# PERSPECTIVES

Research, Development and Commercialisation — Institute of Materials Research & Engineering (IMRE)

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Institute of Materials Research and Engineering
A*STAR

# Reaching out to Local Industry


*By **Ms Angie Choo**, Senior Business Development Executive, Business Development and **Dr Adrian Burden**, Senior Engineering Fellow, Opto- and Electronic Systems Cluster*


One of IMRE's goals focuses on developing and transferring technologies that complement the R&D needs of the local industry. IMRE fulfils this role in many different ways including research collaborations, consultancy services as well as graduate and research attachment training programmes. Partnerships are also formed with companies, which can enhance their competitive advantage through R&D.

***Interaction with members of local enterprise, such as these participants at an Industry Symposium organised by IMRE, is an essential part of our outreach efforts.***

## Helping local companies upgrade R&D capability

IMRE, through the Agency for Science, Technology and Research (A*STAR), the Economic Development Board (EDB) and Spring Singapore, offers programmes that help facilitate the transfer, development and upgrade of technology to local companies.

## Secondment of research staff to industry

Singapore industry now has access to world-class, technical staff employed by A*STAR's network of research institutes (RIs) through the recently launched T-UP (Technology for Enterprise Capability Upgrading) and GET-UP (Growing Enterprises

# Editorial

Dear Readers

One of the key objectives for IMRE is to provide local industry with the technological edge to thrive in a knowledge-based economy through our innovation and advancements in materials research. There are a number of ways to transfer know-how from our researchers - actively seeking collaboration with partners to exploit the research, direct transfer by seconding staff to target industries, holding seminars, workshops and symposiums, and using our publications to create an awareness of the research being conducted in IMRE.

This issue of Perspectives features some of the efforts employed by IMRE in reaching out to industry. From A*STAR's Technology for Enterprise Upgrading (T-Up) and Growing Enterprises with Technology Upgrade (Get-Up) secondment schemes to the seminars and industry workshops organised by IMRE, great emphasis is being placed on ensuring that the successes of research institutes like IMRE benefit local enterprise.

The Editor

with Technology Upgrade) programmes. T-UP aims to strengthen the technical innovation capability of local companies through the secondment of research scientists and engineers (RSEs). Under the scheme, relevant RSEs can be seconded to companies for a period of up to 2 years. Grants are included to offset part of the secondment cost. Opportunities for companies to retain RSEs on a full-time basis are also available, based on mutual agreement. GET-UP on the other hand, involves the appointment of our senior scientists and engineers as technical consultants.

In summary, high-grade technology and scientific know-how, which have otherwise been the domain of large multinational corporations, is being made available to homegrown small and medium enterprises (SMEs).

### OTA/TRM

Operation and technology assessment (OTA), and technology road-mapping (TRM) involves small groups of technical staff from one or more of the national Research Institutes visiting SMEs to discuss opportunities in technology and business at the senior management level. OTA allows the teams to interact and familiarise themselves with that company's operations, which results in a shared understanding of strengths and potential for developing technology. TRM subsequently focuses in greater detail on likely market trends, and methods to adapt products and services to meet new challenges. The outcome is a chart or map that links technology resources to future opportunities, and highlights upgrade routes for a company's technology infrastructure.

### In Partnership with IMRE

The benefits of these efforts are clear. IMRE possesses world-class expertise and know-how in materials research and engineering like optoelectronics, display technology, nanotechnology and polymer design. Sharing this with local companies will greatly increase their technological edge. In addition, IMRE's characterisation laboratory is recognised as one of the best in the region. Technology is a critical component for companies to upgrade and expand in a knowledge-based economy and IMRE can help you realise the potential of your company.

If you are interested in exploring possibilities with us or wish to know more about A*STAR's assistance programmes, please contact the Business Development Department at bdo@imre.a-star.edu.sg

For more information on IMRE's OTA/TRM plans, please contact Dr Adrian Burden at adrian-pb@imre.a-star.edu.sg.

## Upcoming Industry-related Seminars

Industry seminars in the area of "Optoelectronics, Photonics & Display", "Nano-structured Materials and Processing", and "Micro Devices Fabrication and Packaging" are currently being planned. For more information on these and other developments, please look out for future announcements on our website at http://www.imre.a-star.edu.sg.

# IMRE's Director – One of the Most Cited Researchers in Materials Science

*Prof Albert Yee, Director of IMRE*

By **Mr Eugene Low**, *Publications Executive, Corporate Communications*

*Congratulations to Prof Albert Yee, IMRE's Director, for being listed as one of the "Highly Cited" materials scientists! Prof Yee thus joins over 200 materials scientists worldwide for this distinction.*

Prof Yee has some 140 papers published in referred journals. According to the Science Citation Index, these papers have been cited about 3,000 times. Seven of these publications have been cited more than a hundred times.

This rating is given on the web-based ***ISIHighlyCited.com***, a website that collates the work of some of the world's most cited and influential researchers. Part of the ISI (Institute of Scientific Information) Web of Knowledge, ***ISIHighlyCited.com*** helps identify individuals, departments and laboratories that have made fundamental contributions to the advancement of science and technology through the citation of the respective publications.

The selection is based on the total number of citations received by an individual within a given category as recorded in the ISI database. These categories are derived from the journals found in the database that contains millions of articles.

Prof Yee has also been honoured by the American Physical Society by being elected a Fellow in 1983. In 1994, he received the International Adhesion Society Japan 94 Award. In 2001, he was elected by the Polymeric Materials Science and Engineering Division of the American Chemical Society to be a Fellow. In 2002 he was honoured by the College of Engineering of the University of Michigan with a Research Excellence Award.

# Characterisation Expertise Impacts Study on Nanowires

By **Dr Mark Yeadon**, *Senior Research Fellow, Materials Science & Characterisation Laboratory*

*Dr Mark Yeadon*

A research publication, co-authored by two of IMRE's scientists, was featured in the 19 December 2002 issue of ***Materials Update*** of the online version of the ***Nature*** scientific journal.

"This development is important in a variety of applications including fabrication of and wiring together nanoelectronic devices, and the fabrication of 'supertips' for scanning probe microscopes," said Dr Mark Yeadon, an IMRE Senior Research Fellow who had characterised the samples for this study using transmission electron microscopy (TEM). Dr Yeadon is a member of IMRE's Materials Science and Characterisation Laboratory, which is one of the region's most well-equipped, in terms of facilities and capabilities.

Entitled, ***"Field-emission induced growth of nanowires"***, the paper was published in the *Applied Physics Letter, vol. 81 no. 25* on 16 December 2002. The study was conducted using a developed scanning electron microscope (SEM) with in-situ gas injection, developed by Assoc Prof John Thong from NUS' Department of Electrical and Computer Engineering.

According to ***Materials Update***, the technique allows the growth of nanowires of almost any length, and almost any composition depending on the precursor gas used. This permitted the scientists to grow nanowires from a variety of different materials including tungsten, iron, cobalt and carbon. Nanowires are important for their potential use as building blocks in the emerging field of nanoelectronics.

# A Short Course and Workshop on Organic Light-Emitting Devices (OLEDs)

By **Dr Zhu Furong**,
*Senior Research Fellow,*
*Opto- & Electronic Systems Cluster*

A two-day short course on "Science and Technology of OLEDs" (10-11 February 2003), and a one-day technical workshop on "Recent Progress of Organic Electroluminescent Displays" (13 February 2003) were recently organised by IMRE. The workshop was to address recent developments in the science and engineering of novel OLEDs in display applications.

Conducted by Prof Hung Liang Sun from City University of Hong Kong, the short course and workshop are part of outreach efforts in the area of novel OLEDs, one of IMRE's key activities in research on plastic electronics. Prof Hung is well-known in the field of OLED research and was the first to demonstrate a surface emitting OLED that had superior electrical and optical characteristics. He has been honoured as a distinguished inventor at the Eastman Kodak Research Laboratories, published more than 130 papers, and filed some 30 patents.

***Prof Hung (left) in discussions with Prof Chua (right), Cluster Director for IMRE's OESC and Dr Zhu Furong (centre) who organised the event***

The series of lectures that were conducted during the short course provided a comprehensive review on topics relating to OLED research. These included issues on charge injection and transport, organic/electrode interfacial properties and interface engineering, mechanism of degradation processes, device architecture, pixelated OLED displays, and accomplishments and technical challenges in flexible OLEDs.

Over 60 research staff, students, engineers and R&D managers from IMRE, National University of Singapore (NUS), Nanyang Technological University (NTU) and the related display industries attended the course and workshop. The event also allowed scientists from IMRE, NUS and NTU to exchange ideas, discuss, and learn about the latest technical advances in this rapidly expanding field.

# Physics of Thin Films and Surfaces Workshop

By **Dr Low Hong Yee**, *Research Fellow,*
*Molecular & Bio-Materials Cluster*

A Workshop on ***Physics of Thin Films and Surfaces*** was held at IMRE on 13 January 2003. It was a one-day workshop attended by over 20 researchers from IMRE and NUS. The workshop focused on the theoretical and experimental development in the areas of thin films and surfaces properties. Properties of thin films and free surfaces are important in various technological areas such as microelectronic devices, and micro and nano-electromechanical devices (MEMs and NEMs). This is an area of special interest to technologies where scales of size are essential.

Four speakers were invited to give lectures on this topic – Prof K L Ngai, senior scientist from the Naval Research Laboratory, USA, Dr Ophelia Tsui, an Assistant Professor from the Hong Kong University of Science and Technology, Dr Christopher L Soles, Research Scientist from the National Institute of Standards and Technology, USA, and Prof Buddy Ratner of the University of Washington, USA.

The talks included 'Dynamics of Polymer in Thin Films and in Nano-pores', 'Effect of the Air and Substrate Interface on the Glass Transition Temperature of Polymer Films Supported by Substrates', 'Application of Neutrons, Positrons, and X-Rays techniques to investigate the dynamic of thin films', and 'Assessing the Complexity of Biosurfaces with Surface Science Methods'.

***The organisers and the invited speakers; (L-R) Dr He Chaobin (IMRE), Prof KL Ngai (Naval Reseacrh Lab, USA), Dr Christopher L Soles (NIST, USA), Dr Low Hong Yee (IMRE), Prof Albert Yee (Director, IMRE), Dr Ophelia Tsui (HKUST) and Prof Buddy Ratner (UW, USA)***

# Second IMRE Sub-SAB Meeting

*By **Ms Evelyn Oeij,** Assistant Planning & Development Manager, Planning & Development Department*

IMRE hosted the second Sub-Scientific Advisory Board (SAB) meeting from 15-17 January 2003.

The topical meeting focused on discussing several key IMRE projects and their prospect of creating visible short-term impact. The SAB members commented that the projects are scientifically impressive and some would indeed have very good potential for achieving commercial impact. The SAB had recommended that IMRE look into further developing these projects with the necessary resources to reach this goal.

The SAB members who attended the meeting included Professor Wolfgang Knoll (Max-Planck-Institut für Polymerforschung in Mainz), Professor Otto C.C. Lin (Hong Kong University for Science & Technology), Professor Buddy Ratner (University of Washington), Professor William Tang (University of California, Irvine), Dr Masami Tatsumi (Sumitomo Electric Industries Ltd), and Professor G Julius Vancso (University of Twente).

The members of the SAB also had the opportunity to discuss with Professor Jackie Ying, Director of the new Institute of Bioengineering and Nanotechnology (IBN) on the ways IMRE and IBN could collaborate, using their respective materials-centric and bio-centric areas of research.

***IMRE and its SAB hold regular meetings to assess the progress and plan the development of the institute's research portfolio***

The meeting culminated with a joint SAB-IMRE Postgraduate Workshop that was held in conjunction with the meeting. Postgraduate students from both IMRE and the home universities of the SAB members attended the workshop to discuss ways of enhancing the existing links and interactions.

The next SAB meeting is scheduled for 4-5 July 2003.

# Postgraduate Workshop for IMRE and SAB Students

*By **Mr Roderick Lim**, Research Associate, Micro- & Nano Systems Cluster*

In conjunction with the sub-SAB meeting, IMRE organised a postgraduate workshop that brought together students from the Institute and those from the affiliated universities of the SAB members. The workshop was held over a period of three days from 17-19 January 2003.

The participants included students from IMRE, the Max-Planck-Institut für Polymerforschung (Mainz), the University of Toronto, the Tokyo Institute of Technology, the Kyushu Institute of Technology, and the University of Twente.

Initiated by the SAB, the workshop acted as a platform to encourage interaction and networking amongst students and staff. It was also designed to create the opportunity for participants to explore possibilities of staff exchanges, including post-doctorate appointments, across the many different organisations. Some 38 SAB and IMRE postgraduate students attended the event.

The programme for the workshop consisted of oral presentations, interspersed with poster presentations, discussions and laboratory tours. The SAB postgraduate students were also treated to a day sightseeing tour of Singapore.

The informal setting of the workshop created an ideal atmosphere for interaction, where science was mixed with an element of fun. The number of links established is great testimony to the success of the SAB-IMRE Postgraduate Workshop 2003. IMRE intends to organise this workshop on an annual basis.

# IMRE Scientists Form Part of a New Institute

*By **Mr Eugene Low**, Publications Executive, Corporate Communications*

A very hearty congratulations to 20 IMRE research scientists and engineers who will form part of the core of the new Institute of Bioengineering and Nanotechnology (IBN)!

The staff, with expertise in bio-related materials research, will facilitate the building up of the newest research institute (RI) under the A*STAR family, which will be located in the upcoming life sciences hub, the Biopolis. The transfer of staff took effect from 1 April 2003.

Their highly valued talents and experience in areas like tissue engineering, gene delivery and controlled release devices are expected to go a long way in advancing the research capability and resources in the new institute.

IMRE will continue to focus on developing its current materials-centred research and at the same time, leverage on the expertise of these researchers in related areas. As part of the A*STAR organisation, IMRE works in close partnership with other A*STAR RIs in complementary and symbiotic R&D collaborations to achieve technological impact.

***IMRE's management and all the staff wish to thank these researchers for their priceless contribution to our R&D advancements. We also wish them all the best in their new home.***

# Getting Students Interested in Doing Research

*By **Ms Chua Sze Sze**, Administrative Officer, Research Administration Department*

An open house for National University of Singapore (NUS) and Nanyang Technological University (NTU) undergraduates from the faculties of Science and Engineering was organised on 17 February 2003. A total of 32 students from various departments like Mechanical Engineering, Materials Science, and Physics attended the event.

The objective of the open house was to promote IMRE's R&D activities and A*STAR's graduate scholarship schemes.

Representatives from the respective research clusters and characterisation laboratory - Materials Science & Characterisation Laboratory, Opto- & Electronic Systems Cluster, Molecular and Biomaterials Cluster and Micro & Nano Systems Cluster - gave the undergraduates an overview of the current R&D work being conducted in IMRE.

The students were also briefed on the A*STAR Graduate Scholarship (AGS) scheme, a collaboration between A*STAR's Graduate Academy and NUS' Graduate School. AGS comprises a four-year PhD study tenable at NUS and a two-year post-doctoral fellowship in one of the selected top overseas universities or research laboratories in the scholar's chosen field. The PhD degree, covering areas of study that include physical science, engineering and biomedical science is awarded by NUS.

**IN A SIMILAR EVENT** on 3 April 2003, IMRE organised a presentation of its R&D activities at NTU targeted at some 60 students. The aim of the event was to introduce IMRE as well as to give the engineering undergraduates a brief on postgraduate study opportunities available to them.

Scientists from the multidisciplinary research areas were at hand to outline some of the innovative research being conducted in IMRE. Researchers and students also had a chance to interact with one another during a poster display session arranged by the institute.

*Dr Low Hong Yee from IMRE's Molecular & Biomaterials Cluster giving an overview of some of the research activities*

# Spreading the Science Message to JC Students

*By **Mr Eugene Low,** Publications Executive, Corporate Communications*

*Junior college students attending the research symposium*

An IMRE researcher joined scientists from other A*STAR research institutes to give local junior college students an insight into research in Singapore. Held on 18-19 March 2003, and organised by Anglo-Chinese Junior College, the science research symposium entitled "Genesis" was also designed to inspire students to consider research as a career, and deepen their appreciation for science.

The symposium included plenary sessions, special lectures covering scientific research skills, and small group discussions that focused on the applications of these skills.

*Dr Melissa Sander presented a talk on nanoscale science*

Dr Melissa Sander from IMRE's Micro- & Nano Systems Cluster gave an overview of recent progress in nanoscale science, citing some examples of novel nanoscale applications. She also briefly described the various methods used in assembling nanoparticles to create large structures with unique properties and functions.

A total of 180 students were invited to participate in the symposium, which involved junior colleges and centralised institutes nationwide.

# Visitors and Events

### Physics of Thin Films and Surfaces Workshop

**13 Jan 2003**

A one-day workshop on the Physics of Thin Films and Surfaces was held at IMRE. Some 20 researchers from IMRE and NUS attended the workshop that focused on the theoretical and experimental development in the areas of thin films and surfaces properties.

### Second IMRE Sub-SAB meeting

**15-17 Jan 2003**

IMRE held its second Sub-SAB meeting from 15-17January 2003 in conjunction with a joint SAB-IMRE Postgraduate Workshop (17-19 Jan 2003). The topical sub-SAB meeting focused on discussing several key IMRE projects and their prospect of creating visible impact.

### SAB-IMRE Postgraduate Workshop

**17-19 Jan 2003**

The workshop, initiated by the SAB, served as a platform to encourage interaction and networking between postgraduate students from IMRE and the home universities of the SAB members.

*Participants arriving for the OLED workshop*

### OLED short course and workshop

**10-11 Feb 2003 and 13 Feb 2003**

A short course on "Science and Technology of OLEDs" (10-11 February 2003), and a technical workshop on "Recent Progress of Organic Electroluminescent Displays" (13 February 2003) was recently held at IMRE. The short course and workshop are part of IMRE's outreach efforts in the area of novel OLEDs.

### IMRE Postgraduate Open House

**17 Feb 2003**

IMRE invited NUS and NTU science and engineering undergraduates for an open house on 17 February 2003. The students were given a briefing on IMRE's R&D activities as well as the A*STAR graduate scholarship scheme available to them.

*Science and engineering undergraduates attending the IMRE Open House*

### Presentation on IMRE's R&D activities at NTU

**3 April 2003**

IMRE organised a presentation of its R&D activities to some 60 NTU students with the aim of introducing the research institute and to present an overview of postgraduate study opportunities to the engineering undergraduates. Scientists from the various research areas enlightened the students on some of the innovative research being conducted in IMRE. The students also had the chance to interact with the researchers during a poster session prepared by the institute.

*For more details on the above events, please refer to the main article in this issue.*

# Patents and Publications

## Patents Filed (FEBRUARY – MARCH 2003)

### Template-assisted Nanostructure Formation

The invention involves a method to produce dense, large-area arrays of nanoscale molecular islands inexpensively and quickly. Potential applications of molecular islands on surfaces include molecular electronics.

## Publications - FEBRUARY 2003

- **Hydrothermal synthesis of $KNbO_3$ and $NaNbO_3$ powders**
  G. K. L. Goh, F. F. Lange, S. M. Haile and C. G. Levi
  *Journal of Materials Research v18[2], p338 (2003)*
  For further information, contact: g-goh@imre.a-star.edu.sg

- **Measurement of longitudinal piezoelectric coefficient of thin films by a laser scanning vibrometer**
  YAO Kui, Francis TAY Eng Hock
  *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control. Volume: 50(2),pp 113 - 116, 2003*
  For further information, contact: k-yao@imre.a-star.edu.sg

- **Preparation and characterisation of inclusion complexes of biodegradable amphiphilic poly(ethylene oxide)-poly[(R)-3-hydroxybutyrate]-poly(ethylene oxide) triblock copolymers with cyclodextrins**
  Li Xu, Li Jun, Leong Kam
  *Macromolecules, 2003, 36, 1209–1214*
  For further information, contact: x-li@imre.a-star.edu.sg

- **Preparation and characterisation of polypseudorotaxanes based on block-selected inclusion complexation between poly(propylene oxide)-poly(ethylene oxide)-poly(propylene oxide) triblock copolymers and a-cyclodextrin**
  Li Jun, Ni Xiping, Zhou Zhihan, Leong Kam
  *Journal of the American Chemical Society, 2003, 125, 1788–1795*
  For further information, contact: jun-li@imre.a-star.edu.sg

- **Synthesis, characterisation, and physical properties of monodisperse oligo(p-phenyleneethynylene)s**
  Zhou Chuan-Zhen, Liu Tianxi, Xu Jingmei, Chen Zhikuan
  *Macromolecules, 2003, 36, 1457-1464*
  For further information, contact: cz-zhou@imre.a-star.edu.sg

- **New phenyl-substituted PPV derivatives for polymer light emitting diodes - Synthesis, characterisation and structure-property relationship study**
  Zhi-Kuan Chen, Nancy Hoi Sim Lee, Wei Huang, Yi-She Xu, and Yong Cao
  *Macromolecules, 2003, 36, 1009-1020*
  For further information, contact: zk-chen@imre.a-star.edu.sg

## Publications - MARCH 2003

- **Photoluminescence of InGaN/GaN multiple quantum wells originating from complete phase separation**
  P. Chen, S. J. Chua, and Z. L. Miao
  *Journal of Applied Physics, Vol 93 No 5, pp. 2507-2511*
  For further information, contact: p-chen@imre.a-star.edu.sg

- **Secondary ion mass spectroscopy study of failure mechanism in organic light emitting devices**
  L. Ke, K.R. Zhang, N. Yakovlev, S. J. Chua and P. Chen
  *Materials Science and Engineering B, Vol. 97, pp. 1-4, 2003*
  For further information, contact: karen-kl@imre.a-star.edu.sg

- **A study of the decomposition of GaN during annealing over a wide range of temperatures**
  M.A. Rana, H. W. Choi, M. B .H. Breese, T. Osipowicz, S. J. Chua and F. Watt
  *Materials Research Society Symp. Proc. Vol. 742, pp. L11.28.1 - L11.28.6 (2003)*
  For further information, contact: sj-chua@imre.a-star.edu.sg

- **Analysis of the detectivity for triple-layer heterojunction GaSb/GaInAsSb infrared detectors**
  T. Yuan, S. J. Chua and Y. X. Jin
  *Microelectronics Journal, Vol. 34, pp. 305 – 312 (2003)*
  For further information, contact: sj-chua@imre.a-star.edu.sg

- **Nitride-mediated epitaxy of CoSi2 on Si(001)**
  R.K.K. Chong, M. Yeadon, W.K. Choi, E.A. Stach and C.B.Boothroyd
  *Applied Physics Letters 82, 1833 (2003)*
  For further information, contact: m-yeadon@imre.a-star.edu.sg

- **The Strength of silicon die in flip-chip assemblies**
  B.Cotterell, Z. Chen, J.-B. Han, N.-X. Tan
  *Journal of Electronic Packaging, 125, 114 (2003)*
  For further information, contact: brian-c@imre.a-star.edu.sg

- **Reaction of $SiO_2$ with hafnium oxide in low oxygen pressure**
  S. J. Wang, P. C. Lim, A.C. H. Huan, C. L. Liu, J. W. Chai, S. Y. Chow, J. S. Pan, Q. Li, and C. K. Ong
  *Applied Physics Letters, 82, 2047 (2003)*
  For further information, contact: sj-wang@imre.a-star.edu.sg

- **Synthesis, characterisation and polymerisation kinetics of novel ladder-like polysilsesquioxanes containing side-chain propyl methacrylate groups**
  P. S. G. Krishnan and Chaobin He
  *Macromolecular Chemistry 2003, 204, 531-9*
  For further information, contact: sg-krishnan@imre.a-star.edu.sg

- **Poly(amic acid)s and their ionic salt solutions : Synthesis, characterisation and stability study**
  R. H. Vora, P.S.G. Krishnan, S. Veeramani and S. H. Goh
  *Polyimides and Other High Temperature Polymers, Vol. 2, pp 1-33 Ed.K. L. Mittal*
  For further information, contact: sg-krishnan@imre.a-star.edu.sg

- **Effects of poly (ethylene glycol) additive molecular weight on the microstructure and properties of sol-gel-derived lead zirconate titanate thin films**
  Yu Shuhui, Yao Kui, Santiranjan Shannigrahi & Francis Tay
  *Journal of Materials Research, vol 18:(3), 737-741, 2003*
  For further information, contact: k-yao@imre.a-star.edu.sg



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