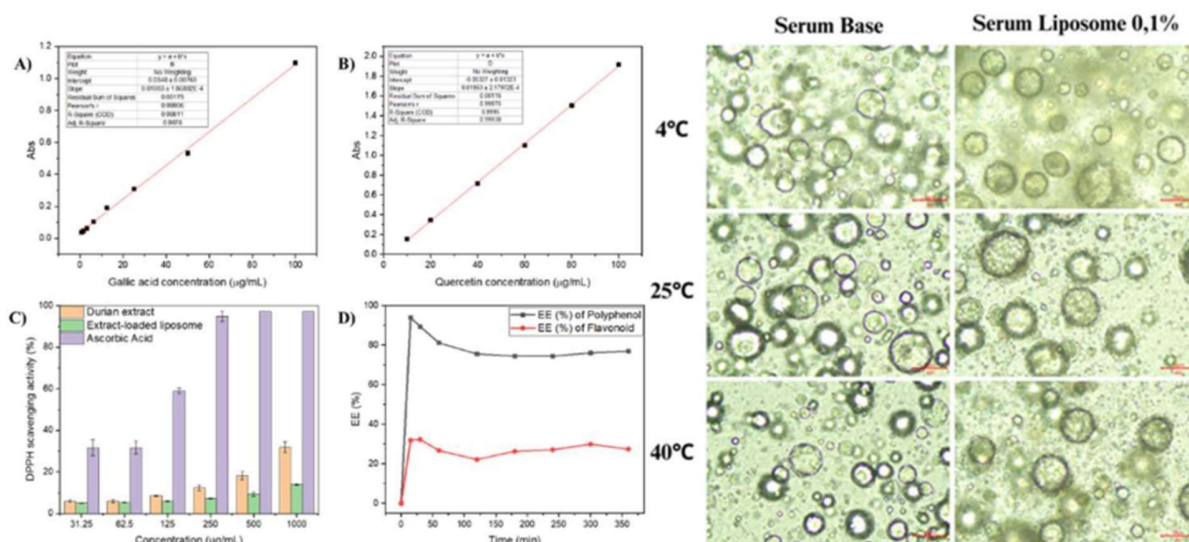


**Figure 4.** The calibration curve of A) Gallic acid and B) Quercetin; C) The DPPH scavenging ability of durian peel extract, and D) The graph expresses the encapsulation rate of phenolic compounds and flavonoids by dialyzing the liposomes over time and Optical micrographs of serum base and 0.1% liposomal serum after 1 month of storage at 4, 25, and 40 °C

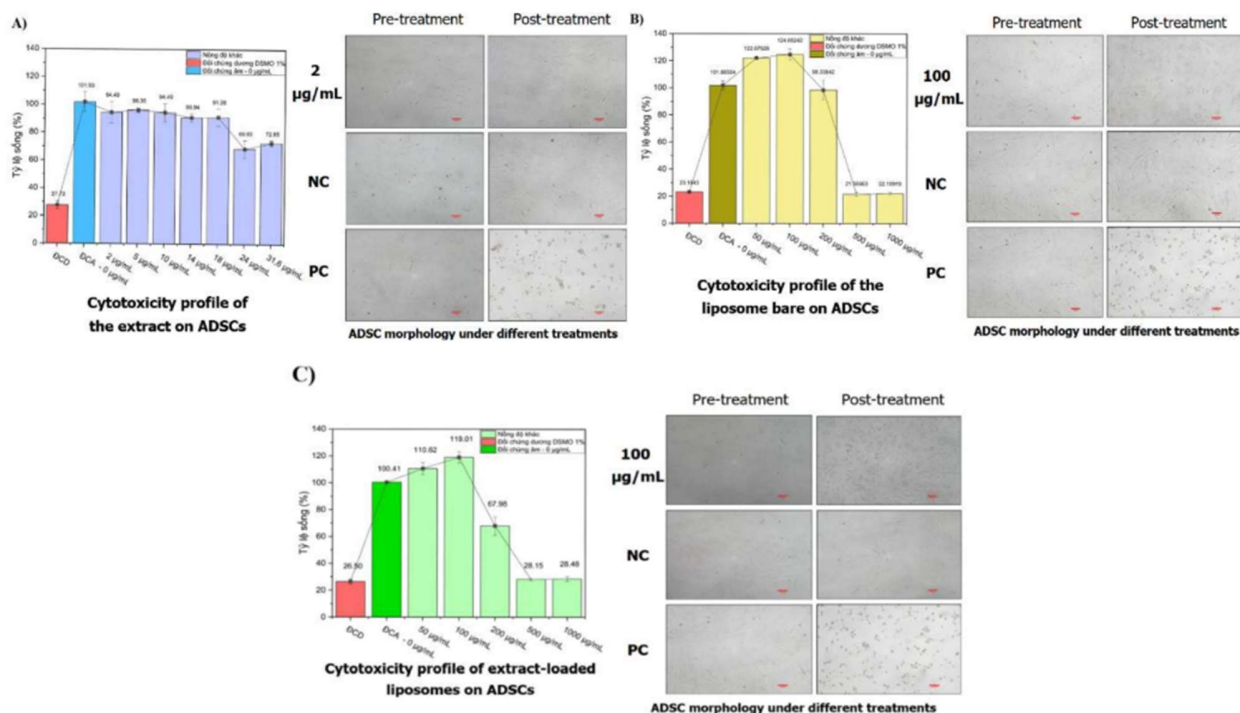


**Figure 5.** Cytotoxicity profiles and morphological observations of ADSCs treated with (A) free extract, (B) bare liposomes, and (C) extract-loaded liposomes.

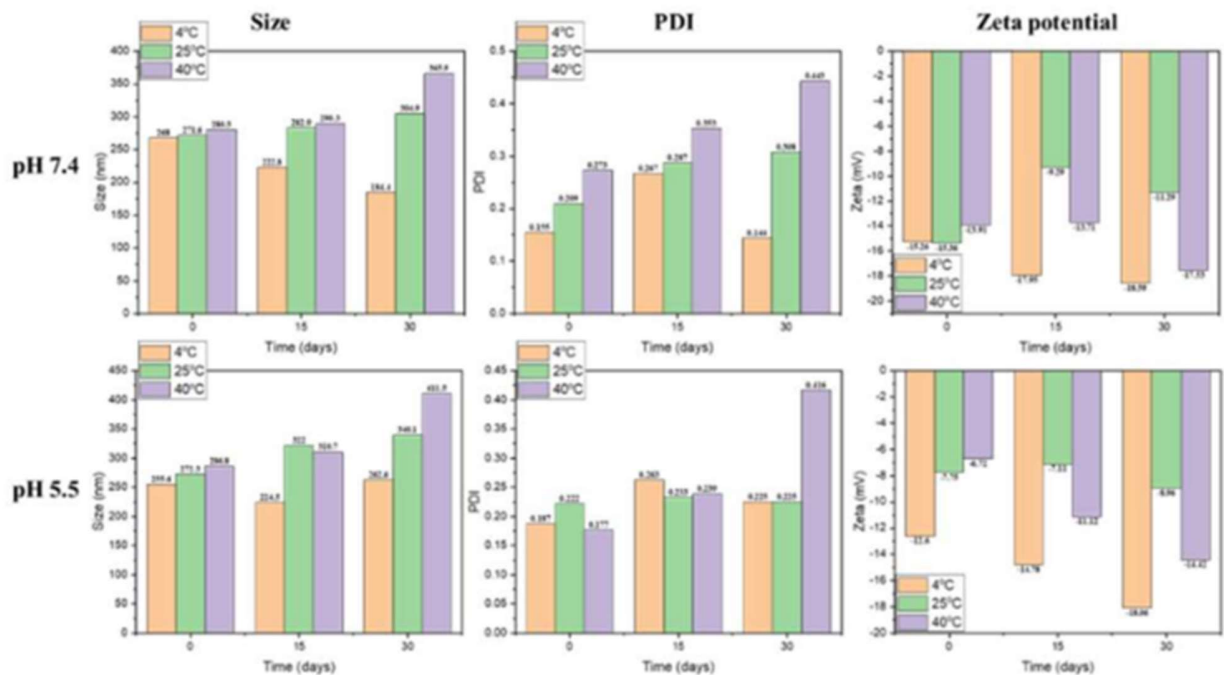


**Figure 6.** pH stability profile of serum formulations stored at 4 °C, 25 °C, and 40 °C over 1 month

Acknowledgements: This research was supported by Ho Chi Minh City University of Technology and Education (HCMUTE) under the student research grant number SV2025-236. The authors also acknowledge the technical support from the Institute of Advanced Technology, Vietnam Academy of Science and Technology (VAST).

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**Keywords:** *Hollow silica, Liposomes, Hard-templating, Thin-film hydration, Microscopy.*

## **PP-10 Growth-Temperature Engineering of Optoelectronic and Thermoelectric Characteristics in In-Doped ZnO Thin Films**

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### **Introduction**

Zinc oxide (ZnO) is a wide-bandgap semiconductor ( $\approx 3.37$  eV) with a high exciton binding energy and favorable optical transparency, making it attractive for optoelectronic devices such as light-emitting diodes, solar cells, transparent electrodes, and sensors. However, intrinsic ZnO typically suffers from limited electrical conductivity due to its moderate carrier concentration, mainly governed by native defects such as oxygen vacancies and zinc interstitials [1] [2][3]. Doping ZnO with group-III elements is a well-established approach to enhance electrical and optical performance. Among these dopants, indium (In) is particularly promising because it can simultaneously improve carrier concentration, electrical conductivity, and optical transparency while maintaining structural stability. Indium-doped ZnO (IZO) has therefore been considered a viable alternative to indium tin oxide (ITO) for transparent conductive oxide (TCO) applications [4]. Our study aims to systematically examine how substrate temperature affects the multifunctional performance of IZO thin films, with an emphasis on achieving an optimal balance between transparency, conductivity, and thermoelectric efficiency.

### **Experimental methods**

Indium-doped ZnO thin films with a doping concentration of approximately 2 at% In were deposited on glass substrates using RF magnetron reactive sputtering. An alloy target composed of high-purity Zn and In (98:2 molar ratio) was employed. Prior to deposition, glass substrates were ultrasonically cleaned in acetone, ethanol, and deionized water, followed by drying and pre-heating to remove residual contaminants. Key deposition parameters included: Base pressure:  $\sim 10^{-6}$ – $10^{-8}$  Torr, working pressure:  $\sim 10^{-3}$  Torr, gas ratio ( $\text{Ar}/\text{O}_2$ ) = 9:1, film thickness:  $\sim 500$  nm, substrate temperatures: 190°C, 220°C, 250°C, and 280°C. These temperature conditions enabled a controlled investigation of growth-temperature-dependent effects on film properties.

### **Results and Discussion**

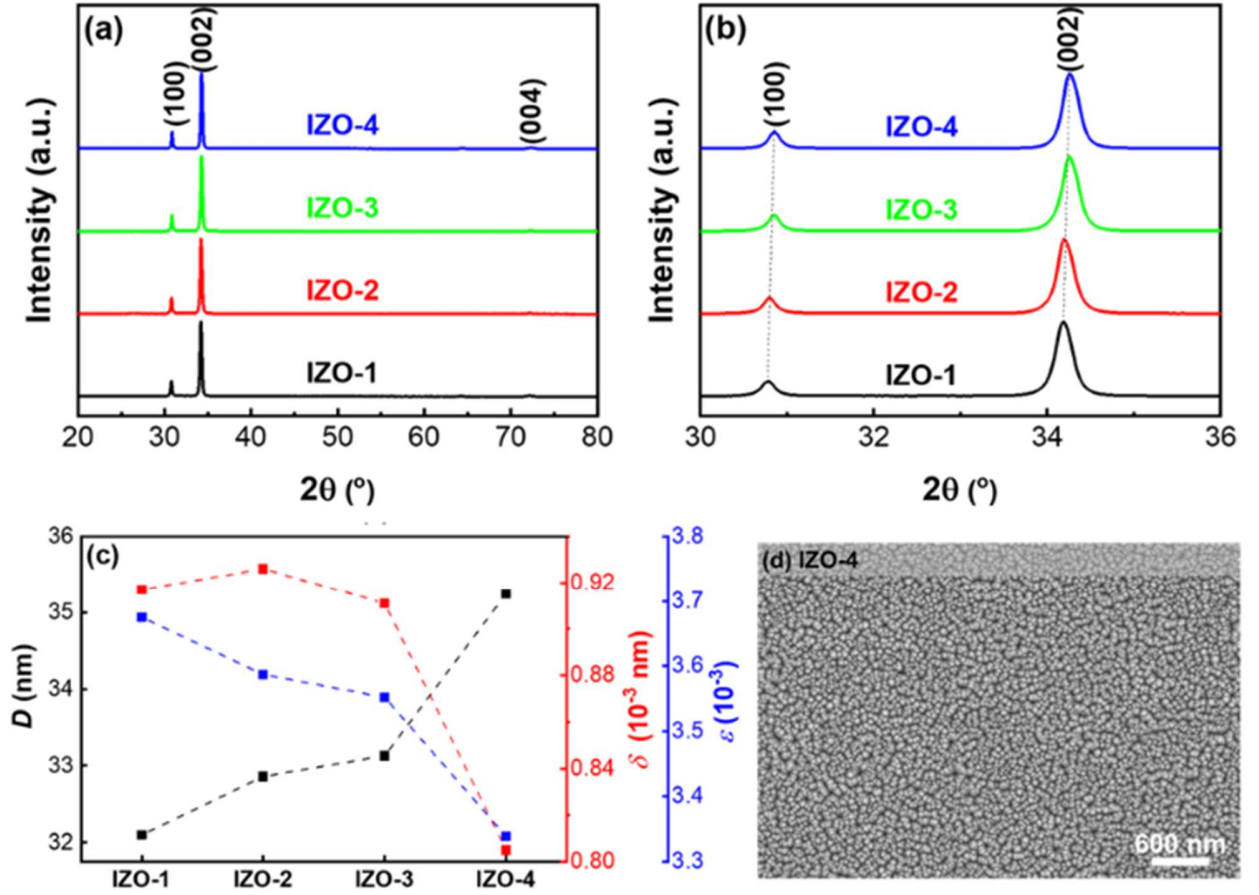


**Figure 1.** (a) XRD pattern of the IZO thin films, with (b) a magnified scale showing the narrow angel range (b). Dependence of crystallite size, dislocation density, and micro-strain on substrate temperature (c), and SEM image of the IZO thin film deposited at 280 °C.

XRD patterns revealed that all IZO films exhibit a hexagonal wurtzite ZnO structure with a strong preferential orientation along the (002) plane, indicating c-axis alignment perpendicular to the substrate surface. As substrate temperature increased from 190°C to 280°C: Crystallite size increased from ~32 nm to ~35 nm, dislocation density and microstrain decreased, diffraction peaks shifted slightly, attributed to ionic radius differences and lattice distortion effects. SEM images further confirmed improved surface morphology at higher temperatures, showing larger grains, smoother surfaces, and well-defined grain boundaries. These trends indicate enhanced atomic mobility and better lattice ordering at elevated substrate temperatures, resulting in improved crystallinity and reduced defect density.

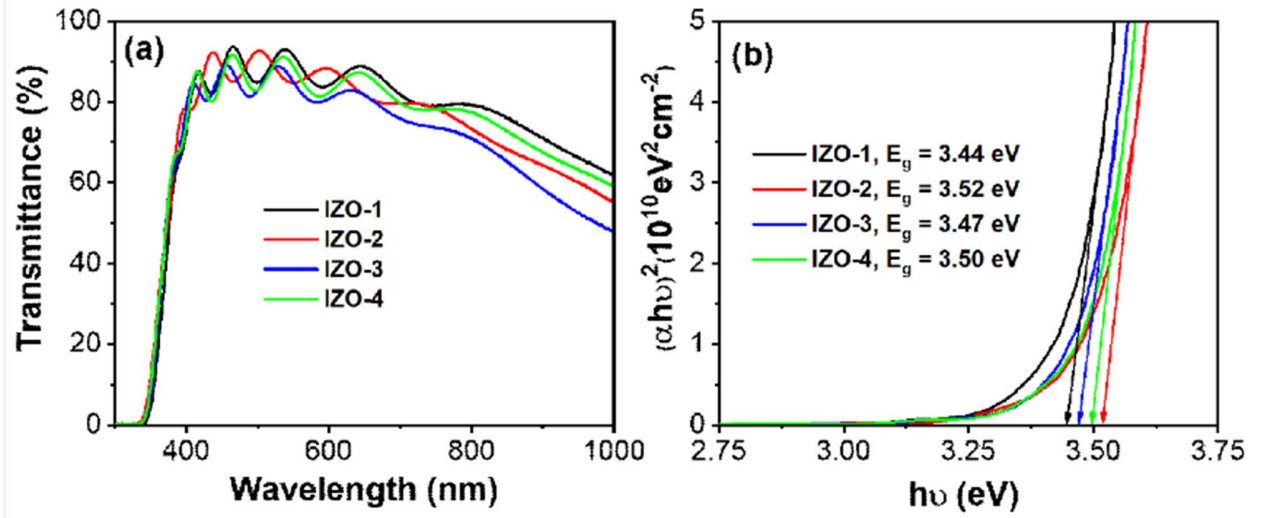


**Figure 2.** Optical transmittance spectra (a) and Tauc plot (b) of IZO thin films at various growth temperatures.

The UV–Vis transmission spectra demonstrated high transparency in the visible region for all samples, with average transmittance values exceeding 80–85%. A strong absorption edge appeared below 400 nm, corresponding to intrinsic ZnO band-to-band transitions. The optical bandgap ranged from 3.44 to 3.50 eV, exhibiting a slight increase with substrate temperature. The behavior is commonly attributed to the Burstein–Moss effect, where increased carrier concentration fills the lower conduction band states, effectively widening the optical bandgap. Minor variations were also associated with lattice strain and electron–electron interactions. The retention of high transparency alongside improved electrical conductivity confirms that IZO films maintain desirable TCO characteristics across the investigated temperature range.

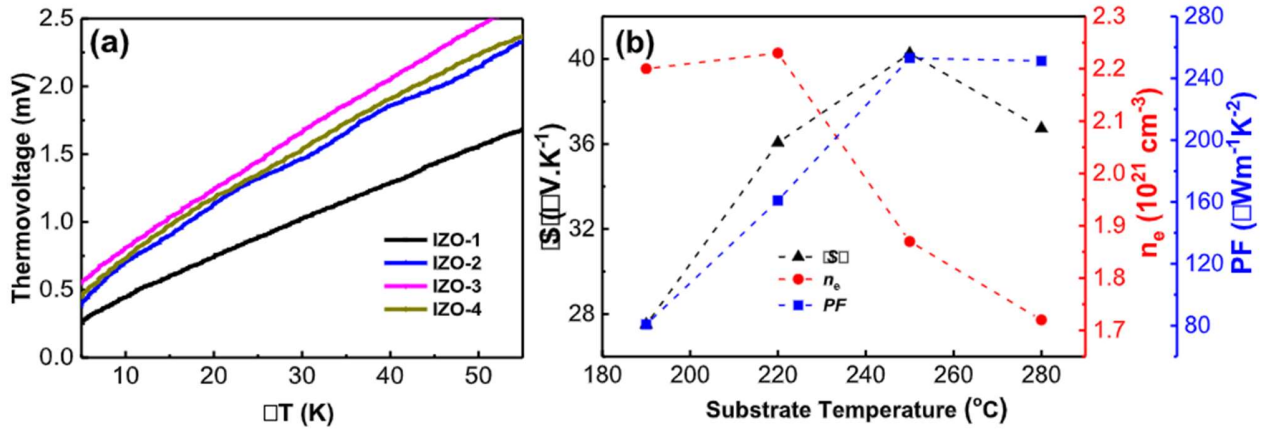


**Figure 3.** (a) Seebeck coefficient and (b) the relationship between the Seebeck coefficient ( $|S|$ ), charge carrier concentration ( $n_e$ ), and the power factor ( $PF$ ) of In-doped ZnO thin films at various substrate temperatures.

The moderate increase in Seebeck coefficient with temperature is consistent with the Jonker–Pisarenko relationship, where reduced carrier concentration leads to higher  $|S|$  values. However, optimal thermoelectric performance results from a balance between conductivity and Seebeck coefficient rather than maximizing either parameter independently. In addition to  $PF$ , the Figure of

Merit (FOM) for transparent conductive performance also improved with temperature, reaching its highest value at 280°C. This indicates that while 250°C yields the best thermoelectric efficiency, 280°C offers the most balanced multifunctional performance across optical, electrical, and thermoelectric metrics. Comparative analysis with previously reported metal-doped ZnO systems shows that the IZO films fabricated in this study approach or exceed the performance of several established TCO materials, highlighting their practical potential.

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**Keywords:** *Indium-doped Zinc Oxide, Multifunctional Material, Transparent Conductive Oxide, the RF-magnetron reactive sputtering method*

## **PP-11 Annealing-Driven Optimization of $\alpha$ -FeOOH for Photocatalytic Degradation of Malachite Green**

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### **Introduction**

Goethite ( $\alpha$ -FeOOH) is a promising iron-based semiconductor owing to its chemical stability, low cost, and strong visible-light absorption, making it suitable for environmental photocatalytic applications [1-2]. Among FeOOH polymorphs,  $\alpha$ -FeOOH stands out due to its tunnel-type structure and high density of surface hydroxyl groups, which confer superior surface reactivity. The photocatalytic performance of this material strongly depends on crystallinity, defect density, and surface properties, which can be effectively tuned through thermal treatment. Annealing at approximately 200°C improves structural ordering while preserving nanoscale morphology and active sites [3-4]. Compared with TiO<sub>2</sub> and Fe<sub>2</sub>O<sub>3</sub>,  $\alpha$ -FeOOH exhibits higher activity under visible-light irradiation in the degradation of organic pollutants. Photocatalytic performance was evaluated through the degradation of Malachite Green under light irradiation, where an intermediate annealing duration yielded the highest efficiency due to the balance between crystallinity and active surface sites. These findings indicate that controlled thermal treatment is an effective approach to optimize  $\alpha$ -FeOOH nanostructures for visible-light photocatalytic applications.

### **Experimental methods (theoretical/simulation models) and materials**

Prepare the precursors FeCl<sub>3</sub>.6H<sub>2</sub>O and NaOH. An NaOH solution and FeCl<sub>3</sub>.6H<sub>2</sub>O were dissolved separately. The NaOH solution was then added dropwise to the FeCl<sub>3</sub>.6H<sub>2</sub>O solution, continuously stirring to form a precipitate. Upon reaching the desired pH, the reaction was maintained under stirring for 15 min. Then, the resulting suspension was transferred into a Teflon-lined autoclave and subjected to hydrothermal treatment at 200°C for various durations. After hydrothermal synthesis, the product was collected by centrifugation and washed repeatedly using ultrasonication. The obtained wet precipitate was dried, calcined, and ground into fine powder to yield  $\alpha$ -FeOOH.

### **Results and Discussion**

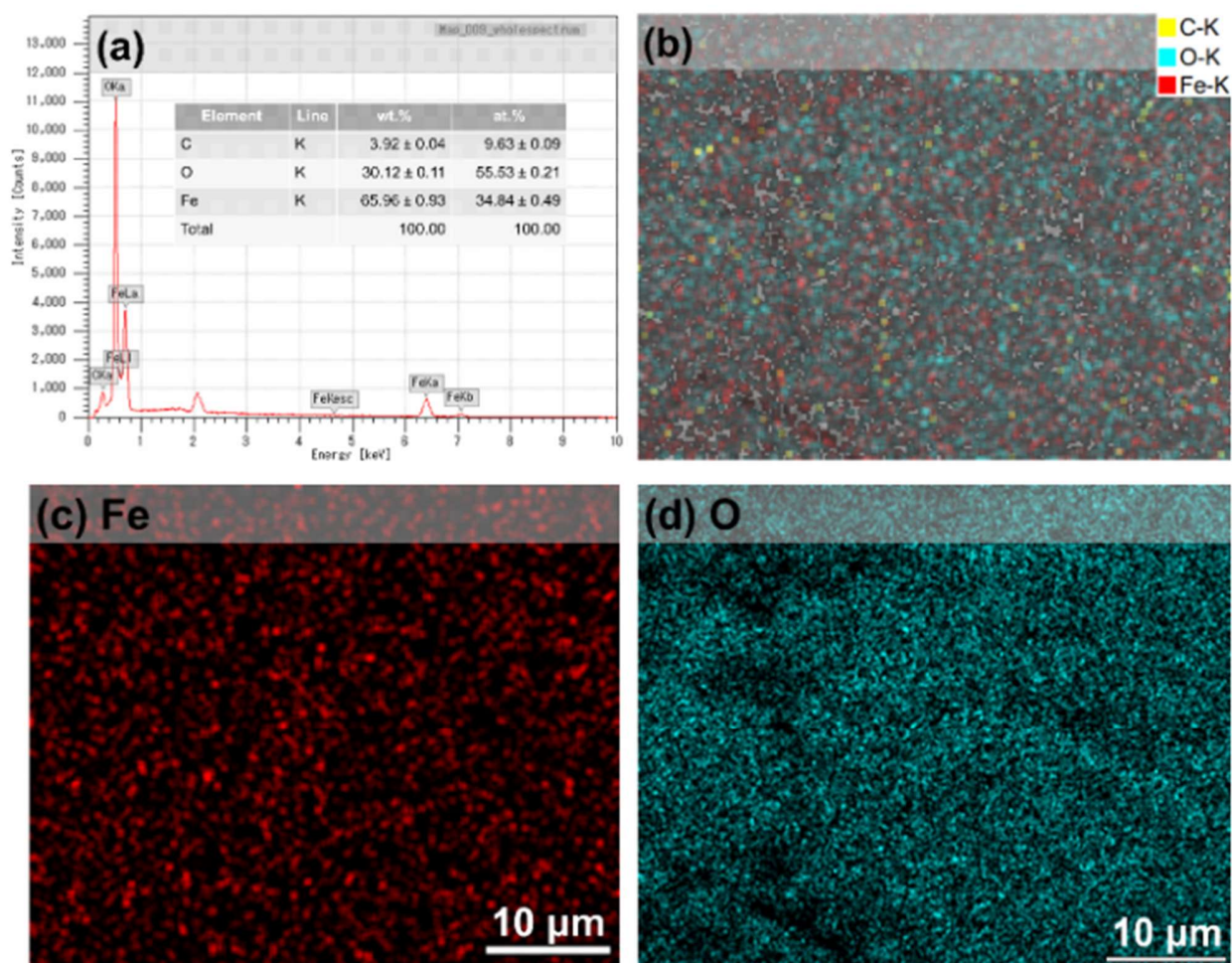


**Figure 1.** EDX spectra (a) and EDX-mapping (b-d) of FeOOH sample.

The elemental content of Fe and O was determined to be  $65.96 \pm 0.93$  wt.% and  $30.12 \pm 0.11$  wt.% respectively, indicating that the O/Fe atomic ratio approximates the theoretical value of FeOOH. The distribution of elements O and Fe is observed by EDX mapping, showing Figure 1b-1d. The elements Fe and O are evenly distributed, with no local separation or agglomeration observed.

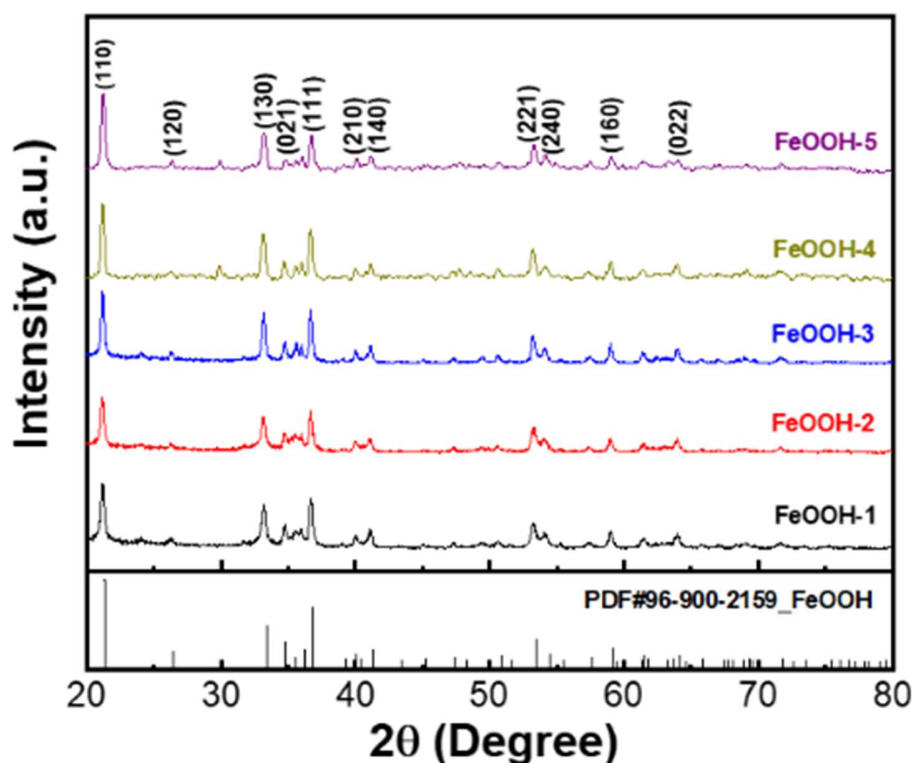


**Figure 2.** XRD pattern of FeOOH sample at various annealing time.

As the incubation time increases, the atoms have more time to arrange in a more orderly manner which reduces the microstrain and deviation density in the Goethite crystal. Besides, too long an incubation period leads to recrystallization and restructuring, which leads to the fragmentation of larger crystals into smaller crystal domains resulting in a reduction in crystal size. The results showed that Goethite's larger, more orderly particle growth was optimal when heat-treated at 200°C for 3 hours. The characteristic characteristics of FeOOH crystals by lattice (110) at different incubation times are summarized in Table 1.

**Table 1.** Crystalline parameters of the FeOOH (110) plane for samples subjected to various annealing durations.

| Sample  | $2\theta$<br>(°) | FWHM<br>(°) | Crystallite<br>size, $D$<br>(nm) | Dislocation<br>density, $\delta$<br>( $10^{-3}\text{nm}^{-2}$ ) | Microstrain,<br>$\varepsilon$<br>( $10^{-3}$ ) |
|---------|------------------|-------------|----------------------------------|-----------------------------------------------------------------|------------------------------------------------|
| FeOOH-1 | 21.19            | 0.298       | 27.13                            | 1.36                                                            | 6.95                                           |
| FeOOH-2 | 21.17            | 0.264       | 30.62                            | 1.07                                                            | 6.16                                           |
| FeOOH-3 | 21.20            | 0.230       | 35.15                            | 0.81                                                            | 5.36                                           |
| FeOOH-4 | 21.20            | 0.241       | 33.54                            | 0.89                                                            | 5.62                                           |
| FeOOH-5 | 21.24            | 0.281       | 28.77                            | 1.21                                                            | 6.54                                           |

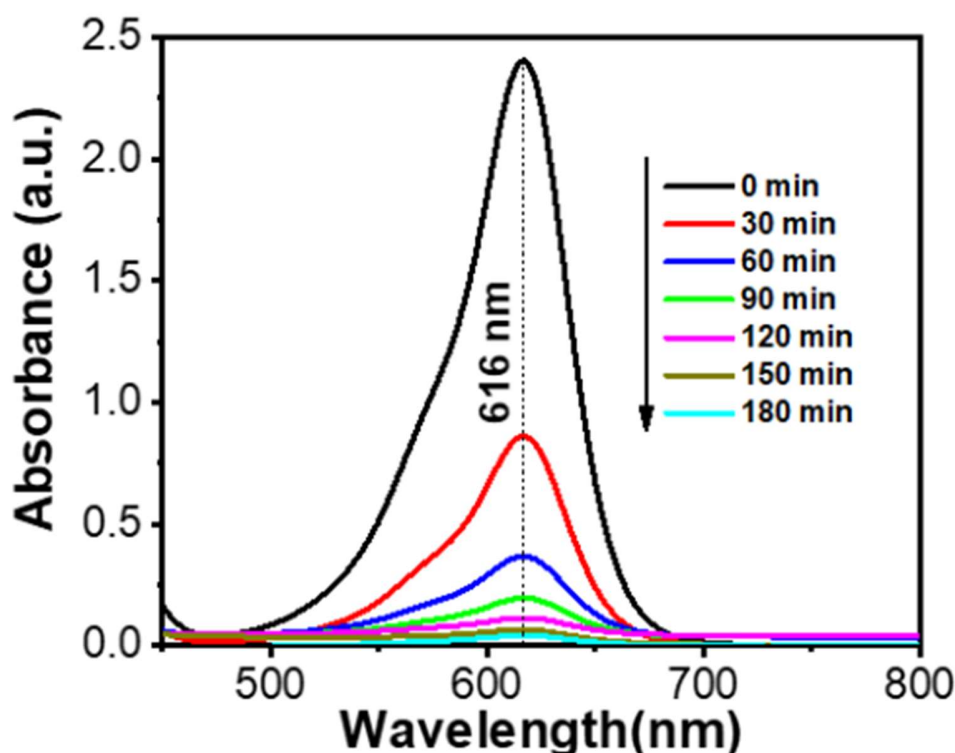


**Figure 3.** UV–Vis absorbance spectra of Malachite Green solution 30 ppm.

Figure 5 shows the UV–Vis absorption spectrum of Malachite Green (MG) during irradiation in the presence of  $\alpha$ -FeOOH catalyst. MG's characteristic absorption band intensity at about 613–616 nm decreases with illumination time and almost disappears after 150 minutes, while the absorption peak position is not shifted. This phenomenon indicates that MG's chromophore has been destroyed, confirming that photocatalytic decay is efficient.

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**Keywords:**  $\alpha$ -FeOOH, nanostructures, thermal annealing, crystallinity, band gap, photocatalysis, Malachite Green degradation.

## **PP-12 Ag Nanowire SEIRA Substrates for Ultralow Concentration Detection**

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### **Introduction**

Noble metal nanostructures have gained considerable attention thanks to not only significant advances in synthesis, manipulation but also their unique chemical and physical properties as well [1-3]. Silver nanowires (AgNWs) are considered critical nanomaterials in various fields such as biomedicine, sensing, optics, and electrical circuits due to their interesting properties, such as outstanding electrical conductivity, strong antibacterial effects, and remarkable optical characteristics [4–6]. However, the controlled synthesis and morphology regulation of AgNWs remains a key challenge, which limits their full exploitation in practical applications. In the detection of ultralow chemical concentrations, two methods have been proposed and continuously improved: Surface-enhanced Raman spectroscopy (SERs) and Surface-Enhanced Infrared Absorption Spectroscopy (SEIRA). In this work, AgNWs were synthesized via a chemical reduction route with  $\text{FeCl}_3$  as a catalytic agent. The influence of reduction duration on their structure, size, and optical properties of the AgNWs was systematically examined. The findings could provide a better understanding of the AgNW growth mechanism. Furthermore, the as-synthesized AgNWs were anchored onto filter paper to fabricate low-cost SEIRA substrates. Employing the localized surface plasmon resonance in AgNWs, the fabricated substrates significantly enhanced the infrared absorption signals of Eosin Y (EY) indicator molecules at ultralow chemical concentrations.

### **Experimental methods**

Silver nanowires were synthesized using the polyol method by dissolving  $8.75 \times 10^{-7}$  mol PVP in 20 mL ethylene glycol (EG) and heating the solution to 160 °C under continuous stirring until thermal stability was reached. A small amount of  $\text{FeCl}_3$  was then added to initiate the reduction stage, and the mixture was maintained for 15–30 minutes to control nanowire growth. Next,  $6.48 \times 10^{-4}$  mol  $\text{AgNO}_3$  was introduced dropwise while stirring until the solution turned cloudy silver, indicating the formation of Ag nanowires, after which the reaction was rapidly quenched in ice water. Filter paper pieces were sonicated and immersed in the AgNW colloid, air-dried for about 30 minutes, and the soaking–drying cycle was repeated three times to improve nanowire density and adhesion. Finally, the coated papers were dipped in Eosin Y solution for 30 seconds, dried at room temperature, and characterized using FT-IR spectroscopy.

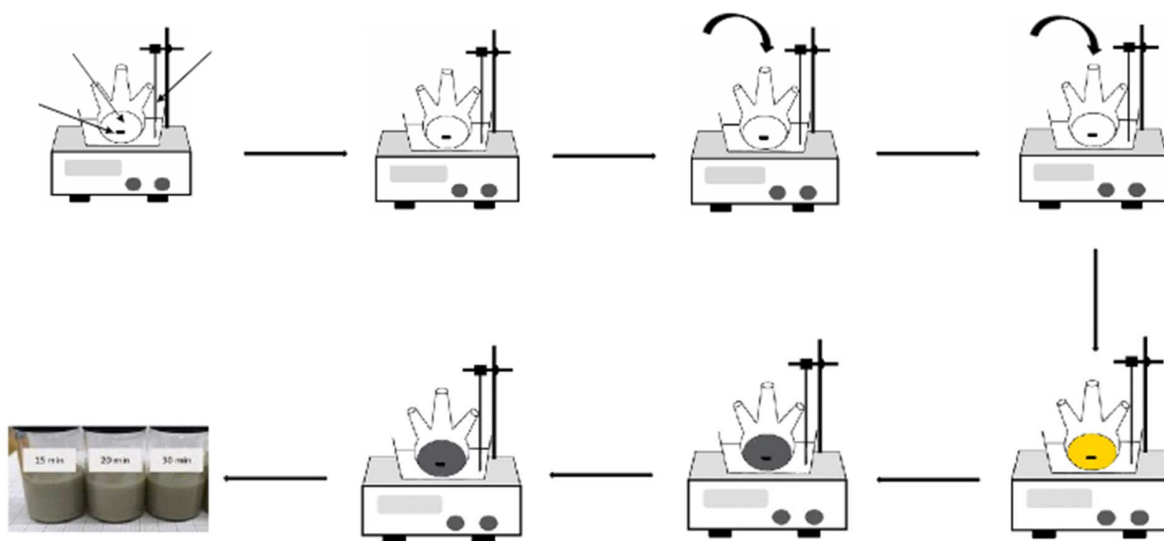


**Figure 1.** Schematic illustration of the AgNWs synthesis process.

### Results and Discussion

Ag nanoparticle (AgNP) content in the samples also decreases over different  $\text{FeCl}_3$  reduction time. As the reduction time of  $\text{FeCl}_3$  gradually increases, the  $I/I_0$  ratio reaches values of 0.61, 0.58, and 0.78, respectively. The higher  $I/I_0$  value obtained for the  $\text{FeCl}_3$ -30 min sample indicates that AgNW formation predominates over the AgNP formation. The results confirm a clear transition from nanoparticle-rich to nanowire-dominated structures with prolonged reduction time.

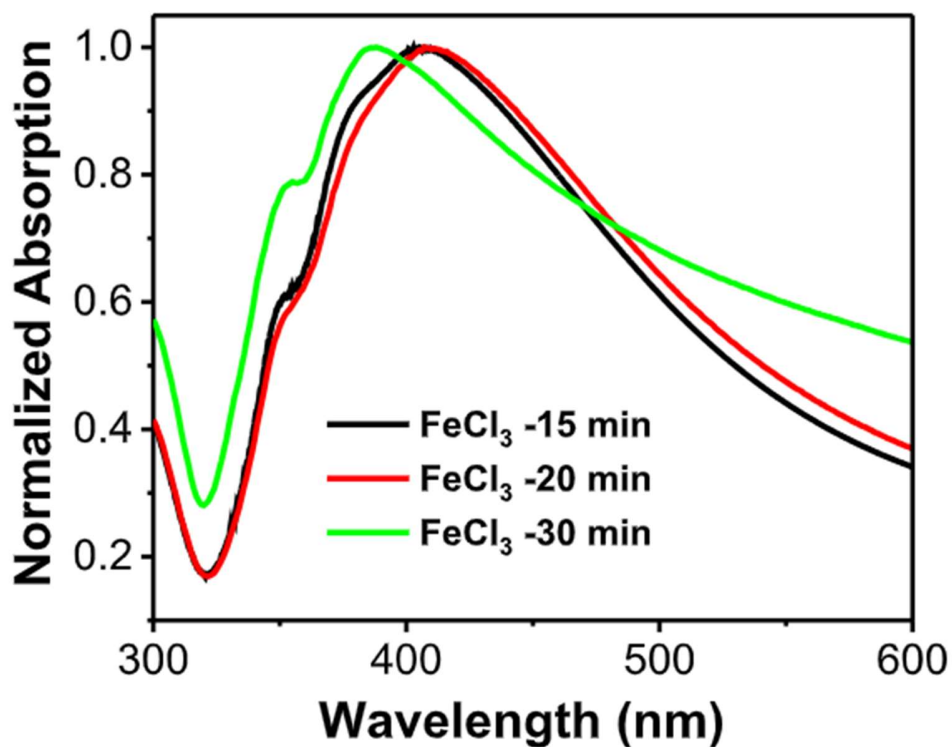


**Figure 2.** Normalized UV-Vis absorption spectra of the AgNW samples.

AgNWs synthesized at 30 min exhibit much higher aspect ratios than those obtained at shorter reduction times. Such high ratios are necessary for shifting the plasmon resonance of PVP-coated Ag NWs to infrared region, which is essential for effective SEIRA applications.

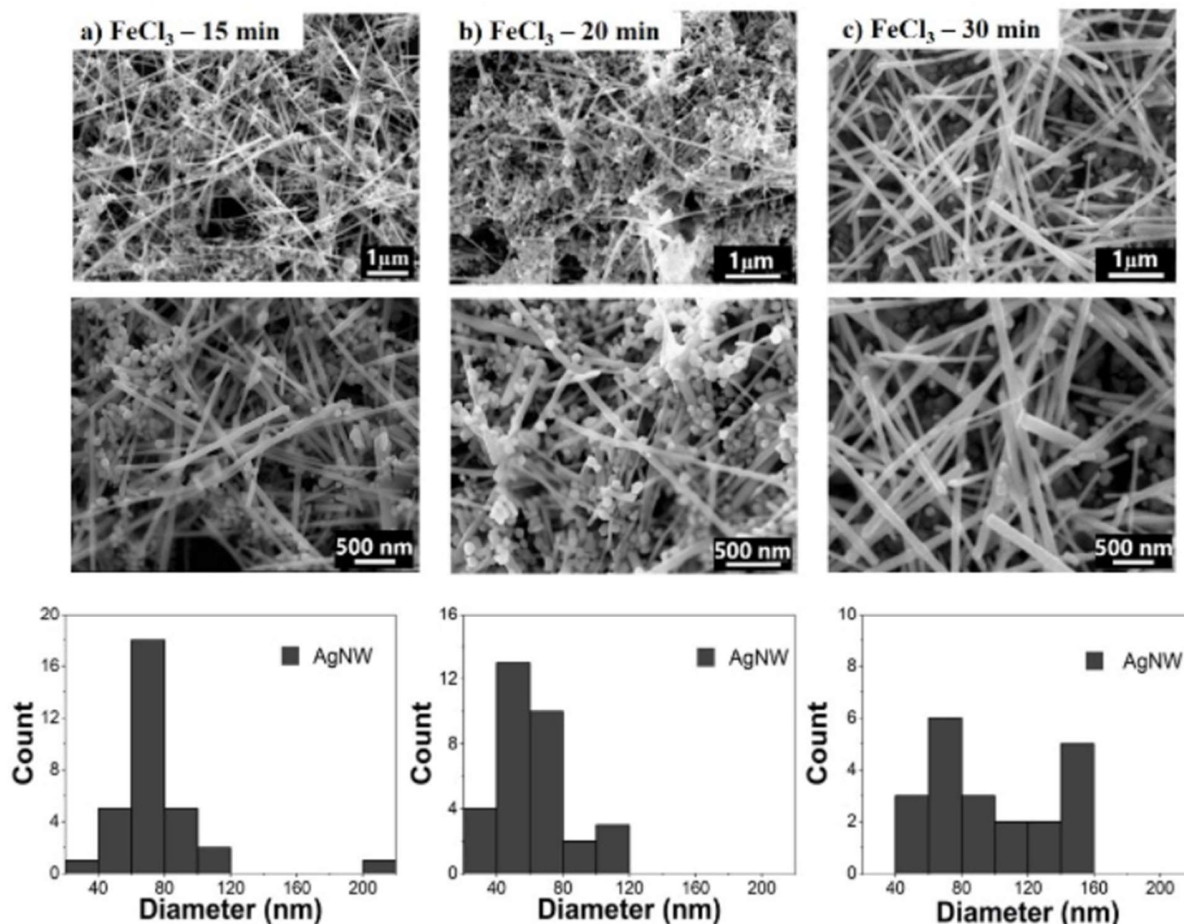


**Figure 3.** SEM images and diameter distribution of AgNW samples a) FeCl<sub>3</sub>–15 min, b) FeCl<sub>3</sub>–20 min, and c) FeCl<sub>3</sub>–30 min.

The presence of AgNWs on SEIRA substrates results in a substantial enhancement of the infrared signals within the 1-10 ppm (Figure 5a) and 10-500 ppb (Figure 5b) regions. This demonstrates that the infrared signal of the Eosin Y solution is markedly amplified on the SEIRA substrate, attributable to the surface plasmon resonance phenomenon.

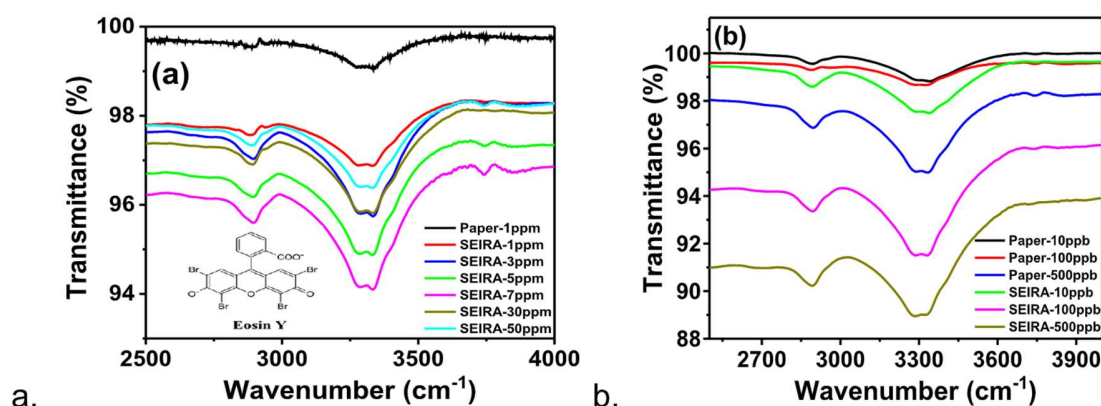


**Figure 4.** FTIR signals of the Eosin-Y on filter paper and SEIRA substrates at ppm (a) and ppb (b) levels

In summary, AgNWs were synthesized by the polyol method using  $\text{FeCl}_3$  as a catalyst, where extending the reduction time from 15 to 30 minutes promoted a nanowire-dominated morphology with high aspect ratios and lengths up to  $\sim 6355$  nm. The high aspect ratio was crucial for shifting plasmon resonance into the infrared region, enabling effective SEIRA activity. The as-prepared AgNWs were anchored onto filter paper to fabricate a low-cost SEIRA substrate. These substrates successfully detected Eosin Y over a wide range from 50 ppm to 10 ppb. Infrared fingerprint peaks were strongly amplified due to localized electromagnetic fields at sharp tips and narrow junctions of the nanowires. An enhancement factor of approximately 98 times at 10 ppb was achieved. Overall,  $\text{FeCl}_3$ -assisted high-aspect-ratio AgNWs provide a simple and economical platform for ultrasensitive detection of organic pollutants and toxic chemicals.

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**Keywords:** Silver nanowire, Catalyst, surface-enhanced infrared absorption, chemical sensors, field enhancement.

## **PP-13** Impact of Soybean Variety on Structure and Quality Attribute of Soy Yogurt

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Soybean variety selection is a key factor influencing the quality and structural characteristics of soy yogurt. In this study, six soybean varieties with distinct nutritional profiles were evaluated to elucidate their effects on the physicochemical, textural, rheological, and microstructural properties of soy yogurt. Pronounced differences in proximate composition, particularly in protein, lipid, and carbohydrate contents, resulted in variety-dependent variations in acidification behavior, water-holding capacity, and gel structure development. Textural and rheological analyses revealed significant differences in gel strength, stickiness, and viscoelastic behavior among samples. Confocal Laser Scanning Microscopy further demonstrated distinct protein network organizations associated with each variety, providing mechanistic insight into the observed macroscopic properties. Overall, the results highlight clear structure–function relationships governed by soybean variety composition, indicating that variety selection should be strategically tailored to targeted quality attributes in soy yogurt rather than aiming for a single universally optimal variety.

**Keywords:** *Soybean varieties; Soy yogurt; Rheology; Microstructure*

## **PP-14 Biological Treatment of Okara Using Enzymes and Microorganisms and its Application in Gluten-Free Biscuits**

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Okara is a nutrient-rich by-product of soy milk and tofu production; however, its direct use in food products is limited by its high insoluble dietary fiber content and unfavorable technological properties. Biological treatments are therefore needed to modify okara structure and improve its functionality for food applications. This study evaluated the effects of biological treatments on the nutritional composition, functional properties, and application of okara in gluten-free cocoa biscuits. Raw okara was treated using enzymatic hydrolysis with Biocelulase WV, containing  $\beta$ -glucanase, cellulase, and hemicellulase, as well as microbial fermentation with lactic acid bacteria (*Lactobacillus bulgaricus* and *Streptococcus thermophilus*) and mold fermentation using *Rhizopus oligosporus*. The results showed that all biological treatments altered okara properties by hydrolyzing cell wall polysaccharides. These changes resulted in an increase in soluble dietary fiber and noticeable changes in water-holding capacity, oil-holding capacity, and swelling capacity. In addition, total polyphenol content and antioxidant activity increased after biological treatments. Microbial fermentation caused metabolic changes, leading to higher antioxidant activity and increased protein content due to microbial biomass formation. Treated okara was applied as a partial replacement for oat flour in gluten-free cocoa biscuits. The type of okara treatment significantly affected biscuit physical and sensory properties. Further evaluation indicated that replacing 20% of oat flour with enzyme-treated okara produced biscuits with the best overall quality. Compared with the control gluten-free biscuits, biscuits supplemented with enzyme-treated okara contained higher dietary fiber while maintaining good sensory quality.

**Keywords:** *soybean residue (okara), biological treatment, polysaccharide hydrolysis, dietary fiber, gluten-free cocoa biscuits*

## **PP-15 Morphological Methods for Diagnosis and Identification of Fungi**

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Fungal infections and contamination represent a significant concern in medicine and human health sciences. The hot and humid tropical climate of Vietnam provides favorable conditions for the rapid growth and proliferation of fungi. Accurate and rapid identification of fungal species plays a crucial role in clinical diagnosis, environmental monitoring, and biomedical research. Traditional morphological identification methods are primarily based on macroscopic and microscopic characteristics, as well as ultrastructural analysis using scanning electron microscopy (SEM). SEM imaging provides high-resolution visualization of the surface structures of fungal spores and hyphae. Raman spectroscopy, which reflects the characteristic vibrational signatures of major biological components such as polysaccharides, proteins, lipids, and nucleic acids, has demonstrated promising potential for fungal identification. Raman microspectroscopy enables rapid acquisition of molecular information with minimal and non-destructive sample preparation. The integration of multiple approaches yields the highest diagnostic and identification accuracy. Furthermore, combining Raman spectral data with multivariate analysis and machine-learning algorithms, within the framework of artificial intelligence, is opening new prospects for automation and improved accuracy in fungal identification.

***Keywords:*** *Raman spectroscopy, fungi.*

## **PP-16** Microstructural Study on Microwave-processed Pure Cu vs Commercial Cu

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In the current study, a comparison is made between microwave-processed pure copper and commercial copper. The domestic microwave oven was used to melt pure Cu at 2.45 GHz and a power level of 900W, with charcoal serving as a susceptor for additional heat development. The microwave-processed pure Cu was melted in 7 minutes. Following this, microstructural characterisation was performed using Field Emission Scanning Electron Microscopy (FESEM) on both microwave-processed pure Cu and commercial Cu. Microstructural analysis revealed a homogeneous hexagonal cellular structure in the microwave-processed pure copper, indicating minimal temperature differences during solidification, while the microstructure of commercial copper shows coarse, equiaxed grains. Porosity analysis of the microwave cast sample shows  $0.81 \pm 0.06$ , whereas commercially cast copper shows  $2.71 \pm 1.89$ .

### **Introduction**

Processing metallic materials with microwave energy proved difficult due to microwave reflection from metallic surfaces [1]. Roy et al. demonstrated that microwave energy can be utilised to process metallic powder [2]. Due to their increased surface area, metallic particles interact with microwaves, resulting in heat generation within the target material [3]. Microwave hybrid heating (MHH) reduces energy usage and enhances heating uniformity by decreasing processing time [4]. During the sintering process, the MHH characteristics were used, including joining, cladding, and melting. In comparison to conventional processing methods, these advanced technologies enhanced the characteristics of products subjected to microwave processing [5-9]. The quick and precise heating characteristics of microwave radiation were examined during the joining and cladding processes, demonstrating enhanced joint and cladding qualities relative to conventional approaches. A limited quantity of studies has demonstrated that employing microwave energy to melt metallic materials significantly reduces processing duration and energy consumption and provides a more environmentally friendly option than traditional heating methods [10].

This research presents a novel and effective process for microwave-processed copper casting. A home microwave operating at 2.45 GHz and 900W was utilised for microwave casting of copper in a conducive atmosphere. The research focuses on the microstructural characteristics of copper casting.

### **Experimentation**

Processing metallic materials is challenging due to their ability to reflect microwave radiation at low frequencies (2.45 GHz). The microwave hybrid heating (MHH) technology enables efficient heating by absorbing microwaves and converting them into heat, utilising susceptor materials such as charcoal and an alumina cavity. As illustrated in Fig. 1, the setup involves placing mechanically blended particles within an alumina cavity surrounded by charcoal to enhance thermal generation. While

metals can reflect microwave radiation, this method allows casting with particular material combinations. The microwave cast pure Cu was melted in 7 minutes.

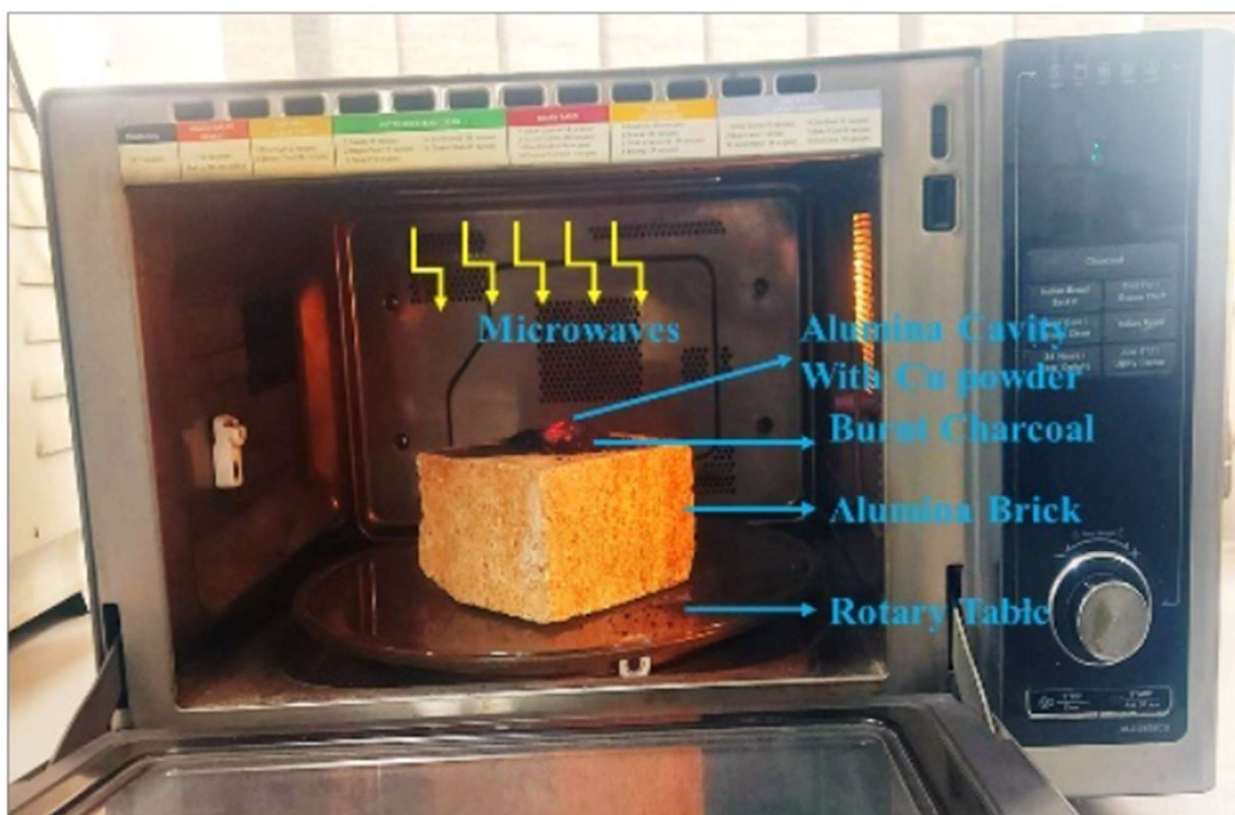


**Figure 1.** Microwave casting of pure Cu

## Results and Discussion

### *Microstructural study of pure Cu vs commercial Cu*

The material's microstructure, primarily influenced by its heating and cooling processes, significantly affects the enhancement of its quality. Figure 2 (a) illustrates the SEM microstructures of the microwave-processed pure copper. The microstructure of pure copper exhibits a uniform, approximately hexagonal structure that reflects the development of cellular structures during solidification. A significant volumetric characteristic of microwave heating is the formation of a solidification structure that minimises temperature gradients. To check the elements present in it, EDS mapping analysis was carried out.

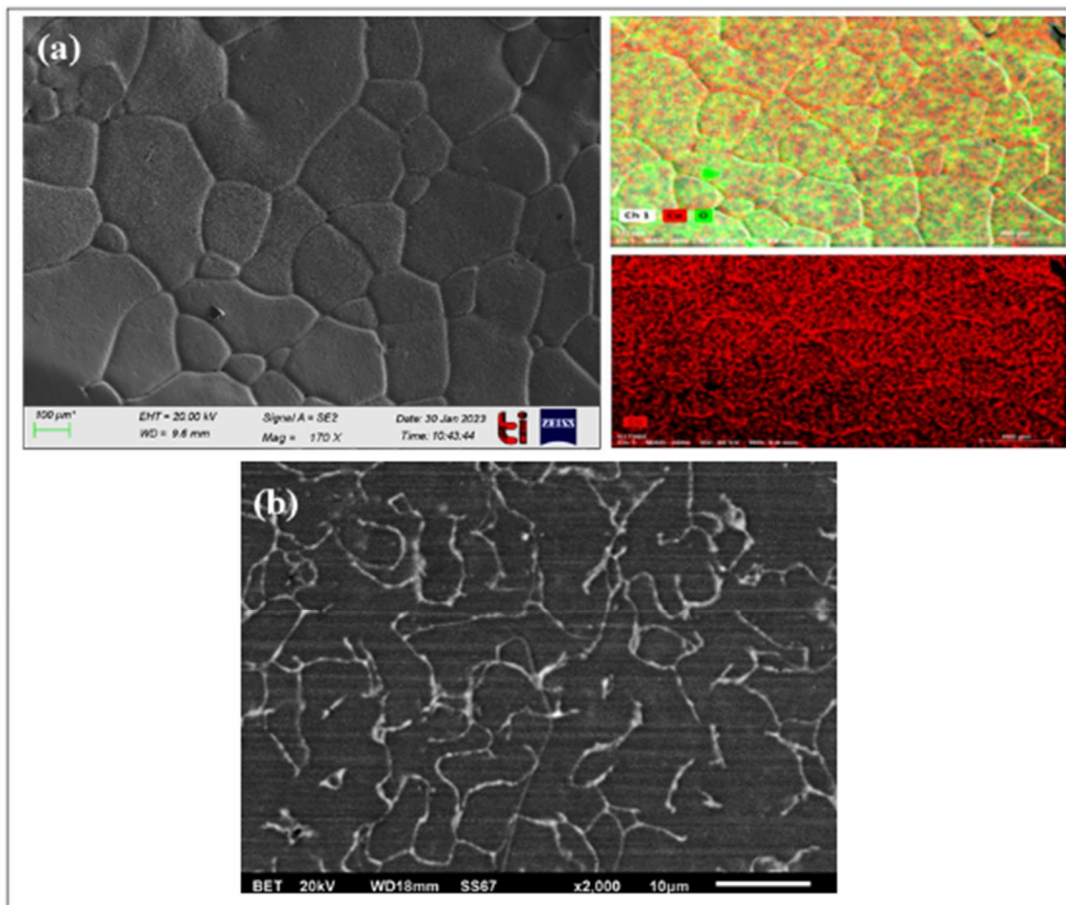


**Figure 2.** SEM Microstructure of (a) microwave-processed pure Cu/ EDS mapping analysis (b) Commercial Cu.

Figure 2(b) shows the SEM microstructure of commercial copper, which exhibits a coarse and non-uniform grain structure with irregular grain boundaries. Unlike the well-defined cellular morphology observed in microwave-processed copper, the commercial copper microstructure reveals elongated and randomly oriented grains, indicating solidification under slow cooling and non-uniform thermal gradients. The presence of pronounced grain boundary networks and microstructural inhomogeneity suggests uncontrolled grain growth during conventional processing.

*Acknowledgements:*

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**Keywords:** *Pure Cu powder, Commercial Cu, Microwave hybrid heating, Microstructural Characterisation*

## **PP-17** Influence of Loading Methods on Physicochemical Properties and Antibacterial Activity of Curcumin-Loaded Nanostructured Lipid Carriers

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Curcumin is a bioactive compound with promising antimicrobial potential. However, its poor water solubility has limited its practical applications. In this study, curcumin loaded in nanostructured lipid carriers (NLCs) were successfully fabricated using four different sonication methods while maintaining the same formulation composition and sonication parameters. The effect of the processing sequence on physicochemical properties, drug release behavior, and antimicrobial activity was systematically investigated. All formulations produced nanoparticles with average diameters ranging from 75.6 to 125.3 nm and highly negative zeta potentials (−56.4 to −59.9 mV), indicating excellent colloidal stability. Among the four formulations, M3 demonstrated the strongest antibacterial activity, exhibited near-complete inhibition of *S. aureus* (99.99%) at 0.4 mg/mL and strong inhibition of *E. coli* (99%) at 0.35 mg/mL. Overall, this study highlights the crucial role of the fabrication method in modulating the structural properties and release behavior of NLCs.

**Keyword:** nanostructured lipid carriers, curcumin, drug delivery

## **PP-18 Synthesis of Au@ZIF-8 Nanocomposites for Enhanced Antibacterial Activity**

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### Introduction

Bacterial infections caused by antibiotic-resistant strains pose an increasing threat to global healthcare systems. Zeolitic Imidazolate Framework-8 (ZIF-8), a subclass of metal–organic frameworks (MOFs), has attracted attention as a potential antimicrobial platform due to its high porosity, good biocompatibility, and pH-responsive Zn<sup>2+</sup> ion release. However, its intrinsic antibacterial performance remains limited. Integrating gold nanoparticles (Au NPs) with ZIF-8 offers a promising strategy to enhance bactericidal efficiency through synergistic physicochemical mechanisms. Au NPs exhibit localized surface plasmon resonance and enzyme-mimicking catalytic properties, which may contribute to reactive oxygen species (ROS) generation and photothermal effects. In this study, we report the aqueous synthesis of Au@ZIF-8 nanocomposites and investigate their potential as advanced antibacterial nanomaterials.

### Experimental methods and materials

ZIF-8 crystals were synthesized in aqueous medium by adding 2-methylimidazole (0.79 M) to zinc acetate solution (0.1 M) under stirring at room temperature for 1 h. The precipitate was collected, washed, and dried. Au nanoparticles were prepared via citrate reduction of HAuCl<sub>4</sub> at 110°C, yielding a stable colloidal solution. Au@ZIF-8 nanocomposites were fabricated by dispersing ZIF-8 powder in ethanol followed by gradual addition into the Au NP solution under stirring at 60°C for 24 h. Structural and chemical properties were analyzed by X-ray diffraction (XRD) and Fourier-transform infrared spectroscopy (FTIR), while optical characteristics of Au NPs were confirmed using UV-Vis spectroscopy. Morphology and nanoparticle distribution are being examined by SEM and TEM.

### Results and Discussion

XRD and FTIR results confirm the successful formation of the sodalite-type ZIF-8 framework. Although distinct diffraction peaks of Au were not observed, this is likely due to the low loading content and nanoscale size of Au NPs. UV–Vis analysis shows a characteristic plasmonic absorption peak at ~527 nm, indicating well-dispersed Au nanoparticles. The Au@ZIF-8 composite is expected to exhibit enhanced antibacterial performance compared to pristine ZIF-8 through a synergistic mechanism involving sustained Zn<sup>2+</sup> ion release and Au-mediated catalytic or photothermal activity. Ongoing biological assays against Gram-negative (*E. coli*, *K. pneumoniae*) and Gram-positive (*S. aureus*) bacteria will elucidate the bactericidal efficiency of the nanocomposite.

### Significance

This work demonstrates a facile aqueous route to MOF-based nanocomposites and highlights the

potential of Au@ZIF-8 as multifunctional antibacterial materials for biomedical and environmental applications.

Acknowledgements: This research is supported by the Advanced Materials Technology Institute (AMTI), VNU-HCM.

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**Keywords:** *ZIF-8, Gold Nanoparticles, Au@ZIF-8, Antibacterial Activity.*

## **SP-01** Conventional specimen preparation for SEM and TEM

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With the evolving requirements of electron microscopy technology, especially in recent years for the advancement of materials science and life sciences, there is an increasing demand for higher quality electron microscopy samples. Therefore, it is crucial to know how to prepare samples that meet the observation requirements of electron microscopy. This presentation will introduce the types of samples for scanning electron microscopy (SEM) and transmission electron microscopy (TEM), as well as the preparation methods and related equipment for electron microscopy samples.

## **SP-02 Electron Microscopy for Life sciences & Material analyses from Thermo Fisher Scientific**

**Vu Van Kien**

*Application Manager, Minh Khang Technical and Trading Services, Co. Ltd.*

Thermo Fisher Scientific provides a comprehensive portfolio of advanced electron microscopy and surface analysis solutions that enable high-resolution structural, chemical, and functional characterization across life sciences and materials science. Scanning Electron Microscopy (SEM) and Focused Ion Beam–SEM (FIB-SEM) deliver nanoscale surface imaging and three-dimensional reconstruction, supporting applications ranging from failure analysis and semiconductor metrology to cellular ultrastructure and tissue architecture. Scanning/Transmission Electron Microscopy (S/TEM) offers atomic-scale imaging and analytical capabilities, including elemental and crystallographic mapping, essential for understanding structure–property relationships in advanced materials and nanotechnology. Cryogenic Transmission Electron Microscopy (cryo-TEM) enables near-native visualization of biological macromolecules, viruses, and complexes, driving breakthroughs in structural biology, drug discovery, and vaccine development. X-ray Photoelectron Spectroscopy (XPS) provides quantitative surface chemical analysis, supporting investigations of thin films, interfaces, corrosion, and biomaterial surfaces. Together, these integrated technologies empower researchers to bridge length scales and disciplines, accelerating discovery, innovation, and translation in both life sciences and materials science through precise, reproducible, and high-throughput nanoscale characterization.

## **Theoretical lecture 1** Scanning electron microscopy in biology: 3D analysis of biological specimens

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I will start with the basics of the scanning electron microscopy (SEM) describing instrument main features and electron beam-specimen interaction. Then spatial resolution of SEM and use of different detectors (backscattered and secondary electrons) will be discussed. Development of low vacuum (LV) SEM and its applications will be illustrated using biological specimens.

SEM is suitable for the analysis of biological specimens prepared in the same way as for transmission electron microscopy, i.e. using glutaraldehyde/osmium tetroxide fixation, staining with uranium acetate and embedded in the Epoxy resin. At low accelerating voltage penetration depth of the electrons does not exceed several nanometers that allow obtaining pictures of the thin layer under the surface of the flat specimen. This feature is used for 3D analysis of biological specimens by SEM-based reconstruction. We will discuss ultramicrotome-based technology and FIB-SEM (focused ion beam trimming of the specimen + SEM imaging). FIB-SEM technology allows serial sectioning with minimal section thickness down to 10 nm and less. This technology is used for precise 3D reconstruction of embedded biological specimens like cultured cells, spheroids, biopsy specimens, etc.

Automated FIB-SEM using special hardware and software is significantly faster compared to serial sectioning using TEM. It allows automated reconstruction of the 3D specimens using hundreds to thousands of sections with minimal distortion and good alignment. Using low voltage SEM nearly isotropic resolution about 5x5x5 nm could be achieved.

Advantages and problems of automated FIB-SEM will be briefly discussed. Limitations of FIB-SEM are the follows. Relatively low contrast because of the limited accelerating voltage and beam current. In the standard scanning microscopes where FIB and main electron beam are inclined to each other at an angle about 50° the field of view is limited by several tens of microns.

## **Theoretical Lecture 2 Atomic Force Microscope for probing the structure and mechanical properties of materials and biological samples at nanoscale**

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Atomic Force Microscopy (AFM) is a powerful nanoscale characterization technique widely used to probe the structural and mechanical properties of materials and biological samples [1,2]. This training-oriented lecture is intended for Master's, PhD, and postdoctoral students at the early stages of experimental research and focuses on the fundamental principles of AFM relevant to materials science and biology. Core topics include probe-sample interactions, principal imaging modes (contact and tapping), force-distance curve measurements, calibration procedures, and strategies for reliable data acquisition. Particular attention is devoted to practical considerations such as artifact minimization, measurement reproducibility, and the quantitative interpretation of morphological and mechanical information at nanoscale. The lecture further introduces data processing and analysis using NanoScope Analysis, Gwyddion, and NanoLocz, emphasizing standard workflows for image correction, plane leveling, filtering, surface roughness quantification, and extraction of physically meaningful parameters. Representative case studies from both material and biological systems illustrate the capability of AFM to provide complementary structural and nanomechanical insights under realistic experimental conditions. By integrating theoretical foundations, experimental best practices, and robust data analysis approaches, this session aims to equip Master's, PhD, and postdoctoral researchers with the essential competencies required for the confident application of AFM in materials and biological research.

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## **Theoretical lecture 3** Optical microscopy in life sciences: Time lapse imaging of living cells to uncover biological processes

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An optical or light microscope is an essential tool for investigating the morphology and dynamic localization of molecular components within a cell or tissue, as well as their function. This presentation aims to show how to utilize optical microscopes to track or monitor dynamic changes in the molecular activity and structural integrity of specific proteins of interest within a dividing cell using time-lapse imaging, often known as live cell imaging. We will demonstrate how to decipher the mechanism behind asymmetric cell division by extracting valuable information from these time lapse images. This live cell imaging method can also be used to quantify the interactions between nanoparticles and living cells, as well as their effects on cell division. Furthermore, it is also possible to observe and quantify with great accuracy how nanoparticles, biomaterials, or metal surfaces interact with bacteria and their biofilm. Hence, optical microscopes are an essential and powerful instrument in contemporary science that influences our comprehension of cutting-edge discoveries in the fields of life sciences and materials.

**Keywords:** *Optical microscope, live cell imaging, asymmetric cell division, molecular activity*

## **Practical Lab 1** Advanced image processing to extract relevant information from live cell imaging data

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Optical or fluorescent microscopes frequently produce stunning images that show the localization of molecular components inside a live or fixed cell with incredibly precise detail. To fully understand the mechanism behind the basic process of interest, it is more crucial to extract information from these images. This exercise focuses on applying new techniques to extract valuable information from live cell imaging data to explain the fundamental phenomena frequently seen in the life sciences. In this hands-on session, we will learn how to quantify the amount of non-muscle Myosin II on the cell cytoskeleton and cell surface curvature during asymmetric cell division using time-lapse images of a dividing cell to understand the mechanism that drives asymmetric cell division. Next, we will try to relate the amount of non-muscle Myosin II with the curvature of the cell cortex in order to comprehend the influence of contractile force on the cell cortex, which will explain the cell shape change phenomenon that is frequently observed during cell division.

**Keywords:** *Optical microscope, live cell imaging, non-muscle Myosin II, and cell surface curvature*

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- SEM/TEM Electrical Analysis
- Electrical Failure Analysis
- BSE Acquisition
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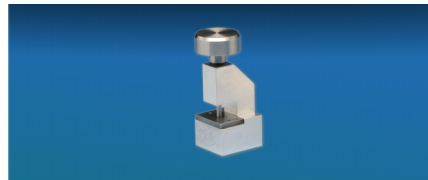


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**Automatic Twin-Jet Electropolisher**  
► Model 110



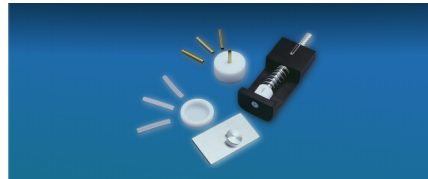
**Specimen Punch**  
► Model 130



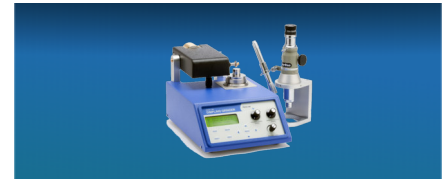
**Specimen Grinder**  
► Model 160



**Ultrasonic Disk Cutter**  
► Model 170

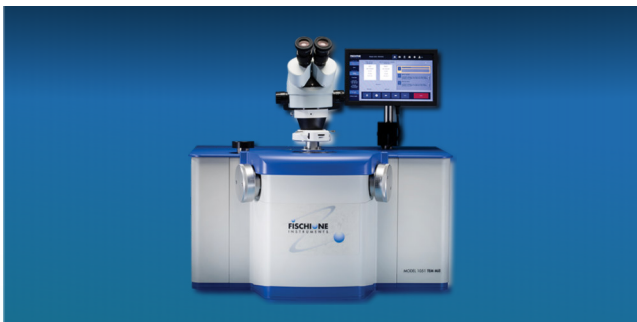


**XTEM Prep Kit**  
► Model 180



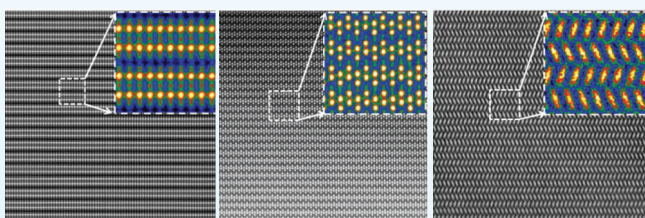
**Dimpling Grinder**  
► Model 200

## Ion beam preparation



**TEM Mill**  
► Model 1051

Environmentally controlled sample preparation  
Ion beam preparation  
TEM specimen preparation

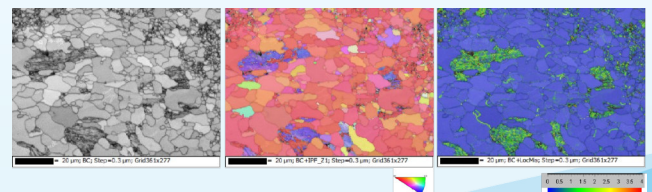


Y. Zhang, H. J. Wu, and S. Pennycook, National University of Singapore, Singapore.



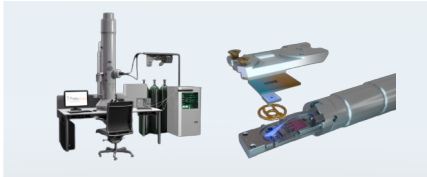
**SEM Mill**  
► Model 1061

Cross-section sample milling  
Electron backscatter diffraction (EBSD)  
Environmentally controlled sample preparation  
Ion beam preparation  
Sample delayering  
SEM sample preparation

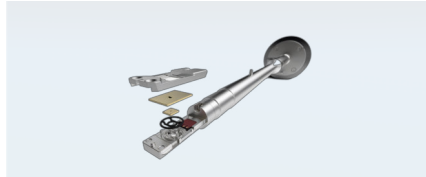


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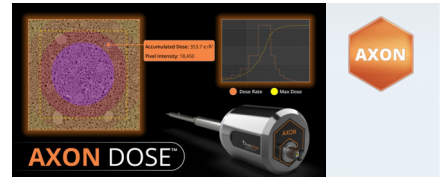
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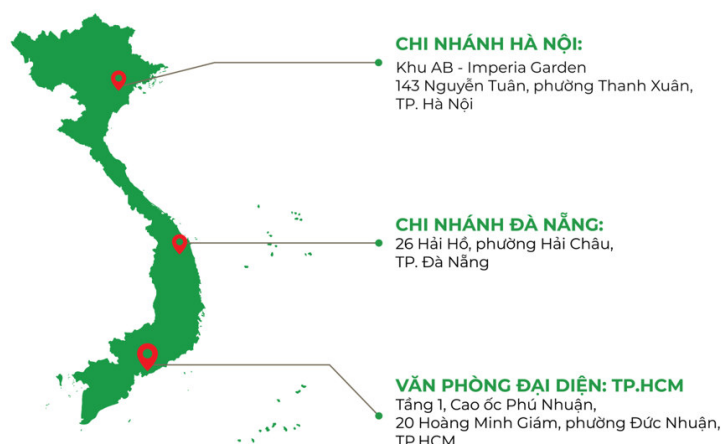


**MINH KHANG**  
Quality Control Solutions

Công ty TNHH Kỹ thuật và Thương mại Minh Khang, được thành lập năm 2006 bởi đội ngũ kỹ sư giàu kinh nghiệm, là đơn vị chuyên tư vấn và cung cấp giải pháp thiết bị khoa học – phân tích tiên tiến, đặc biệt trong lĩnh vực kính hiển vi và phân tích vật liệu cho nghiên cứu khoa học và công nghiệp tại Việt Nam

Trải qua 20 năm hình thành và phát triển, Minh Khang tự hào là đối tác phân phối và triển khai giải pháp kính hiển vi của các hãng công nghệ hàng đầu thế giới như Bruker và Thermo Fisher Scientific. Chúng tôi cung cấp các hệ thống Kính hiển vi điện tử (EM), Kính hiển vi hồng ngoại FTIR, Kính hiển vi lực nguyên tử (AFM), phục vụ hiệu quả cho khoa học vật liệu, các nghiên cứu liên ngành và các ứng dụng liên quan đến vật liệu môi trường và công nghệ tiên tiến.

Minh Khang cam kết cung cấp các giải pháp tối ưu, cập nhật theo xu hướng khoa học quốc tế, dựa trên sự kết hợp giữa chất lượng thiết bị, chuyên môn kỹ thuật và dịch vụ hỗ trợ toàn diện. Với định hướng lấy khách hàng làm trung tâm, công ty không ngừng đổi mới, tuân thủ các chuẩn mực đạo đức nghề nghiệp và quy định pháp luật, hướng tới phát triển bền vững và đóng góp thiết thực cho cộng đồng khoa học Việt Nam.



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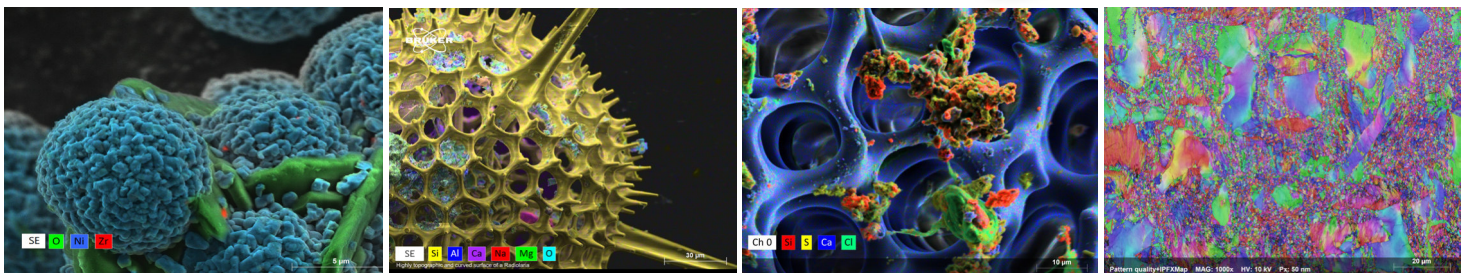
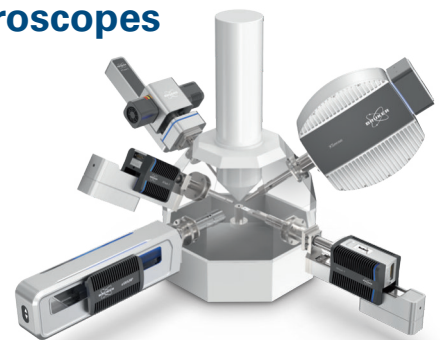
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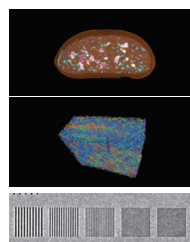


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