Creating molecular-sized processor chips

IMRE partners 10 European Union (EU) research organisations to work on the groundbreaking €10 million ATMOL project that lays the foundation for creating and testing a molecular-sized processor chip.

First came the world’s first controllable molecular gear. Now, IMRE’s scientists will team up with researchers from the EU to build what is essentially a single molecule processor chip. These pioneering steps in atom technology could one day lead to computer processors so small that 1000 such processors could fit into one of today’s microchips. Computing power can be increased significantly but take a day lead to computer processors and electronics may be made in the future”, said Prof Andy Ho, Executive Director of IMRE. Annual ATMOL meetings will gather all the project partners for regular progress updates and synchronisation, with the first meeting on atomic scale interconnection machines to be held in Singapore in 2011. The project will officially commence on 1 January 2011.

IMRE and its partners are working on new technology for making anti-bacteria surfaces

Marine mammal-inspired new chemical-free, anti-bacteria plastic ‘skins’

The IMRE-led Industrial Consortium On Nanoimprint (ICON) plans to engineer anti-microbial surfaces for use on ships, lenses and bio-medical devices.

Want to know more about the Industrial Consortium On Nanoimprint (ICON)?

ICON members enjoy a number of advantages:

- Access to the advanced nanoimprint technology and know-how in A*STAR
- Shared R&D resources and costs to develop new products and applications that reduces R&D risks and investments
- Training of manpower in nanoimprint techniques and tools
- Networking with companies that cover the entire spectrum of nanopatterning service

A new project on roll-to-roll nanoimprint technology is expected to begin in the second quarter (Q2) of 2011.

For more details, please contact Mr Rick Ong (Industry Development Manager) at ongr@imre.a-star.edu.sg
Talking shop and shopping - Gathering the brightest young minds in nanotechnology

The Asia Nano Forum’s (ANF) 3rd Asia Nanotech Camp brought together 40 hand-picked young researchers from the Asia-Pacific region to discuss, debate, network and collaborate on their favourite pastimes - nanotechnology, eating and shopping!

For one week, top young nanotechnology scientists from some 35 universities in 13 countries across the Asia-Pacific region met in Singapore to discuss nanotechnology and experience the cultures of the host nation. Apart from academic presentations on nanostructured materials, and discussions on the impact of nanoscience and nanotechnology on society, the unique camp had a substantial part of the programme dedicated to activities that allowed participants to discover more about Singapore - research-wise, economically and culturally.

The participants visited local universities, research organisations and companies that made use of nanotechnology research such as Hyflux. Cultural immersion programmes also introduced them to the sights, sounds, diversity, and tastes of Singapore.

"Just as important as the exchange of ideas on research are, the camp allowed the participants to learn more about the culture and lifestyle of people living in Singapore and how R&D impacts that lifestyle", explained Prof Andy Hor, Executive Director of IMRE, whose own nanotechnology R&D includes nanostructured materials, nanocomposites, nanotechniques and nanoimprinting.

Echoing his sentiments, Dr Lim Khiang Wei, Vice-President of ANF said, "The camp is a networking opportunity for these young researchers. This 'peer support group' will be essential to them in the future when they begin to take on their roles as principal drivers of research and innovation in their respective countries".

The camp, organised in Singapore by IMRE from 4-9 October, was just the first leg in a two country journey, with the second leg hosted by Akademi Sains Malaysia.

Publication highlights

Listed below are some highlighted IMRE research publications.

Supramolecular quantum dot (QD) patterns for sensing

**Visualizing Resonance Energy Transfer in Supramolecular Surface Patterns of CD-Functionalized Quantum Dot Hosts and Organic Dye Guests by Fluorescence Lifetime Imaging;** Small 2010, 6 (24), 2870-2876; A. H. Velders, G. J. Vancso, et al.

**Abstract:** Colloidal quantum dots (QDs) are bright, long-lasting, light emitting nanoparticles that revolutionised the field of biological imaging and sensing. In particular, the low photobleaching rates of QDs make them suitable for applications in devices designed for sustained monitoring. However, integrating QDs with sensing devices requires chemical engineering of their surface to include specific functional groups. In a publication co-authored by IMRE researchers a strategy that combines supramolecular attachment to "molecular printboards" and supramolecular host-guest sensing via a Fluorescence Resonance Energy Transfer (FRET) transduction mechanism using QDs was demonstrated. The QDs had been coated with cyclodextrin, a member of the cyclic sugars family of molecules that can act as hosts in the complexation of small organic molecule guest in the cyclodextrin cavity. To overcome the reversible nature of the supramolecular host-guest binding, multiple host-guest interactions that effectively anchor the QDs to guest-functionalised substrates were needed. Fluorescence Resonance Energy Transfer (FRET) occurs when a suitable energy donor-acceptor pair is brought to each other’s proximity to within a few nanometers. FRET systems are therefore ideal for use as nanoscopic optical rulers and proximity sensors because they use the correlation between the energy transfer efficiency and distance between the donor and acceptor. QDs, which have broad absorption spectrum are well-suited for FRET. Using QDs, one can therefore avoid interference between the FRET emission and directly excited acceptor signal.

The research opens the way for devices integrating proximity sensing, e.g. via FRET, that have higher detection selectivity. Such sensors can be used in devices for early detection of diseases and for the monitoring of contaminants in water.

For more information about the publication, please contact:

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Cyclodextrin-coated QDs are attached to a molecular printboard by using a multivalent supramolecular "glue". Binding of model analytes to the cyclodextrin on the QD surface results in FRET.
Abstract: IMRE has developed a new fabrication method that significantly improves the material properties of indium nitride (InN), which enhances the performance of InN-based light emitting devices (LEDs). By simply placing an additional thin layer of semiconductor material, or a ‘cap’, on the surface of InN thin films during the growing process, surplus electrical charge can be effectively displaced. This results in improvements in material performance such as the electron density, which decreased from $3.5 \times 10^{13} \text{ cm}^{-2}$ to $5 \times 10^{12} \text{ cm}^{-2}$ and electron mobility, which increased from 4 to 457 $\text{cm}^2\text{V}^{-1}\text{s}^{-1}$. This can be explained by assuming the film consists of a surface accumulation layer and a bulk layer. It was found that the accumulation layer could be eliminated by capping the surface with silicon nitride, gallium nitride or zinc nitride of 2 nm each, respectively; while an aluminum nitride (AlN) cap layer caused the formation of two-dimensional electron gas at the AlN/InN interface. The innovative capping allows the creation of more efficient nitride-based LEDs across the whole visible spectrum. More importantly, the research will make it possible to grow LEDs of different colours on one semiconductor chip and in a single growth process. For more information about the publication, please contact:

**Dr Liu Wei**

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New ‘coat’ for water-soluble quantum dots (QDs) helps enhance stem cell labelling

IMRE researchers have patented a new coating and bio-conjugation method for QDs for use in stem cell labelling.

**Dr Subramanian Tamil Selvan**

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Unique light emitting diodes (LEDs) that produce polarized light

New invention produces polarized light from a conventional InGaN/GaN LED structure by using a sub-wavelength metal grating (SWMG) and does away with the need for additional polarizer in LED display and imaging devices.

**Dr Teng Jinghua**

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Giving a boost to terahertz (THz) emissions

New patented method enhances the efficiency of photoconductive antenna (PCA) terahertz (THz) photonics and increases the output power of such devices.

**Dr Teng Jinghua**

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2010 AsiaNANO Young Researcher Award

Dr Tan Yen Nee was one of the winners of the AsiaNANO 2010 Young Researcher Award.

**Dr Tan Yen Nee**

Winner of AsiaNANO 2010 Young Researcher Award

**IMRE**

Dr Tan Yen Nee, a Research Engineer with the Materials Characterisation and Analysis group, was one of the winners of the 2010 AsiaNANO Young Researcher Award at the AsiaNANO meeting held in Japan from 1-3 November 2010. The award, which is in recognition of outstanding papers authored by young researchers and presented at the conference, was given out for her presentation on “Gold Nanoparticles-based Biosensor”. 

**IMRE’s Dr Tan Yen Nee, a Research Engineer with the Materials Characterisation and Analysis group, was one of the winners of the 2010 AsiaNANO Young Researcher Award at the AsiaNANO meeting held in Japan from 1-3 November 2010.**

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From aerospace, food packaging to armour: New age composite materials developed for a variety of industries

IMRE showcases polymer and nanocomposites R&D for new transparent high-barrier film packaging, low dental shrinkage materials, anti-scratch coatings, aerospace carbon-fibre reinforced polymers and soft, high-impact resistant protective padding.

Made from two or more physically and chemically distinct materials, engineered composites are versatile materials that have been used to produce anything from lightweight, high-strength plastics for aircraft to barrier films for food packaging. IMRE showcased its composites R&D at the JEC Composites Show Asia 2010 at Suntec Convention Centre, Singapore from 12-14 October 2010.

The composite technologies included:

- New transparent polymer films - Keeping food fresher for longer
- Soft, lightweight, flexible composite materials that harden on impact for use as protective armour
- Strong, light and low-cost carbon-fibre reinforced polymers (CFRP) - A fraction of the weight, many times the load-bearing capability

IMRE Workshop on Characterisation of Photovoltaic Materials and Devices

13 Oct 10

The workshop by IMRE, National Institute of Advanced Industrial Science and Technology (AIST), Japan Science and Technology Agency (JST) and A*STAR arranged for nine secondary school students to visit IMRE on 9 Sep 10 in conjunction with the National Engineering Carnival. The students were introduced to research life and R&D in IMRE and visited the bioensors, nanoimprint, chemical synthesis and Scanning Tunnelling Microscopy laboratories.

Reaching out to secondary school students

6 & 9 Sep 10

Two groups of secondary schools students were given a tour of IMRE’s laboratories and a briefing on some of the R&D done here. Some 30 Secondary 3 students visited IMRE on 6 Sep 10 in an event organised by the Science Centre Singapore. Separately, the Institute of Engineers Singapore (IES) and A*STAR arranged for nine secondary school students to visit IMRE on 9 Sep 10 to give them a taste of the type of research and R&D work done at IMRE.

Top company executives from Japanese companies tour IMRE

13 Oct 10

IMRE hosted 20 senior management executives of Japanese companies for a tour organised by the Japanese Chamber of Commerce and Industry. An in-depth briefing of IMRE’s R&D capabilities, opportunities for collaboration, tour of the facilities and networking session was arranged for the attendees who included Managing Directors and General Managers from chemical and materials-related companies such as Mitsubishi Chemicals, Toyo International, Sumitomo Seika, Sekisui Plastics, Nagase and Teijin Polycarbonate.

IMRE Workshop on Atomic Layer Deposition (ALD) and Its Applications

23 Nov 10

IMRE, in association with Beneq and Azimuth Technologies, organised the workshop to introduce recent ALD developments, particularly its novel applications as well as its equipment and precursor design for such applications. Some 80 attendees were treated to presentations by invited speakers from Beneq, Picoum, NUS, NTU, and IMRE.

IMRE Symposium on Organic and Polymer Electronics

9 - 10 Dec 10

More than 100 participants attended the symposium where some of the world’s top organic electronics scientists and industry players converged to discuss new materials, research and techniques that will advance the manufacturing of affordable and versatile plastic electronics. A range of topics were covered including new materials, theoretical studies, and device fabrication and characterisation of organic light-emitting diodes, organic photovoltaics and organic field effect transistors.

3rd Singapore Scanning Probe Microscopy Symposium (SingSPM 2010)

15 Dec 10

Organised by IMRE, SingSPM 2010 aimed to promote Singapore’s SPM research and foster international interactions by featuring internationally renowned keynote speakers in the field of SPM. More than 70 attendees attended talks by SPM practitioners who presented their research, which ranged from novel instrumentation to applications in biology, and featuring special talks highlighting technology areas where SPM can create impact. In addition, this year’s SingSPM 2010 saw the launch of a new book on “Scanning Probe Microscopy” co-edited by IMRE’s Dr Johnson Goih and Dr Nikodem Tomczak.

IMRE Workshop on Magnetic Materials and Characterisation

13 Dec 10

The workshop showcased the capabilities for magnetic characterisation and modelling in IMRE, A*STAR Institute of High Performance Computing (IHPC) and NUS and provided a platform for researchers to share their experiences in characterisation techniques for measurement of magnetic properties of a variety of magnetic materials.

IMRE Workshop on Biosensors for Medical Diagnosis, Environmental Monitoring and Fundamental Research

28 Oct 10

The workshop aimed to demonstrate how new materials, advanced microfabrication technology and nanotechnology have led to highly integrated and miniaturised biosensors / sensor systems with excellent performance. Some 100 participants attended the workshop that served as a platform for the biosensor R&D community to interact, identify technical challenges and gaps between research and product development, and to develop commercialisation strategies.

Diary of upcoming events @ IMRE

10 – 11 January 2011
Molecular Materials Meeting (M3) @ Singapore
Biopolis, Singapore

12 January 2011
IMRE - Hong Kong Baptist University Workshop
IMRE, Singapore

21 January 2011
Singapore - Kyoto Forum on Nanotechnologies and Engineering for the Green Future
IMRE, Singapore

To find out more about IMRE’s seminars and events, please visit www.imre.a-star.edu.sg/eventsall.php

Past issues of our newsletters are available on our website at www.imre.a-star.edu.sg

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