IMRE 25th Anniversary Scientific Conference

Institute of Materials Research and Engineering

IMRE

25 years of materials innovation

1997 - 2022

Institute of Materials Research and Engineering
IMRE

25 years of materials innovation
1997 - 2022

IMRE 25TH ANNIVERSARY SCIENTIFIC CONFERENCE

Sands Expo & Convention Centre
8 September 2022
0800 – 1630

0800 Registration and Welcome Refreshments

0845 **Welcome Remarks**
Prof. Loh Xian Jun
Executive Director, Institute of Materials Research and Engineering (IMRE)

0850 **Plenary Talk**
Prof. Sir Anthony K. Cheetham FRS
Research Professor, University of California, Santa Barbara
Distinguished Visiting Professor, National University of Singapore
Chemical Synthesis and Materials Discovery

0940 **Invited Talk**
Prof. Chen Xiaodong
President's Chair Professor in Materials Science and Engineering,
Nanyang Technological University & IMRE
Sensing-of-Everything (SoX)

1000 **Strategic Initiative Talk**
Prof. Huang Kuo-Wei
Principal Scientist, IMRE – ISCE²
Fueling the Future

1015 **IMRE Tech Highlights: Urban Solutions**

Dr. Derrick Fam
Scientist, Polymer Composite
Structural Power – A Multifunctional Strategy for Electrification

Dr. Wu Jing
Scientist, Soft Materials
Thermal and Thermoelectric Transport in 2D Materials

Dr. Wang Pei
Scientist, Structural Materials
Metal Additive Manufacturing for Sustainable Metal Economy

Dr. Ho Pin
Scientist, Electronic Materials
Hybrid Chiral Spintronics: Memory and Unconventional Computing

1055 **Invited Talk**
Prof. Liu Xiaogang
Provost's Chair Professor, National University of Singapore & IMRE
Luminescent Nanoparticles: A Wonderful Toolbox for Imaging and Assistive Technologies

1115 **Rapid-Fire Talks by the Winners of IMRE Poster Competition**

1125 Lunch and Sponsors Exhibitions

1305 **Invited Talk**
Prof. Liu Bin
Senior Vice Provost (Faculty & Institutional Development)
Distinguished Professor National University of Singapore
Accelerating the Development of Fluorogens with Aggregation-Induced Emission for Biomedical Applications

Institute of Materials Research and Engineering
IMRE

25 years of materials innovation
1997 - 2022

IMRE 25TH ANNIVERSARY SCIENTIFIC CONFERENCE

Sands Expo & Convention Centre
8 September 2022
0800 – 1630

1325 **Strategic Initiative Talk**
Dr. Xu Zhengtao
Principal Scientist, IMRE
Superconductors and 3D Graphenes: Wild Dreams of Metal-Organic Frameworks

1340 **IMRE Tech Highlights: Medtech**
Dr. Jason Lim
Scientist, Soft Materials
Transforming Ophthalmology with Hydrogels

Dr. Yang Le
Scientist, Strategic Research Initiative
Cyber Physiochemical Interfaces: Wearable Biosensors

Dr. Su Xiaodi
Principal Scientist, Soft Materials
Portable Nanosensors for Wound Care and Infection Monitoring

1410 **Invited Talk**
Dr. Steven Lukman
Editor, Nature Materials
Science and Materials for a Sustainable World – Perspective from Nature Materials' Editor

1430 **Industry Partnership Talk**
Dr. Hui Li
Director of Sales and Service, Thermo Fisher Scientific
Innovative Solutions for Electron Microscopy and Microanalysis Help to Tackle Some of the World's Most Significant Challenges in Materials Science

1440 **Rapid-Fire Talks by the Winners of IMRE Poster Competition**

1450 **Refreshments and Sponsors Exhibitions**

1530 **Strategic Initiative Talk**
Prof. Lam Ping Koy
*A*STAR Chief Quantum Scientist, IMRE*
Making Waves for Quantum Technology with Continuous Variable Systems

1545 **IMRE Tech Highlights: Quantum and Optics**
Dr. Aaron Lau Chit Siong
Scientist, Quantum Technologies for Engineering
A 2D Semiconductor Quantum Dot

Dr. Zhu Di
Scientist, Quantum Technologies for Engineering
Integrated Photonic Devices for Scalable Quantum Information Processing

Dr. Wu Mengfei
Scientist, Advanced Optical Technologies
Manipulating Photons and Excitons: from Lasers to Upconversion

Dr. Wang Qian
Senior Scientist, Nanofabrication
Reconfigurable Nanophotonic Platform Based on Phase Change Materials

1625 **Closing Remarks**
Dr. Cedric Troadec
Division Director of Optics & Electronic Division, IMRE

Plenary Talk

Thursday, 8 Sep 2022 **Simpor Junior Ballroom**

8.50 am – 9.40 am Plenary Talk

Prof. Sir Anthony K. Cheetham FRS

Research Professor, University of California, Santa Barbara
Distinguished Visiting Professor, National University of Singapore

Chemical Synthesis and Materials Discovery

The discovery of a new material with exciting functionality is often preceded by the synthesis of a new chemical compound on which the material is based. This sequence of events can happen in different ways and on different timescales.[1] In rare cases, the discovery takes place serendipitously, as in the famous examples of Teflon (polytetrafluoroethylene, PTFE) and the Buckyball, C60. Occasionally, the materials discovery is based upon the use of design rules that are defined by previous work in the area and a clear material need. For example, the development of important conducting polymers based on conjugated organic molecules stems from an original finding that polyacetylene was semiconducting and that the conductivity could be enhanced by doping with iodine. Variations on this theme ultimately led to the design of excellent conducting polymers for displays, sensors and other optoelectronic devices. Most commonly, however, major materials discoveries arise from work on chemical compounds that were originally made out of curiosity or for an entirely different application. Important examples include $TiNb_2O_7$, a new anode for lithium-ion batteries,[2] which we and others studied almost 50 years ago for entirely different reasons.[3] An even more striking case concerns the perovskite, $CsPbX_3$ (X = Cl, Br, I), which has been known since 1893.[4] It has very interesting optical properties but suffers from chemical and structural instability. Very recently,[5] we were able to stabilize the photoluminescent phase by forming a composite with a metal-organic framework glass[6] that we made out of curiosity just a few years ago, never imagining that it might be used for such an exciting application.

Biography

Tony Cheetham is a Research Professor at the University of California, Santa Barbara, and a Distinguished Visiting Professor at the National University of Singapore. He was formerly the Goldsmiths' Professor of Materials Science at the University of Cambridge (2007-2017) and the Treasurer and Vice-President of the Royal Society (2012-2017). Cheetham obtained his D.Phil. at Oxford in 1972 and did post-doctoral work in the Materials Physics Division at Harwell. He joined the Chemistry faculty at Oxford in 1974, and then moved to UC Santa Barbara in 1991 to become Professor in the Materials Department. From 1992-2004 he was the Director of UCSB's Materials Research Laboratory. Cheetham is a leader in the materials chemistry community and renowned for his contributions to the development of procedures to study the structures of materials and deduce their chemical, mechanical and physical properties. He is a Fellow of the Royal Society and a member of American Academy of Arts and Sciences as well as several other national academies. He has received numerous awards for his work in the field of materials chemistry, including the Platinum Medal of the Institute of Materials, Minerals & Mining (2011), a Chemical Pioneer Award from the American Institute of Chemists (2014), and the Sheikh Saud International Prize for Materials Science (UAE, 2022). In January 2020 he was knighted by the Queen for "Services to Materials Chemistry, UK Science and Global Outreach".

1. A. K. Cheetham, R. Seshadri & F. Wudl, Nature Synthesis 1, 514 (2022)
2. K. J. Griffith, Y. Harada, S. Egusa, R. M. Ribas, R. S. Monteiro, R. B. Von Dreele, A. K. Cheetham, R. J. Cava, C. P. Grey & J. B. Goodenough, Chem. Mater. 33, 4-18 (2021)
3. R. B. Von Dreele & A. K. Cheetham, Proc. Roy. Soc. London, A338, 311 (1974)
4. H. L. Wells, Zeit. für Anorgan. Chem. 195 (1893)
5. J. Hou, P. Chen, A. Shukla, ... A. K. Cheetham, S. M. Collins, V. Chen, L. Z. Wang and T. D. Bennett Science 374, 621 (2021)
6. T. D. Bennett, J. C. Tan, Y. Z. Yue, C. Ducati, N. Terrill, H.H.M. Yeung, Z. Zhou, S. Henke, A. K. Cheetham & G. N. Greaves, Nature Comm. 6, 8079 (2015)

Institute of Materials Research and Engineering
IMRE

25 years of materials innovation 1997 - 2022

Invited Talks

Thursday, 8 Sep 2022

9.40 am – 10.00 am

Simpor Junior Ballroom

Invited Talk

Prof. Chen Xiaodong

President's Chair Professor in Materials Science and Engineering, Nanyang Technological University & IMRE

Sensing-of-Everything (SoX)

The fast-evolving technologies on the Internet of Things, 5G, big data, and autonomous vehicles are driving massive digitization in almost every aspect of life. Sensors, the node that translates the physical world into digital data, plays an integral role in this pursuit, enabling the rapid integration and deployment of AI and IoT-enabled solutions. To collect high-quality data and generate insightful readouts from a diverse range of physical objects and environments, i.e., to realize 'Sensing-of-Everything' (SoX), we identified three key challenges. The first key challenge, Sensing on Everything, is collecting data on unconventional objects such as the soft and dynamic human body. The second challenge, Sensing to Everything, relates to syncing communication between electronics and biology and achieving efficient data transmission between devices. The third challenge, Sensing for Everything, will be generating intelligible feedback from sensor data in vast applications. In this talk, I will discuss how our research on flexible electronics technology tackles the three challenges through materials engineering, device architecture innovations and system integration, and machine learning-assisted data analysis towards artificial sensation.

Biography

Professor Xiaodong Chen is the President's Chair Professor in Materials Science and Engineering, Professor of Chemistry (by courtesy) and Medicine (by courtesy) at Nanyang Technological University, Singapore (NTU). He is also the scientific director and principal scientist at the Institute of Materials Research and Engineering (IMRE) at A*STAR, Singapore. His current research interests include mechano-materials science and engineering, flexible electronics technology, sense digitalization and cyber-human interfaces and systems. He has been elected as Fellow of Singapore National Academy of Science and the Academy of Engineering Singapore. Prestigious accolades for his exceptional scientific contributions include the Singapore President Science Award, Singapore National Research Foundation (NRF) Investigatorship, Singapore NRF Fellowship, Winner of Falling Walls, and Friedrich Wilhelm Bessel Research Award. He serves on the editorial advisory board for numerous global journals and is currently the Editor-in-Chief of ACS Nano.

Strategic Initiative Talks

Thursday, 8 Sep 2022

10.00 am – 10.15 am

Simpor Junior Ballroom

Strategic Initiative Talk

Prof. Huang Kuo-Wei

Principal Scientist, IMRE – ISCE²

Fueling the Future

In 2021, the estimated world population of 7.0 billion people consumed ~14 Gtoe of energy (at an average rate of 19.0 TW). Globally, burning of carbon-based fossil fuels supplies over 81% of the energy demand, and hence the prospering industrial societies are responsible for the observed increase in carbon dioxide levels form preindustrial 280 ppm to a new record high in 2021, 414.72 ppm. The constantly increasing atmospheric CO_2 concentration is highly likely to result in global warming, sea level rise and ocean acidification. To reduce the environmental footprint of modern societies and address the limitations of fossil recourses, the projected increase in global energy demand must go along with the implementation of low-carbon energy production and carrier systems. In this presentation, the current energy status and future options will be discussed and compared. It will then be concluded by introducing our research efforts in utilizing formic acid as a NET-ZERO hydrogen/energy carrier and e-fuel.

Biography

Kuo-Wei Huang received his B.S. from National Taiwan University as a Yuan T. Lee Fellow and Ph.D. from Stanford University as a Regina Casper Fellow. Prior to joining KAUST as a founding faculty member, he had been Assistant Professor in National University of Singapore and Goldhaber Distinguished Fellow at Brookhaven National Laboratory. The research interests of his group include CO_2 utilization, hydrogen storage, small molecules activation (particularly on the $PN^3(P)$ ligand platform his group has developed and pioneered) and kinetic and DFT studies of transition metal and organocatalysis. He has received numerous awards, including Appreciation of distinguished teaching contribution, Ministry of Education, Saudi Arabia (2017), Rising Stars Lectureship, 41st International Conference on Coordination Chemistry (2014), and Asian Rising Stars Lectureship, the 15th Asian Chemical Congress (2013). He was recently highlighted in “Pioneers and Influencers in Organometallic Chemistry” in Organometallics in 2020. https://doi.org/10.1021/acs.organomet.0c00056

IMRE Tech Highlights

Urban Solutions

Thursday, 8 Sep 2022

10.15 am – 10.55 am

Simpor Junior Ballroom

Urban Solutions Talk 1

Dr. Derrick Fam

Scientist, Polymer Composite

Structural Power – A Multifunctional Strategy for Electrification

Electrification could provide many benefits towards the environment like lessening the dependence on non-renewable resources and reducing emissions when applied in the space of transportation. However, their battery packs take up a significant amount of space, decreasing the cargo capacity of EVs and payload of electric planes. Therefore, electrification of transportation options is driven largely by the advancement of battery technology and light-weighting composites with the goal of achieving a higher energy while reducing weight and saving space.

To that end, the concept of providing structural power in the form of multifunctional structural power devices has been deemed as a potentially viable strategy to achieve both high energy density, light-weighting, and space savings simultaneously. However, the scientific problems facing the development of multifunctional materials for structural power devices are especially hard to solve due to the seemingly incongruent material requirements for energy storage and structural stability. In this talk, I will be taking you through the various strategies my group are employing to overcome the challenges of multifunctionality in the various constituent materials to achieve overall systemic efficiencies in energy storage and structural stability.

IMRE Tech Highlights

Urban Solutions

Thursday, 8 Sep 2022

10.15 am – 10.55 am

Simpor Junior Ballroom

Urban Solutions Talk 2

Dr. Wu Jing

Scientist, Soft Materials

Thermal and Thermoelectric Transport in 2D Materials

Here, we mainly focus on understanding the unique mesoscopic transport properties of atomically thin 2D materials and related heterostructure systems. By employing electrical and optical measurements, imaging and other transport measurement techniques, we investigate and explore the transport dynamics arising from interactions between electrons, phonons and photons, as well as the complex interplay of new physical phenomena in 2D materials over a wide range of temperatures. From which, we can effectively manipulate the electrical, thermal, and thermoelectric transport of these quantum systems towards transforming and developing novel technological applications in high-performance electronics, energy harvesting, sensing, and computing devices.

IMRE Tech Highlights

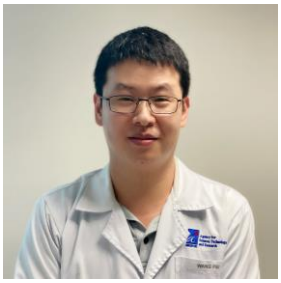
Urban Solutions

Thursday, 8 Sep 2022

10.15 am – 10.55 am

Simpor Junior Ballroom

Urban Solutions Talk 3



Dr. Wang Pei

Scientist, Structural Materials

Metal Additive Manufacturing for Sustainable Metal Economy

Additive Manufacturing (AM) which enables 3D printing of metallic components directly from powders increases by 17.7% in 2018 and is deemed as a transformative technology in the future of manufacturing. More importantly, the customization nature resulting in high unit value is deemed as a suitable technology for land scarce Singapore. Research in metals and alloys for metal additive manufacturing (AM) are attracting broad interests because of the huge demanding in new materials from manufacturing industries. We have developed several technologies for rapid alloy screening to speed up the alloy development process for metal AM. Metal AM is also considered as a clean manufacturing technology for future model factory. However, the reuse and recycling of metal powder waste hinders the further improvement of powder utilization rate of AM technology. In this presentation, I will share my research in metal AM materials aiming at creating sustainable and cleaner manufacturing solutions for industry. Meanwhile, I will also present my strategy in materials research in metal AM as well as producing AM metal powders from AM recycled powder scrap waste.

IMRE Tech Highlights

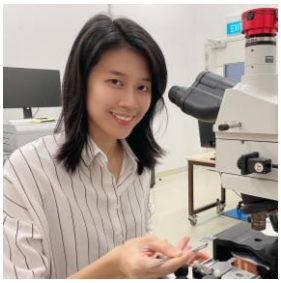
Urban Solutions

Thursday, 8 Sep 2022

10.15 am – 10.55 am

Simpor Junior Ballroom

Urban Solutions Talk 4



Dr. Ho Pin

Scientist, Electronic Materials

Hybrid Chiral Spintronics: Memory and Unconventional Computing

Spin-based technologies, exploiting the intrinsic magnetic spin and electronic charge of electrons, offer promising avenues for memory and computing applications. The realisation of chiral spin textures – comprising myriad distinct, nanoscale arrangements of spins with topological properties – has established novel pathways to engineer robust, energy-efficient and scalable elements for non-volatile nanoelectronics. First, we establish magnetic multilayer platforms which host room-temperature chiral spin textures by modulating their magnetic interactions through material stack design. Next, we harness such chiral spin textures for next-generation memory and brain-inspired computing, built upon their mobility in race-track wire devices and manipulation in magnetic tunnel junctions. Finally, we discuss the potential of hybrid material platforms, including chiral anti-ferromagnets and topological multiferroic textures, for the emerging field of chiral spintronics research and applications.

Invited Talks

Thursday, 8 Sep 2022

10.55 am – 11.15 am

Simpor Junior Ballroom

Invited Talk

Prof. Liu Xiaogang

Provost's Chair Professor, National University of Singapore & IMRE

Luminescent Nanoparticles: A Wonderful Toolbox for Imaging and Assistive Technologies

Lanthanide-doped nanoparticles exhibit unique luminescence properties, including massive Stokes shift, sharp emission bandwidth, high resistance to optical blinking, and photobleaching. They are also unique in converting long-wavelength stimulation into short-wavelength emission. These attributes offer the possibility of developing alternative luminescent labels for organic fluorophores and quantum dots. In recent years, researchers have demonstrated spectral-conversion nanocrystals for many biological applications, such as highly sensitive molecular detection and autofluorescence-free cell imaging. With significant progress over the past decade, we can now design and fabricate nanoparticles that display tailorable optical properties. In particular, by controlling different combinations of dopants and dopant concentrations, we can generate a plethora of colors under excitation with a single wavelength. By incorporating a set of lanthanide ions in defined concentrations into different layers of a core-shell structure, we have expanded the emission spectra of the particles to cover almost the entire visible region, which is not possible with conventional bulk phosphors. This talk will highlight recent advances in the broad utility of lanthanide-based nanocrystals and perovskite nanomaterials for multimodal imaging, bio-detection, therapy, X-ray scintillation, and assistive technology.

Biography

Xiaogang Liu earned his B.E. degree (1996) in Chemical Engineering from Beijing Technology and Business University, P. R. China. He received his M. S. degree (1999) in Chemistry from East Carolina University under the direction of Prof. John Sibert. He completed his Ph.D. (2004) at Northwestern University under the supervision of Prof. Chad Mirkin. He then became a postdoctoral fellow in the group of Prof. Francesco Stellacci at MIT. He joined the faculty of the National University of Singapore in 2006. He holds a joint appointment with the Institute of Materials Research and Engineering, Agency for Science, Technology and Research. Currently, he sits as an Associate Editor for Nanoscale and serves on the editorial boards of Chemistry - An Asian Journal, Advanced Optical Materials, Journal of Luminescence, Research, and Journal of Physical Chemistry Letters. His research encompasses optical nanomaterials and energy transfer and explores the use of luminescent nanocrystals for photocatalysis, sensing and biomedical applications.

1. "Rare-Earth Doping in Nanostructured Inorganic Materials," Chemical Reviews 2022, 122, 5519-5603.
2. "Organic phosphors with bright triplet excitons for efficient X-ray-excited luminescence," Nature Photonics 2021, 15, 187-192.
3. "Mapping Drug-Induced Neuropathy through In-Situ Motor Protein Tracking and Machine Learning," Journal of the American Chemical Society 2021, 143, 14907–14915
4. "Continuous-wave Near-IR STED Microscopy using Downshifting Lanthanide Nanoparticles," Nature Nanotechnology 2021, 16, 975-980.
5. "Anomalous upconversion amplification induced by surface reconstruction in lanthanide sublattices," Nature Photonics 2021, 15, 732-737.
6. "Enantiospecific Detection of D-Amino Acid through Synergistic Upconversion Energy Transfer," Angewandte Chemie International Edition 2021, 60, 19648-19652.
7. "High-resolution X-ray luminescence extension imaging", Nature 2021, 590, 410-415.
8. "Lanthanide-doped inorganic nanoparticles turn molecular triplet excitons bright," Nature 2020, 587, 594-599.

Invited Talks

Thursday, 8 Sep 2022

1.05 pm – 1.25 pm

Simpor Junior Ballroom

Invited Talk

Prof. Liu Bin

Senior Vice Provost (Faculty & Institutional Development)
Distinguished Professor, National University of Singapore

Accelerating the Development of Fluorogens with Aggregation-Induced Emission for Biomedical Applications

Recent years have witnessed the fast growth of fluorogens with aggregation-induced emission characteristics (AIEgens) in biomedical research. The weak emission of AIEgens as molecular species and their bright luminescence as nanoscopic aggregates distinguish them from conventional organic luminophores and inorganic nanoparticles, making them wonderful candidates for many high-tech applications. In this talk, I summarize our recent AIE work in the development of new fluorescent bioprobes for biosensing and imaging. The AIE dot probes with different formulations and surface functionalities show advanced features over quantum dots and small molecule dyes in noninvasive cancer cell detection, long-term cell tracing, and vascular imaging. In addition, our recent discovery that AIEgens with high brightness and efficient reactive oxygen species generation in the aggregate state further expanded their applications to image-guided cancer surgery and therapy. Through combing the accurate prediction of material performance via first-principles calculations and Bayesian optimization-based active learning, a self-improving discovery system was realized for high-performance photosensitizers, which significantly accelerated our materials innovation for biomedical research.

Biography

Dr. Bin Liu is currently a Professor and Senior Vice Provost of the National University of Singapore. She is a foreign member of the US National Academy of Engineering, a Fellow of the Singapore National Academy of Sciences, the Academy of Engineering Singapore, the Asia-Pacific Academy of Materials, and the Royal Society of Chemistry. She received her B.S. degree from Nanjing University and a Ph.D. degree from the National University of Singapore (NUS), before her postdoctoral training at the University of California, Santa Barbara. She joined NUS in late 2005 and was promoted to Dean's Chair Professor in 2014, Provost's Chair Professor in 2017, and Distinguished Professor in 2022.

Liu's research is focused on organic nanomaterials for energy and biomedical applications. She is among the World's Most Influential Minds and the Top 1% Highly Cited Researchers in Materials Science and Chemistry 2014-2021. Liu has received many prestigious awards, and the recent ones include ACS Nano Lectureship Award 2019 and the RSC Centenary Prize and Medal 2021. Liu is passionate about nurturing the next generation of research leaders and encouraging more women to pursue careers in science, engineering, and nanotechnology.

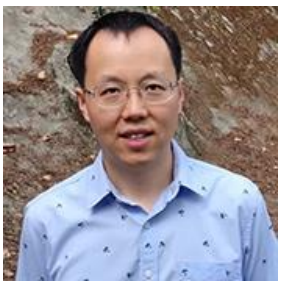
Strategic Initiative Talks

Thursday, 8 Sep 2022

1.25 pm – 1.40 pm

Simpor Junior Ballroom

Strategic Initiative Talk

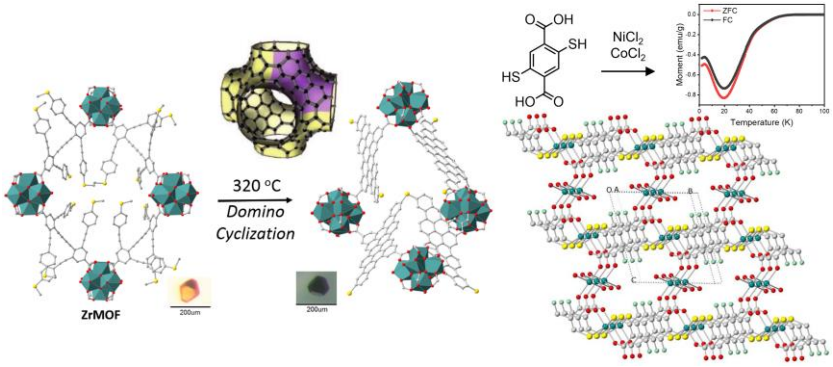


Dr. Xu Zhengtao

Principal Scientist, IMRE

Superconductors and 3D Graphenes: Wild Dreams of Metal-Organic Frameworks

In the first part, we employ a two-step strategy for accessing crystalline porous covalent networks of highly conjugated π-electron systems emulating the coveted 3D graphenes (Figure, left, a). For this, we first assembled a crystalline metal-organic framework (MOF) precursor based on Zr(IV) ions and a linear dicarboxyl linker molecule featuring backfolded, highly unsaturated alkyne backbones; massive thermocyclization of the organic linkers was then triggered to install highly conjugated, fused-aromatic bridges throughout the MOF scaffold while preserving the crystalline order. The resultant polycyclic aromatic network exhibits greatly enhanced stability, electroactivity and charge transport. In the second part, we report breakthrough in the modular synthesis of MOF solids extensively equipped with the mercaptan function, in order to fully exploit the unique metal-uptake, catalytic and electronic properties afforded by the thiol function, e.g., potential superconductivity observed of a designer coordination polymer system sporting the chemically soft mercaptan and hard carboxyl groups (Figure, right).



Biography

After BS (1996) at Peking University, Xu had a plan for organic chemistry, but ended up with a PhD from Cornell on coordination networks (MOFs). After postdoc at IBM and faculty appointment at George Washington University—as life would have it--Xu started anew in Hong Kong (2005), became a professor in 2015, and relocated to Singapore in 2022. Our work at IMRE/A*STAR carries forth the interest in catalytic and (super)conductive frameworks. Xu also enjoys Tolstoy, Schopenhauer and other classics.

IMRE Tech Highlights

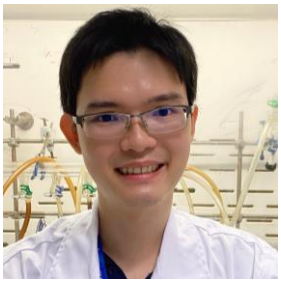
Medtech

Thursday, 8 Sep 2022

1.40 pm – 2.10 pm

Simpor Junior Ballroom

Medtech Talk 1



Dr. Jason Lim

Scientist, Soft Materials

Transforming Ophthalmology with Hydrogels

Visual impairment is a major global health issue, with more than one billion sufferers worldwide, severely impacting their quality of life and reducing their work productivity. Although advances in modern ophthalmology have gone a long way towards alleviating some of the most common eye diseases, much remains to be improved. Amongst the most significant ophthalmological conditions is retinal detachment, whose sudden onset can cause devastating loss of vision and whose current treatment is highly uncomfortable. Herein, I will introduce IMRE's thermogel technology, and show how we have exploited its unique combination of favourable properties such as transparency and temperature-responsive gelation to address some of the most critical issues facing retinal reattachment surgery today. In addition, our thermogels can also prevent the onset of proliferative vitreoretinopathy (PVR), one of the most common causes of vision loss after retinal reattachment, by preventing tissue scarring at a cellular level. Finally, strategies for using thermogels to treat new ophthalmological diseases such as age-related macular degeneration (AMD) will be discussed.

IMRE Tech Highlights

Medtech

Thursday, 8 Sep 2022

1.40 pm – 2.10 pm

Simpor Junior Ballroom

Medtech Talk 2

Dr. Yang Le

Scientist, Strategic Research Initiative

Cyber Physiochemical Interfaces: Wearable Biosensors

In this talk, we will introduce the work undertaken by our PROFESS Group (Printed Organic Flexible Electronics & Sensors). In particular, we will take a focused foray into our group's present effort on Cyber Physiochemical Interfaces, or wearable sensors, targeting non-invasive real-time continuous monitoring of sweat and on-skin biomarkers. We will look at sweat electrochemical sensors on metabolites, on-skin wearable sensors, sweat channelling and engineering, sensor electrode engineering, and electrochemiluminescent analytics. It is a challenging but invigorating field that our group has been venturing the past 2-3 years, contributing towards a new era of digital healthcare, cloud-based health data, and wearable personalised devices.

IMRE Tech Highlights

Medtech

Thursday, 8 Sep 2022

1.40 pm – 2.10 pm

Simpor Junior Ballroom

Medtech Talk 3

Dr. Su Xiaodi

Principal Scientist, Soft Materials

Portable Nanosensors for Wound Care and Infection Monitoring

Nanomaterials have distinct physical and chemical properties that can be exploited for designing rapid and easy-to-use biosensors. In this talk I will introduce our inorganic nanoparticles-based biosensors technologies. Our research activities include essential scopes from nanoparticle synthesis, biofunctionalization, to assay developments exploiting various optical readouts (e.g., color change, fluorescent modulation, and Raman spectroscopy etc.). We also process the sensing materials into wearable forms, e.g., printing on paper, embedding in gel etc. Wound healing is a complex process that consists of multiple phases, including haemostasis, inflammation, proliferation, and tissue re-modelling. Assessment of wound healing status currently requires manual adjustment or removal of dressings for visual inspection, which often induce pain to patients and elevate the risk of infection. The slow-turnover time in detecting infection (~2 days for bacterial culture of wound exudates) further restricts the time window and the clinicians' options for treating wound infection. Viral and bacterial infection detection largely rely on cell culture and PCR, which is slow and costly. In this talk I will discuss our nanosensor technologies for wound healing monitoring, as well as bacterial and microbial infection detection. We have kept in mind the market demand of faster, better, smaller, cheaper, and greener etc. analytical sensors, during the technology development. Comparing to conventional laboratory-based analytical technologies, our sensing technologies have advantageous attributes (cost, portability, sensitivity, selectivity etc.) for on-site applications.

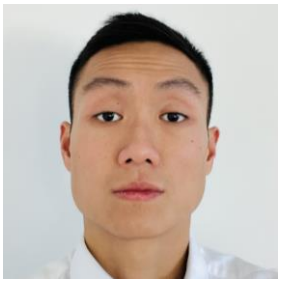
Invited Talks

Thursday, 8 Sep 2022

2.10 pm – 2.30 pm

Simpor Junior Ballroom

Invited Talk



Dr. Steven Lukman

Editor, Nature Materials

Science and Materials for a Sustainable World – Perspective from Nature Materials' Editor

Almost everyone has already experienced the impact of global warming, perhaps to a different extent depending geographically where one is, from unforeseen heatwaves, forest fires, increasing sea level, famine, drought, and flooding. On top of that, recently, our reliance on fossil fuels are strongly highlighted with the situation between Russia-Ukraine, which should call for immediate form of action from the leaders around the world. These are only a couple of examples, but there are many more issues that are interconnected and need to be collectively addressed immediately, as we, the current occupants, are held accountable for ensuring this planet is habitable for the next generation. What can one do to participate in this global effort? There are numerous ways that one can contribute, whether you are politicians, scientists, policy-makers, end consumers, suppliers, and even editors. As the voice of the community, moving forward, we are especially interested in attracting more scientific works on material discoveries and their clever unique application to meet the increasing demands of sustainable development, as documented in the 17 Goals of United Nations agenda[1] , such as Clean Water and Sanitation, Affordable and Clean Energy, Sustainable Cities and Communities, Good Health and Well-Being, Climate Action, as well as Innovation and Infrastructure.

Biography

Steven Lukman received his first degree in materials science and engineering from Nanyang Technological University (Singapore), followed by a MSc in nuclear physics from University of Tokyo, and a PhD in optoelectronics from University of Cambridge. After his PhD, he moved to the Agency for Science, Technology, and Research (A*STAR) in Singapore where he investigated the photo-physics of two-dimensional semiconductors for infrared and THz technology. Steven became a scientific editor at Nature Communications in 2020 and joined Nature Materials in January 2022, where he handles manuscripts in the areas of applied physics and devices, including flexible electronics, photovoltaics, optoelectronics, and neuromorphic computing.

1. Department of Economic and Social Affairs 2022, United Nation Sustainable development website, accessed July 2022, <https://sdgs.un.org/goals/>

Industry Partnership Talk

Thursday, 8 Sep 2022

2.30 pm – 2.40 pm

Simpor Junior Ballroom

Industry Partnership Talk

Dr. Hui Li

Director of Sales and Service for SEA, India and ANZ,
Materials and Structural Analysis Division of Thermo Fisher Scientific

Innovative Solutions for Electron Microscopy and Microanalysis Help to Tackle some of the World's Most Significant Challenges in Materials Science

Materials properties are determined by their composition and structure. In most cases the structure at the micrometer and nanometer scale is important. Thus, to develop materials with improved properties, we need to understand the microstructure of the material. Electron Microscopy (EM) has long been a technique of choice analyse the microstructure down to atomic level. Here we will introduce some innovative EM solutions on developing next-generation lithium batteries, new and improved metal nanoparticle catalysts, advanced metal alloys, and advanced composite.

Biography

Hui Li is Director of Sales and Service for SEA, India and ANZ at Materials and Structural Analysis Division of Thermo Fisher Scientific. She received her Bachelor degree in Chemistry from University of Science and Technology of China, the Master degree in Material Science and Engineering from Lehigh University, the Ph.D. degree in Material Science and Engineering from Shanghai Jiaotong University. She has been working in electron microscopy industry for 14 years. She started her career in US as an installation and training specialist for EDS&EBSD products. Then she had hold positions as application scientist, China sales manager, APAC sales manager before joining Thermo Fisher Scientific as director of sales and service for SEA, India and ANZ, managing the EM and XPS business since Jan 2021.

Strategic Initiative Talks

Thursday, 8 Sep 2022

3.30 pm – 3.45 pm

Simpor Junior Ballroom

Strategic Initiative Talk

Prof. Lam Ping Koy

*A*STAR Chief Quantum Scientist, IMRE*

Making Waves for Quantum Technology with Continuous Variable Systems

In quantum physics, the concept of wave-particle duality states that every quantum entity can be described as a wave, and also as a particle. This concept of quantum complementarity is beautifully illustrated in many versions of Young's double slit experiments. The particle and the wave nature of a quantum system can both be equivalently exploited for technological applications that could deliver "quantum advantages". As a wave has continuously varying amplitude and phase, quantum systems that utilise wave measurements are referred to as continuous variable (CV) quantum systems. One of the most notable applications of CV quantum systems is in astronomical gravitational wave detection. In LIGO's 4 km long baseline interferometers, a sensitivity of $>10^{-23}$ in strain measurement is attained. This is equivalent to being able to sense fluctuations in length smaller than the width of a hydrogen atom when measuring the distance between the earth and the sun! In this talk, I will present examples of lab-based CV quantum technologies that exploits the wave nature of light. Using quantum light sources that are quieter than vacuum, we explore the potential applications of CV technologies for quantum sensing, metrology, data encryption and computing.

Biography

Lam Ping Koy is a renowned experimental physicist in the research field of quantum information and metrology. He has made many scientific contributions in using laser to generate quantum states of light, slow and stop light, study quantum entanglement, encrypt information, perform precision measurements and inter-connect quantum platforms. Ping Koy started his career as an engineer for Sony and Hewlett-Packard before completing his PhD at the Australian National University in 1999. He was also an Alexander von Humboldt fellow to Germany and a CNRS visiting professor in Paris University. He was awarded two Australian Eureka Prizes, in recognition of his research in quantum teleportation and quantum encryption in 2003 and 2006, respectively. In 2007, Ping Koy co-founded QuintessenceLabs – an award-winning Australian company that commercialises quantum communication technology. More recently, Ping Koy was awarded the Australian Institute of Physics Alan Walsh Medal in recognition of his contribution to Australian Industry and was made a Laureate Fellow of the Australian Research Council. In 2020, he was elected as a Fellow of the Australian Academy of Science. Ping Koy has published close to 300 scientific articles with more than 50 papers appearing in Physical Review Letters, Science and the Nature research journal suite.

IMRE Tech Highlights

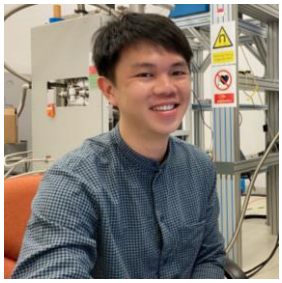
Quantum and Optics

Thursday, 8 Sep 2022

3.45 pm – 4.25 pm

Simpor Junior Ballroom

Quantum and Optics Talk 1



Dr. Aaron Lau Chit Siong

Scientist, Quantum Technologies for Engineering

A 2D Semiconductor Quantum Dot

2D semiconductors have potential for many applications including quantum but progress is severely hindered by contact and dielectric engineering. I will discuss our group's efforts to establish high-quality contacts at cryogenic temperatures where we revealed new insights into the nature of metal/2D semiconductor interface. Next, I will discuss our work on the influence of dielectrics and interface roughness on carrier transport and present our measurements on the first gate-defined chemical vapour deposition grown bilayer WS_2 quantum dot. Finally, we will share some of our latest work on integrating ultrathin metal oxides printed from liquid metals with 2D materials, and how they can potentially address crucial device engineering challenges in 2D materials.

1. C.S. Lau, J.Y. Chee et al., 'Quantum Transport in Two-Dimensional WS2 with High-Efficiency Carrier Injection through Indium Alloy Contacts', ACS Nano, 14 (10), 13700-13708 (2020)
2. C.S. Lau, J.Y. Chee et al., 'Gate-Defined Quantum Confinement in CVD 2D WS2, Advanced Materials, 2103907 (2021)

IMRE Tech Highlights

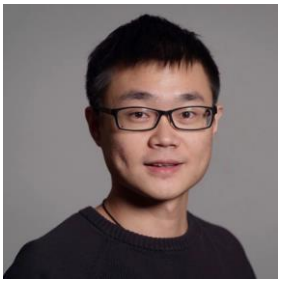
Quantum and Optics

Thursday, 8 Sep 2022

3.45 pm – 4.25 pm

Simpor Junior Ballroom

Quantum and Optics Talk 2



Dr. Zhu Di

Scientist, Quantum Technologies for Engineering

Integrated Photonic Devices for Scalable Quantum Information Processing

Quantum science and engineering are poised to bring a technological revolution to our society in the coming decade. Optical photons, as natural carriers of quantum information, have played central roles in numerous recent breakthroughs, from record-distance quantum secure communication to computational supremacy. However, scaling today's photonic quantum technologies to realize complex systems for practical computation and simulation still faces critical challenges. Such systems often require thousands to millions of components, which are infeasible to implement using traditional bulk optics. Integrated photonics is likely the only solution.

In this talk, we will describe our research efforts at QTE/IMRE on the development of integrated photonic devices for scalable quantum information processing. We will first introduce thin-film lithium niobate as an ideal material platform for the generation and manipulation of quantum light. We will then present superconducting nanowires as an effective solution for single-photon detection. Combining both, we aim to realize a fully integrated quantum photonic processor that allows single-photon generation, control, and detection on a single chip.

IMRE Tech Highlights

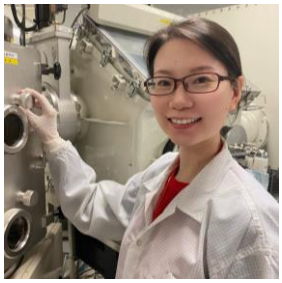
Quantum and Optics

Thursday, 8 Sep 2022

3.45 pm – 4.25 pm

Simpor Junior Ballroom

Quantum and Optics Talk 3



Dr. Wu Mengfei

Scientist, Advanced Optical Technologies

Manipulating Photons and Excitons: from Lasers to Upconversion

Organic molecules and semiconductor nanocrystals have become increasingly important in optoelectronic and sensing technologies, thanks to their wide spectral tunability, facile device fabrication and flexible form factor. Excited states in molecules and nanocrystals, unlike in traditional semiconductors, do not consist of mobile charge carriers but contain localised pairs of opposite charges, known as excitons. Light-matter interaction in these materials, such as absorption and emission, is largely mediated by excitons. Here, we explore two multiexciton phenomena, namely lasing, which produces photons with the same characteristics, and upconversion, which turns low-energy photons into higher-energy ones. Integrating excitonic materials in optical cavities, we have demonstrated room-temperature lasing in colloidal nanoplatelets and colloidal quantum dots, and upconversion of near-infrared light into visible light at sub-solar incident flux. For both lasing and upconversion, we will discuss key challenges, strategies for improvement and potential future applications.

IMRE Tech Highlights

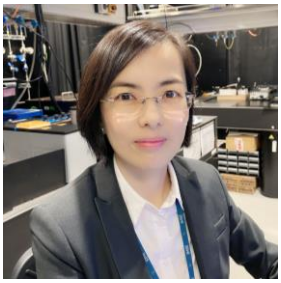
Quantum and Optics

Thursday, 8 Sep 2022

3.45 pm – 4.25 pm

Simpor Junior Ballroom

Quantum and Optics Talk 4



Dr. Wang Qian

Senior Scientist, Nanofabrication

Reconfigurable Nanophotonic Platform Based on Phase Change Materials

Nanophotonics has garnered intensive interests owing to the unique capabilities on unprecedented manipulation of light in the subwavelength regime for high speed and large bandwidth information transmission and computation. However, to rival electronics in terms of integrability and reprogrammability, nanophotonics must evolve into the next generation miniaturized and reconfigurable platforms with tunable properties on demand. Chalcogenide phase-change materials (PCMs), which retain the 'memory' of sub-threshold excitations and enable multiple-step gradual phase transition, have been identified as a promising platform for reconfigurable nanophotonic frameworks for ubiquitous functionalities from imaging and communication to sensing and others.

In our work, we explore multi-level optical phase transition of chalcogenide phase change material, Germanium-antimony-tellurium (GST), induced by femtosecond laser pulses. The pixilated phase change of GST in sub-micro marks results in a dramatic change in optical properties from amorphous to crystalline states. With such unique properties, various applications are demonstrated including high density data storage, re-writable flat photonics metamaterial, reconfigurable phase change photomask, and multi-step tuning of third harmonic generation. In addition to top-down nanofabrication of multi-functional phase-change metamaterials, bottom-up grown nanomaterial can offer possibilities for developing ultra-thin advanced optical devices. In our recent work, a highly birefringence ferrocene nanocrystal was synthesised for a true zero order waveplate. In addition, heterostructured 2D material structures are explored for manipulation of surface phonon polariton confinement. It is believed that the such nano materials engineering will advance photonics in the next-generation light-related applications e.g., all-optical neuromorphic computing, adaptive optics, imaging, and sensing, etc.