# Faculty of Science

## Dayong Jin Student Fellowship

### IBMD Research Projects Available – 2026 Summer Round

- **Seeing Tiny Particles Spin: A Microfluidic Sensor for Extracellular Vesicles** – A/Prof GunGun Lin and Zelyu Chen

  Can you make a microscopic magnetic bead spin, and use its motion to detect biological particles? In this project, you will build and test a miniaturised lab-on-a-chip sensor that uses tiny magnetic beads to detect changes in their surrounding environment. The ultimate goal is to develop a new approach for detecting extracellular vesicles (EVs)—nanoscale particles released by cells that are increasingly important in biomedical research and disease diagnostics. You will design and fabricate a microfluidic chip containing an array of microscopic trapping sites, each designed to hold a single magnetic bead. By applying a rotating magnetic field using Helmholtz coils, you will make the trapped beads spin. Their motion will be recorded using optical microscopy, allowing you to extract quantitative information from each bead. The exciting part is that, the way a bead rotates depends on the fluid around it. Changes in the local viscosity can therefore be detected simply by analysing how fast and how smoothly the bead spins. You will investigate whether this physical signal can be linked to the concentration of extracellular vesicles in the sample. The big question: Can the motion of a single microscopic magnetic bead reveal what is happening in its surrounding biological environment? If you enjoy building things, experimenting at the microscope, solving physical problems, coding, or exploring biomedical applications, this project offers the chance to work across all of these areas, and contribute to the development of a new microscale sensing technology.

- **Nanophotonic Engineering of Light Matter Interactions for Bioimaging** – Dr Yuyang Gu

  Light carries far more information than just colour and brightness. Modern nanophotonics offers powerful ways to engineer how light interacts with matter by tailoring materials and structures at the nanoscale. This project will explore luminescent nanomaterials, engineered thin films and other nanophotonic architectures, including how these systems can be designed, synthesised, assembled or integrated into hybrid photonic structures and resonant surfaces. SEM and TEM will be used to reveal their nanoscale architecture, while optical spectroscopy and quantitative analysis will establish how changes in geometry, composition and organisation influence light emission and other photophysical responses. The primary focus will be fluorescence lifetime engineering, using nanophotonic structures to tune emission dynamics rather than simply fluorescence brightness. More broadly, the project will explore how engineered light matter interactions can create new optical responses and information channels for next generation bioimaging, sensing and photonic technologies.

- **Polyphenol-functionalised biointerfaces for modulating injury responses in brain organoids** – Dr Franco Centurion

  Can a coating made from natural plant compounds help protect laboratory-grown brain organoids after injury? Brain organoids are small, three-dimensional models grown from human cells in the laboratory. They reproduce some important features of brain tissue and allow researchers to study how neural cells respond to injury and stress. This project will investigate polyphenols, a family of natural compounds found in many plants, fruits and tea. Tannic acid is one example. Polyphenols can act as antioxidants and may help reduce harmful inflammation. They can also be used to form very thin coatings on the surfaces of microdevices. The internship will focus on the first essential steps towards answering this question. Students will prepare polyphenol coatings on flat SU-8 surfaces and study their uniformity, stability and compatibility with biological conditions. Students will investigate whether the coating can be applied to self-folding microdevices without interfering with their ability to fold and gently wrap around three-dimensional objects. Depending on the availability of mature brain organoids, students may also participate in preliminary experiments comparing coated and uncoated surfaces. These pilot studies may examine organoid contact, short-term viability or responses to cellular stress. The devices are laboratory research tools and are not intended to be implanted into the brain. Through this project, students will gain practical experience in preparing bioactive coatings, SU-8 microfabrication, self-folding devices, optical microscopy, image analysis and experimental design. They may also gain introductory experience in brain organoid handling and biological characterisation. The results will provide an important foundation for developing laboratory tools that can interact with and potentially protect three-dimensional neural tissues.

- **Fluorescent Polymer-based Nanothermometer for Intracellular Temperature Sensing** – Dr Yee Yee Khine

  Polymers are versatile materials extensively used in biomedical applications due to their biocompatibility, tunability, and diverse mechanical properties, making them suitable for medical applications such as drug delivery, tissue engineering, medical devices, and diagnostics. This project focuses on the development of smart polymeric materials exhibiting temperature-dependent properties—specifically, polymers that undergo a reversible hydrophilic-to-hydrophobic phase transition in response to external temperature changes. A fluorescent molecule is incorporated into the polymer structure, whose emission intensity varies with changes in local hydrophilicity or hydrophobicity. This design enables the creation of a polymer-based nanothermometer capable of real-time monitoring of intracellular temperature variations. This technology holds significant potential for temperature-based disease diagnostics, including early detection and treatment monitoring in cancer and other thermally sensitive medical conditions. The project will involve the synthesis of a

- **Engineering Membrane Potential with Fusogenic Liposome to Modulate Cellular Functions** - Dr Peiran (Victor) Zhao
  This project aims to develop fusogenic polysome nanoparticles for membrane potential engineering and intracellular drug delivery. Students will participate in the synthesis and characterization of lipid-based nanoparticles, live-cell imaging, and quantitative membrane potential analysis. These nanoparticles are designed to modulate cellular membrane potential and investigate its role in regulating drug delivery efficiency. The project integrates nanomaterial synthesis, chemical modification, advanced microscopy, data acquisition, and quantitative image analysis, providing comprehensive training in nanomedicine, cell biology, and biomedical research.

- **Mitochondrial Mechanobiology in Lipid Membrane Toxicity** – Dr Le (Leo) Zhang
  Explores how toxic alterations in cellular lipid membranes influence mitochondrial structure, mechanics, and function. This project investigates how changes in membrane composition or lipid stress affect mitochondrial dynamics, membrane tension, bioenergetics, and stress signaling pathways that contribute to cell injury and disease. Students will gain hands-on experience with a range of experimental techniques, which may include mammalian cell culture, fluorescence and confocal microscopy, live-cell imaging, mitochondrial membrane potential and respiration assays, lipid treatment models, molecular biology methods (such as PCR and protein analysis), and quantitative image/data analysis. Participants can expect training in experimental design, data interpretation, and scientific communication within an interdisciplinary research environment.

- **Develop Nanothermometers to Unlock Secrets in Living Cells** - Prof Jiajia Zhou and Ms Yitong Zhao
  How do temperature dynamics inside a single cell drive disease or signal health? Join our project to build and apply the next generation of nanoscale thermometers to answer these fundamental questions. You will get hands-on experience synthesising and functionalizing upconversion nanoparticles (UCNPs), using these novel nanoprobes to perform live cell imaging, and visualising temperature gradients in real-time within physiological environments. This interdisciplinary project offers you the chance to be involved in every step: from nanoparticle synthesis and surface chemistry to cell culture and advanced optical microscopy. You will be directly involved in developing new biomedical applications, from mapping metabolic activity in cells to pioneering new thermo-diagnostic strategies. Let's turn light into temperature and knowledge.

- **Develop Automated Image Analysis Workflows for Live Cell Quantum Sensing** - Prof Jiajia Zhou and Ms Yitong Zhao

  Advances in live-cell quantum sensing are enabling researchers to investigate biological processes with unprecedented sensitivity and spatial resolution. However, these experiments often generate large volumes of microscopy images, creating major challenges in data processing and interpretation. This project focuses on developing and evaluating automated image analysis workflows for live-cell quantum sensing datasets using real experimental imaging data generated at the Institute for Biomedical Materials and Devices (IBMD), University of Technology Sydney (UTS). Students will gain hands-on experience in scientific programming, image processing, quantitative analysis, and data visualisation while working at the intersection of biotechnology, data science, and computational research. Through this interdisciplinary project, you will contribute to improving the efficiency, reproducibility, and scalability of image-based quantum sensing research, helping transform complex biological imaging data into meaningful scientific insights.

- **Microfluidic droplet technology for high-throughput cell encapsulation and sorting** – Dr Guocheng Fang

  Droplet microfluidics have emerged as a powerful technique for compartmentalizing reactions and single cells into picoliter-scale droplets, enabling high-throughput screening, diagnostics, and synthetic biology. This project aims to design and develop a microfluidic chip capable of generating monodisperse droplets at high throughput, with precise control over size, composition, and generation rate. The microfluidic chip will utilize flow-focusing or T-junction geometries fabricated using soft lithography or 3D printing. By optimizing channel dimensions, flow rates, and surfactant systems, the platform will produce stable water-in-oil or oil-in-water droplets at rates exceeding 10,000 droplets per second. Parallelization strategies (e.g., multi-nozzle arrays) will be employed to further scale up production. Finally, the designed device will be used for cell encapsulation and further sorting.

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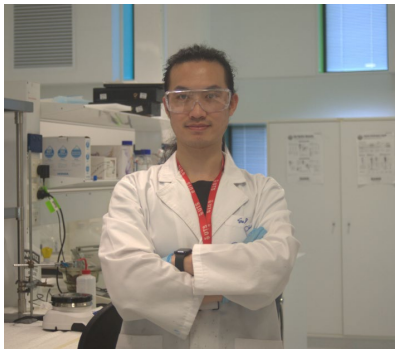
## IBMD Project Supervisors

**Associate Professor Gungun Lin**

A/Prof Gungun Lin leads the group of “Intelligent BioMEMS” at the University of Technology Sydney, and he is a core member of the Institute for Biomedical Materials and Devices (IBMD). His research focuses on functional micro- and nanomaterials and MEMS technologies for biomedical applications, with particular interest in magnetic sensing, actuation, and microscale device development. His work combines materials science, microfabrication, and analytical technologies to develop new sensors, actuators, and robotic systems for biomedical analysis.

**Zelyu Chen**



Zelyu Chen is a Postdoc Researcher at the University of Technology Sydney. His work focuses on magnetic microrobotics, microfluidics, interfacial transport, and quantitative experimental systems. He has experience in microfabrication, magnetic actuation, imaging, computational modelling, and data analysis for microscale sensing and transport.

**Dr Yuyang Gu**

Dr Yuyang Gu is an ARC Discovery Early Career Researcher Award (DECRA) Fellow at the University of Technology Sydney. His research integrates chemistry, nanophotonics and advanced microscopy, with a focus on engineering nanoscale light matter interactions for biological imaging and sensing. He develops luminescent nanomaterials and photonic nanostructures, and applies fluorescence spectroscopy, fluorescence lifetime imaging and super-resolution microscopy to investigate their optical and biological functions. Dr Gu received his PhD in Chemistry from Fudan University and undertook postdoctoral research at the National University of Singapore. He has published more than 20 research papers, including work in Nature Photonics and ACS Nano.

**Dr Franco Centurion Rodriguez**

Dr Franco Centurion Rodriguez is a postdoctoral researcher at the Institute for Biomedical Materials and Devices (IBMD), University of Technology Sydney. He completed his PhD in Chemical Engineering at UNSW, specialising in advanced functional materials, nanomedicine and interfacial engineering. His research focuses on developing dynamic biointerfaces that integrate materials science, microfabrication and bioelectronics. His current work explores self-folding microdevices designed to interact conformally with three-dimensional biological models, including brain organoids. These devices combine microfabricated structures, microelectrodes and functional coatings to enable controlled interactions with biological tissues and potentially monitor their electrical activity. The overall goal of his research is to engineer active and responsive biointerfaces for investigating tissue injury, recovery and functional activity, with potential applications in neuroengineering, mechanobiology and next-generation biomedical devices.

**Dr Yee Yee Khine**

Dr Khine is a Postdoctoral Research Associate in the School of Mathematical and Physical Sciences at the University of Technology Sydney (UTS) and a core member of the Institute for Biomedical Materials and Devices (IBMD). She holds an MEngSc in Chemical Engineering (2014), an MSc in Chemistry by Research (2016), and a PhD in Polymer Chemistry (2021) from the UNSW, where she received the University International Postgraduate Award. She has conducted research at UNSW (Australia), Indiana University (USA), and the Karlsruhe Institute of Technology (Germany), and has collaborated extensively with industry partners worldwide. Her expertise lies in the design and development of polymeric materials for biomedical applications, with a current focus on engineering polymer-based nanothermometers for intracellular temperature sensing.

**Dr Peiran (Victor) Zhao**

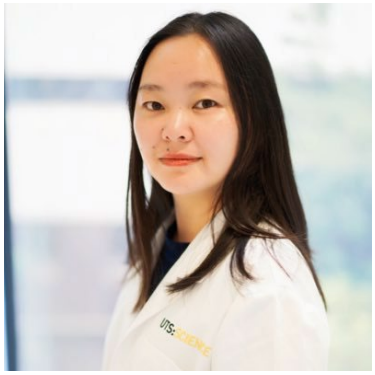
Dr Peiran Zhao is a Postdoctoral Researcher Fellow at the Institute for Biomedical Materials and Devices (IBMD), University of Technology Sydney. His research focuses on the development of functional nanomaterials and bionanotechnology for biomedical applications. He is particularly interested in understanding nano-bio interactions and harnessing them to modulate cellular functions. By integrating chemistry, materials science, and biology, his work aims to develop innovative nanotechnology-based platforms for cell engineering and therapeutic applications.

**Dr Le (Leo) Zhang**

Dr Zhang serves as a Postdoctoral Research Fellow at UTS and plays a pivotal role as a core member of the UTS Institute for Biomedical Materials and Devices (IBMD). He completed his PhD in Biomedical and Microbiology at UTS in 2021, under the guidance of Distinguished Professor Dayong Jin. Emerging as an international leader in antimicrobial resistance (AMR), his primary focus lies in exploring the mechanisms behind bacterial evolution of antibiotic resistance through a variety of interdisciplinary approaches. These methods include single-molecule microscopy, whole-genome sequencing, and global transcription analysis. Dr Zhang's groundbreaking work involves the integration of photonics and advanced materials into molecular biology, significantly contributing to the understanding of AMR. His research has yielded 19 journal publications, featuring in prestigious outlets such as Nature Methods, eLife, and Analytical Chemistry.

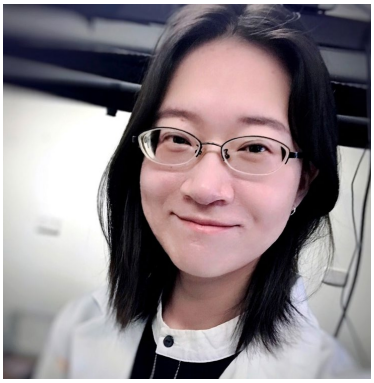
**Professor Jiajia Zhou**

Prof. Jiajia Zhou is an internationally recognised leader in single particle spectroscopy at the University of Technology Sydney, where her work focuses on nanoparticles while preserving their optical properties for applications in biomedical sensing, imaging, display technology, and security inks. As a recipient of major awards and grants such as the prestigious David Syme Research Prize, ARC Future Fellowship and NHMIC Investigator Grant, Prof. Zhou has driven innovations in rapid COVID-19 testing and protein detection, publishing extensively in high-impact journals including Nature and Nature Photonics.



**Yitong Zhao**

Ms Yitong Zhao is a postdoctoral research associate at the University of Technology Sydney (UTS), specialising in nanoscale functional imaging for biological systems. Her research focuses on developing advanced temperature sensing methods to study heat generation and transfer at the cellular level, with potential applications in biomedicine, diagnostics, and treatment.



**Dr Guocheng Fang**

Dr. Guocheng Fang is a Cancer Institute Early Career Fellow at the School of Biomedical Engineering, University of Technology Sydney (UTS). He is also a visiting Fellow at the Institute for Biomedical Materials and Devices (IBMD), School of Mathematical and Physical Sciences. Prior to joining UTS, he was a Presidential Postdoctoral Fellow (PPF) at the Nanyang Technological University, Singapore (2022-2024). Dr. Fang envisions harnessing engineering innovations to address critical medical and clinical challenges, ultimately advancing human health and well-being. Currently, his research focuses on the intelligent organoid-on-chip systems, aiming to establish reliable and responsive platforms for disease modeling, drug screening, and man–machine interfacing.