

# PERSPECTIVES



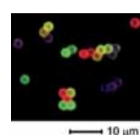
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## CORPORATE NEWS

## Chemical innovations for a sustainable future

IMRE, A\*STAR's Institute of Chemical and Engineering Sciences (ICES) and The Chemical Daily from Japan brought experts together to discuss new chemical and materials processes and innovations that have lesser impact on the environment.

A\*STAR's IMRE and ICES, together with The Chemical Daily from Japan co-organised the "Japan-Singapore Chemicals R&D Conference 2011- Innovation for Sustainable Growth" in October. The event highlighted emerging chemical and engineering R&D in Japan and Singapore. Chemistry experts from both nations also discussed cost-effective and eco-friendly chemical processes that could be used in making pharmaceuticals, speciality

chemicals, petrochemicals and consumer care products.

Research on new chemical reactions, processes and sustainable production methods help develop novel eco-friendly materials and low carbon processes with reduced environmental impact. Speakers for the event included scientists from research institutes as well as companies like Mitsui Chemicals, Shell Chemicals and Rio Tinto Minerals.



Prof Andy Hor (centre), IMRE's Executive Director facilitating the open forum session involving the conference's keynote speakers



**Dr Loh Xian Jun**  
Elected as first Singaporean Fellow at Fitzwilliam College, University of Cambridge

Dr Loh Xian Jun, an IMRE researcher and new Fellow of Fitzwilliam, is in Cambridge University under an A\*STAR Graduate Scholarship doing research on anti-cancer biomaterials.

The prestigious college that Dr Loh has been inducted to counts a number of very notable alumni in its ranks. They include Nobel

Prize winner Albert Szent-Györgyi who discovered Vitamin C and Singapore's first Prime Minister, Mr Lee Kuan Yew who is an honorary

Fellow at the college.

"Joining Fitzwilliam College has been a very humbling and exciting appointment that has given me

the opportunity to be part of the unique pedagogic faculty at Cambridge. Together with my research experiences, this exposure has enabled me to have personal insight into the eclectic and vibrant culture here," said Dr Loh whose current research is on multi-stimuli responsive 'exploding' bubble-like micelles. These are being used as an anti-cancer drug delivery vehicle that specifically targets cancer cells.

Dr Loh completed his PhD studies under the A\*STAR Graduate Scholarship (NUS) in Dec 2009 and deployed to IMRE before being awarded the A\*STAR Graduate Scholarship (Postdoctoral Fellowship) in Oct 2010 to do post-doctoral work at Cambridge. Dr Loh is listed as a Visiting Professor at Cambridge's Melville Laboratory in the Department of Chemistry.

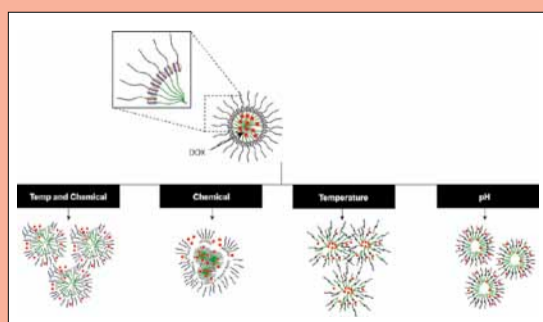


Prof Andy Hor, Executive Director of IMRE joined eleven other distinguished top local scientists to be conferred SNAS Fellowships on 24 November.

Prof Hor's fellowship citation stated his significant contributions to education, research and service in Chemistry since he began his career in Singapore in 1984.

The SNAS Fellowships recognise outstanding Singapore scientists

who have distinguished themselves in their respective fields. The candidates go through a rigorous selection process that requires screening by the SNAS selection committee, review of reports from nominators and finally a review by the SNAS Council.



Schematic showing the micelle and how it reacts to different stimuli

It then 'explodes' in the presence of a chemical trigger to release chemotherapeutic drugs, thus killing only the cancer cells but not the surrounding healthy cells.

## Anti-cancer smart bombs

"The unique micelles that I'm working on are like smart bombs that 'explode' to release the chemotherapeutic drug at suspected cancer tumour sites," said Dr Loh explaining what his current research work is about. His cucurbituril-based biomaterial is more stable and is able to better form single, discrete drug-carrying micelles than the commonly used cyclodextrin version. His micelles are stimuli-responsive and tailored to react to certain environmental factors. When the pH

## PEOPLE

### The Power of Research: Profile – Mr Tan Siah Hong

With a passion for energy R&D, Tan Siah Hong is back in A\*STAR's IMRE for a year before he heads off to complete his PhD studies overseas. He is currently developing new ways to store energy harnessed from the sun.



where he studied for a Chemical and Biomolecular Engineering undergraduate degree under A\*STAR's National Science Scholarship. This led to him being on A\*STAR Chairman's Honours List for three consecutive years. His research interest is in one of today's hottest topics – energy. While keen on research into the generation, storage, transport and use of solar fuels, Siah Hong also realises the importance of coupling research with understanding the social, economic, technological and business implications of a renewable energy-powered future.

**M**r Tan Siah Hong puts the 'A's in A\*STAR, literally. He is a straight-A scholar who was a regular feature on the Dean's List at Johns Hopkins University, USA

#### Why materials research?

I got involved in materials research as I believe that developing effective storage solutions for solar energy is a very important problem to solve if we want to see solar power become a mainstream energy resource for mankind. IMRE offers me the chance to participate in such research and has given me excellent grounding in many of the semiconductor processing and characterisation techniques crucial in energy R&D.

#### What specific research are you doing in IMRE?

I am working with Drs. Wang Wei and Soh Chew Beng on light-assisted water splitting. This is an approach where one uses sunlight to drive the formation of fuels (ie. hydrogen from water). The hydrogen can then be stored and used later in a fuel cell on demand. This potentially solves the problem of intermittent power that solar energy currently faces. I am studying the effects of micro- and nanostructuring on p-type silicon, as well as searching for earth-abundant catalysts to replace traditional expensive ones like platinum, and analysing how these will affect the efficiency of the photocathode for hydrogen generation.

#### Why is this important to the man on the street?

Finding a cost-effective way to generate fuel, such hydrogen or methanol, using sunlight will be a tremendous breakthrough in allowing solar energy to be used as a baseload resource. This means that we will be able to tap into this energy source during cloudy days or even at night. This solar-generated fuel will enable renewable energy to be distributable on a much larger scale. Once this technology matures, you would not need to refuel your car at the pump, nor purchase electricity from your local utilities company. Ideally, everything would be generated on-site, and any surplus demand can be sold and become a potential source of income. We may still be a long way from realising this future but we are making good, steady progress.

#### What do you hope to achieve in your research career?

There are two main (and complementary) ways in which renewable energy can be adopted on a large scale. One is to develop effective storage solutions. The other is to develop a 'smart grid' that can efficiently manage and balance energy produced and consumed at different locations in a seamless, cost-effective network. I would like to work on either problem, and eventually enable renewable (particularly solar because of its favorable cost structure) energy to be a mainstay in satisfying each and every person's energy needs.

#### What are the traits of a successful scientist?

Scientists should have thorough and complete knowledge in their fields, have a deep passion for their work, have the determination and ability to drive projects to completion, and take an active interest in helping to nurture talents under their charge.

#### What do you do when you are not harnessing the full power of the sun?

I enjoy listening to music of many different genres. I also play classical piano from time to time. Also, I enjoy working out in the gym – a healthy body supports a healthy mind.

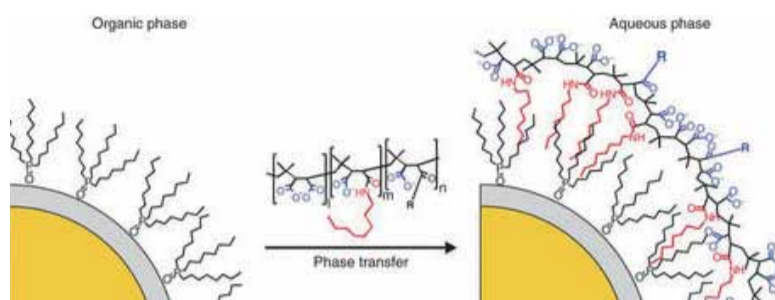
#### Do you have any words of advice for budding scientists or those considering a career in science?

Follow your dreams, be flexible when needed but never give up.

## RESEARCH

### Easy-to-make polymer shells for quantum dots may help enhance tracking and detection of biomolecules

IMRE researchers have developed a simpler, cheaper recipe for making customisable quantum dots (QDs) that can potentially help scientists enhance tracking and detection of certain molecules such as cancer cells.



Schematic showing the attachment of functional groups to the polymer shell of the QDs

**B**eing able to tag a molecule with nanometer-sized QDs – brightly coloured, long lasting, fluorescent particles - is one of the most effective ways for scientists to study cells and molecules, especially in disease research. However, QDs are usually not water-soluble and need to be adapted by a lengthy complicated process so that they can be used in water-based environments like the body. IMRE researchers have devised a simple, cost-effective process that coats the QD in a protective shell to make QDs water-soluble. Different molecules can also be attached to the QD's surface making the QD highly customisable.

"Our protocol is a straightforward recipe using commercially available and cheap polymeric precursors, available anywhere in the world," explained IMRE scientist and research

co-author, Dr Dominik Janczewski, on the advantage that the new protocol has over existing ways for making water-soluble QD biomarkers. "Our protocol is faster, generic and can be tailored to specific applications due to the additional functional groups that can be attached to the QD's surface." "The protocol is so simple that the process and reactions can be done by undergraduate students in any university laboratory."

The secret of the research lies in the two-layer polymer shell. The inner layer facing the quantum dots is hydrophobic, or water-repelling, while the outer layer is hydrophilic, or water-loving, which gives the QDs their solubility.

"The generic nature of the protocol allows it to be applied in many different research fields, from

materials science and biology," added Dr Nikodem Tomczak, an IMRE scientist and co-author of the research. "We can already see immediate application of this work in bioimaging of cancer cells and increasing sensitivity limits for sensors, although the range of applications is really limited only by one's imagination."

The results of their research were published recently in Nature Protocols, a new publication of the Nature journals family.

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Reference for the research paper: Dominik Janczewski, Nikodem Tomczak, Ming-Yong Han & G Julius Vancso; "Synthesis of functionalized amphiphilic polymers for coating quantum dots"; Nature Protocols 6, 1546–1553 (2011); Doi:10.1038/nprot.2011.381

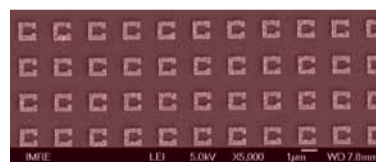
**“Our protocol is faster, generic and can be tailored to specific applications due to the additional functional groups that can be attached to the QD's surface.”**

## Publication highlights

Listed below are some noteworthy IMRE research publications.

### Flexible metamaterials for chemical and biological sensing using EBL

**Xinlong Xu, Bo Peng, Dehui Li, Jun Zhang, Lai Mun Wong, Qing Zhang, Shijie Wang, and Qihua Xiong; "Flexible Visible-Infrared Metamaterials and Their Applications in Highly Sensitive Chemical and Biological Sensing"; Nano Lett. 2011, 11, 3232–3238; DOI: 10.1021/nl2014982**



Scanning electron microscopy image of metamaterial structure fabricated by using electron beam lithography (EBL)

**Abstract:** IMRE and Nanyang Technological University (NTU) researchers have demonstrated a flexible metamaterial-based visible-IR photonic device with potential applications in portable photonic devices that have high sensitivity strain, biological and chemical sensing functions. The metamaterial structures were made using electron beam lithography (EBL) and consists of split ring resonators (SRRs) of 30 nm thick Au or Ag on poly(ethylene naphthalate) (PEN) substrates line widths of 30 nm. The absorption resonances can be tuned from middle IR to visible range. The flexible metamaterial devices made show superior

responses with a shift of magnetic resonance of 4.5 nm/nM for nonspecific bovine serum albumin protein binding and 65 nm for a self-assembled monolayer of 2-naphthalenethiol, respectively. It exhibits high sensitivity response to strain, local dielectric environments and surface chemical changes in the visible-IR region. The achievement is significant as EBL was used to make the very small feature size patterns needed for the metamaterials to operate in the infrared and visible wavelengths. Current flexible metamaterials were demonstrated mainly in the microwave and terahertz regions and EBL was believed only to work on metamaterials placed on rigid and flat substrates.

**“The research contributes to flexible electronic and photonic devices that can lead to potentially low cost, light-weight, transparent, biocompatible, and portable devices for a wide range of applications.”**

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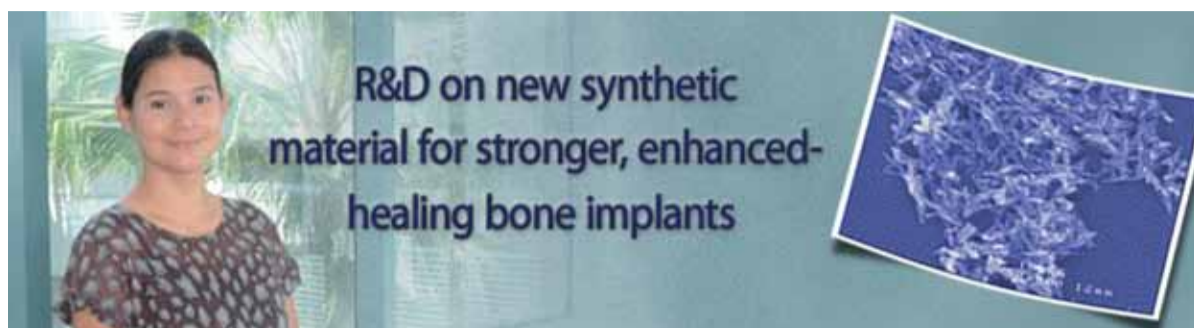
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## AWARDS



IMRE scientist heads new R&D grant which looks at nanocomposite material for bone implants that mimic the healing properties and strength of natural bone.

IMRE's Dr Emma Luong Van will lead a joint project on enhanced bone implants with Dr Bina Rai from the Institute of Medical Biology (IMB) under a research grant given by the A\*STAR Scientific Conference Young Research Collaborative Grant.

The R&D project looks at new nanocomposite materials with embedded biomolecules that may make bone implants stronger and can help repair damaged bones. The researchers believe that the material developed will have strong

clinical potential.

For more information about this research work, please contact Dr Luong Van at [luonge@imre.a-star.edu.sg](mailto:luonge@imre.a-star.edu.sg)

## UPCOMING EVENTS

### Diary of upcoming events @ IMRE

**18 January 12**  
IMRE Industry Day  
IMRE, Singapore

To find out more about IMRE's seminars and events, please visit [www.imre.a-star.edu.sg/eventsall.php](http://www.imre.a-star.edu.sg/eventsall.php)

Past issues of our newsletters are available on our website at

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For general enquiries please write in to [enquiry@imre.a-star.edu.sg](mailto:enquiry@imre.a-star.edu.sg)

## OUTREACH

### Getting the young interested in research

Giving secondary school students a taste of research life and introducing undergraduates to IMRE's research capabilities in materials R&D are just some of the ways to nurture Singapore's next generation of scientists.



NYGH students on attachment

IMRE played host to a number of student groups recently. A select group of undergraduates were given a tour of IMRE's advanced characterisation facilities and were briefed on the capabilities of IMRE clean room on 3 October. The undergraduates were students from the Microfabrication Process

module at the National University of Singapore (NUS).

Another batch of 18 NUS students from the Electrical and Engineering Department visited IMRE on 19 October so that they could learn more about the research and characterisation techniques of tools such as X-ray

photoelectron spectroscopy, transmission electron microscopy and time-of-flight secondary ion mass spectroscopy.

29 secondary school students from Nanyang Girls' High School (NYGH) did research attachments at IMRE from 14-18 November. The first such attachment between IMRE and NYGH, the comprehensive attachment programme provided students with a basic understanding of synthetic chemistry and hands-on experience in the synthesis and characterisation of various compounds and materials. The students were also given an introduction to the modern tools used in the characterisation of materials.

### Launch of the Journal of Molecular and Engineering Materials (JMEM)



IMRE Executive Director Prof Andy Hor launching JMEM

#### 15 November 11

IMRE hosted a number of academics and industry guests related to molecular materials work during the launch of JMEM, a new publication by World Scientific Publishing. The journal targets reviews, communications and regular papers in all areas under molecular and

engineering materials. Molecular materials is an intersecting field of materials and molecular science, whereas engineering materials integrates materials research with the broad engineering field.

For more information please go to [www.worldscinet.com/jmem](http://www.worldscinet.com/jmem)

### Visit by the Organic Electronics Association



Visitors from the Organic Electronics Association being briefed on IMRE's OPV technology

#### 24 November 11

Some 20 delegates from the Organic Electronics Association were briefed on IMRE's organic electronics R&D such as organic photovoltaics. Hosted by Dr Zhang

Jie the delegates were taken on a tour of the characterisation as well as organic synthesis and photovoltaics laboratories.

### Green chemistry conference in Singapore

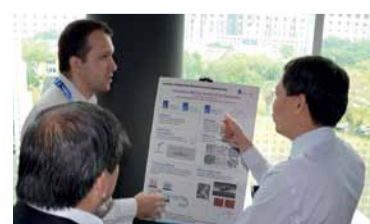
IMRE and the Singapore National Institute of Chemistry (SNIC) organised the second International Conference on Green & Sustainable Chemistry (2nd ICGSC 2011).



ICGSC-2 participants being briefed on IMRE's facilities

IMRE researchers helped in the organising committee and were invited as speakers for the conference, which was held in Singapore from 14-15 Nov 11. The conference provided a common platform for some 120 researchers, academics, consultants and industry professionals to discuss the latest developments in key areas of green and sustainable chemistry. Some of the topics covered included alternative energy & fuel cells, sustainable materials, green syntheses, waste treatment and biomimetic systems.

### Singapore Maritime Institute (SMI) Forum



Dr Dominik Janczewski briefing Transport Minister, Mr Lui Tuck Yew on IMRE's ship anti-biofouling technology at the SMI Forum

#### 12 October 11

IMRE showcased its capabilities in high-strength, low-weight carbon fibre reinforced polymer research and innovative marine anti-fouling solutions during an exhibition held in conjunction with the Forum.