

# PERSPECTIVES

Research, Development and Commercialisation

Institute of Materials Research & Engineering (IMRE)

IMRE is a research institute supported by the Agency for Science, Technology and Research and is an affiliate of the National University of Singapore.

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## Putting the "spotlight" on cancer genes and proteins

Imagine being able to identify cancer genes and proteins just by looking at the colour of the light they emit.

This is now a real possibility with the nano-biotechnology research done by Dr Han Mingyong, a senior research fellow at IMRE who also holds a joint appointment at NUS.

He embeds semiconductor nanocrystals, also known as quantum dots, into polymeric beads that are capable of emitting colours to light up specific biomolecules like genes and proteins.

"We can even tailor-make the quantum-dot-coded beads to emit multicolours to identify different disease genes or proteins present", says Dr Han whose diagnostic kits he terms "lab-on-a-bead" may prove to be a faster and cheaper alternative to currently available devices.

Dr Han was one of the 12 recipients of the Young Investigator Award, an award given out jointly by the National University of Singapore and the Biomedical Research Council of A\*STAR to promising ▶



"Lab-on-a-bead" featured on the cover of the July 2001 issue of Nature Biotechnology

## Editorial

Dear Readers,

As some of you may have noticed, the PERSPECTIVES has taken on a different look. The name's the same but the layout is fresh and we have added a few new features (including this editorial column). More highlights on our research activities and achievements will supplement our regular features. Though these will only present brief and basic details, the more in-depth technical aspects will be explored in greater detail in our research newsletter, IMPACT. In so doing, we hope to reach out farther and to a wider audience, thus increasing the level of interest from not only academics but from industry players. In this issue of the PERSPECTIVES, we highlight some of the young talents already in place in Singapore and whose contributions to innovative research remain the best tools to achieve IMRE's objectives of a world-class research organisation. Innovation and intellectual property too provide the edge we need to propel IMRE to new heights. An added boost came in the form of the recent "re-branding" of the local R&D scene paving the way for closer cooperation between IMRE and her sister research institutes, with Singapore's economy as the eventual beneficiary. The infrastructure is in place, the plans are afoot and the signal is clear – Singapore research will soon be a force to be reckoned with.

The Editor

► continued from page 1

researchers in recognition of their innovative research work.

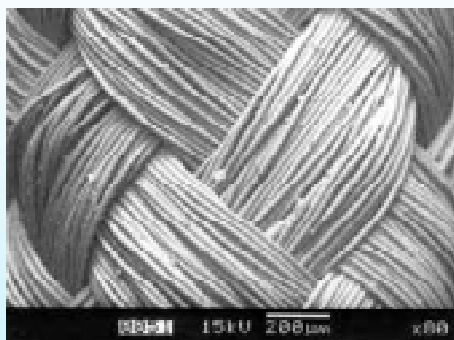
Each of the researchers will also be entitled to a grant of up to \$550,000 over a period of 3 years to be used in furthering the research in their respective fields.

For more information on "lab-on-a-bead", please contact Dr Han Mingyong at [my-han@imre.org.sg](mailto:my-han@imre.org.sg)



Dr Han Mingyong, one of the recipients of BMRC's Young Investigator Award

## The right connection: Student wins award for innovative research



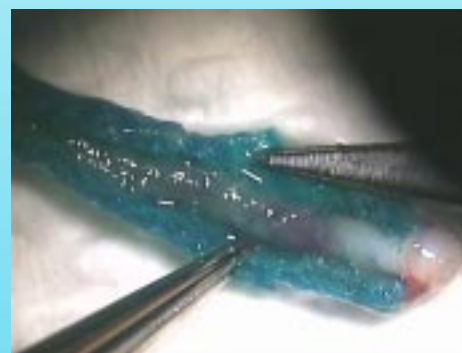
SEM picture of the microbraided structure

Sometimes the simplest devices turn out to be the most innovative. And it was for this reason that Ms Bini Thumbarathy was conferred the Silver Medal in the Hewlett-Packard - Far Eastern

Economic Review Young Investors Award 2001. She was selected from a field of 220 young researcher nominees from across the Asia-Pacific region.

The technology in question is a microbraided nerve guide conduit. Looking more like a rolled-up shoelace, this deceptively simple tube may be a cheap, efficient answer to repairing the body's severed or damaged nerves, blood vessels, ligaments and tendons.

Made out of a polylactic glycolic acid (PLGA) that is completely biodegradable, the conduit is woven together using basic cloth-weaving technology around a Teflon tube scaffold that is then removed, creating a



The microbraided tube being removed from a regenerated nerve

hollow all-PLGA fibre tube. PLGA is commonly used to suture wounds during surgery.

"My research revolves around the use of these fibrous tubes as nerve guide conduits to aid in the regeneration of severed nerves," says Bini who is currently pursuing a doctorate degree from the National University of Singapore (NUS) based on the research done here in IMRE.

The flexible tube is attached at the junction of the severed nerve acting as a bridge to connect the two ends of the nerve together while regeneration occurs. Without this sheath, the process would be lengthier and would be less likely to succeed. The most common method currently for repairing severed nerves involves nerve grafting - an invasive, cumbersome procedure that requires the patient to donate nerve cords from other parts of the body.

"The new microbraided conduits are better because they are stronger, safer and are biodegradable," says Dr Wang Shu, a senior research fellow with IMRE and the supervisor in charge of the research. "The microbraided structure possesses the necessary mechanical strength yet is flexible enough to endure the rigours of the human body, making it suitable even in bridging long gaps," says Dr Wang. He



*"The new microbraided conduits are better because they are stronger, safer and are biodegradable"*

- Dr Wang Shu, IMRE

added that this was an improvement when compared to existing tubes that were either too rigid, were not porous enough or splintered easily.

Bini had been working on fibres for quite some time and was planning to start research on fibrous scaffolds for tissue engineering before she hit on the idea of adapting this to the tubes.

"I realised that most of the body's internal structures like nerves, ligaments,

intestines are tubular in nature. So why not make tubular fibrous scaffolds to suit these?" commented Bini on the inspiration behind the microbraided tubes.

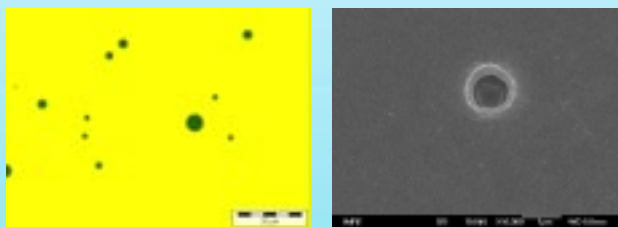
For her efforts, the mechanical engineering student will receive a

computer system from the main sponsor Hewlett-Packard (HP), and be flown to Palo Alto, California for a tour of the HP labs. A sum of US\$5,000 will also be donated to NUS to encourage further development of this technology.

Although tested successfully in laboratory rats, the tube has yet to enter clinical trials for use in humans. The research team involved is currently collaborating with the National Neuroscience Institute to test the efficiency of the tubes in repairing severed nerves with gaps up to 15mm in length.

For more information on this research, please contact Dr Wang Shu at [shu-wang@imre.org.sg](mailto:shu-wang@imre.org.sg)

## Shedding new light on OLED "dark spots"



A close-up of the dark spots on an OLED (left) and an SEM picture of a dark spot (right) on the OLED surface

Organic light-emitting devices (OLEDs) are being touted as successors to the current cathode-ray tube and liquid crystal display. This next generation lighting and display technology offers a range of advantages including flexibility, lower-power consumption, high luminosity and reduced width profiles.

However, a problem plaguing the OLED is the

appearance of dark spots on the lighted surface due mainly to the quick degradation of the light-emitting polymer thereby limiting long-term applications.

Studies done by a research team from IMRE have helped shed light on the subject of "dark spots". Recently featured in the Materials Update (dated 4 April 2002) section of the Nature Publishing Group website, the research team's work was a study on the mechanisms of degradation and failure of OLEDs.

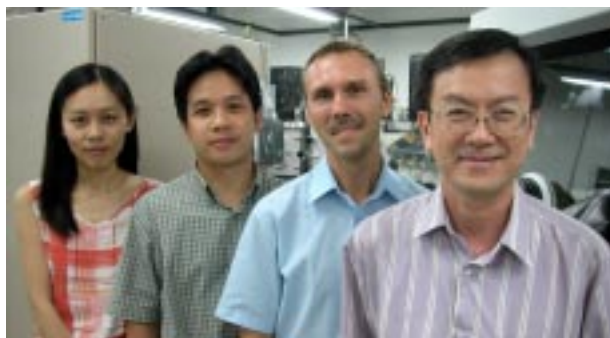
"Many studies have been done on this phenomenon with most of the work focusing on the formation of the spots and analysing the chemical elements formed during degradation", says Ms Ke Lin, the main author of the

publication entitled, *Degradation and failure of organic light-emitting devices*, which was published in the 25 March 2002 issue of *Applied Physics Letters* (Vol. 80, No. 12). "In IMRE, we looked at the device as a whole instead", adds Ms Ke Lin, a senior research officer with the institute's Opto- & Electronic Systems Cluster.

From experimental data, the team has discovered that the cause of the problem may be centred on the electrodes and the electrode-polymer interface.

OLEDs primarily comprise a light-emitting polymer sandwiched between a cathode and an anode on a transparent substrate. These electrodes, located on the polymer coat are where electrical currents are applied, causing electrons and holes to recombine and resulting in the emission of light from the polymer layer.

The team has discovered that imperfections in the cathode and the inherent properties of the polymeric material results in less than smooth contact at the interface between the cathode and polymer. This leads to differing current densities at different points along the interface causing some areas to experience increased luminescence and heat, and an eventual short circuit of these



The authors of the publication, (from left to right) Ms Ke Lin, Mr Zhang Keran, Dr Nikolai Yakovlev and Prof Chua Soo Jin

localised areas. Circular non-emissive regions start to appear on the device's active polymer layer indicating that dark spots are being formed here. These dark spots then nibble away at the active polymer area causing current fluctuations and the formation of more dark spots. The device destabilises and ultimately fails.

This discovery will go a long way in perfecting OLED technology and bring it to the next stage of development. "This discovery will help us in inhibiting dark spot formation and growth, giving us devices with a longer lifetime," says Ms Ke Lin.

For further details about this discovery or if you wish to make enquiries about the publication, please write to Ms Ke Lin at [karen-kl@imre.org.sg](mailto:karen-kl@imre.org.sg)

## Materials Research Society (MRS) Spring Meeting, 1-5 April 2002

The annual Spring Meeting of the MRS was held in San Francisco in early April. The MRS meetings bring together scientists, researchers and engineers from the world over for a week of symposiums, sessions and updates on the latest highlights in multidisciplinary advanced materials research.

This year's Spring Meet saw some of IMRE's researchers presenting papers on some of the research work done here. The Institute also took the opportunity to seek out new talent to supplement and enhance the strength of IMRE's current research capability. "Where else can we find the best and brightest talents in materials research then at one of its premier conferences," said Ms Ng Puay Chen, Senior Administrative Officer with IMRE's Planning & Development Department. Ms Ng added that part of the strategy for getting good recruits involved actively seeking them out instead of waiting for them "to come knocking at our door".

IMRE's multinational research personnel number close to 150 with more than half holding doctorate qualifications.

### RESEARCH PAPERS PRESENTED BY IMRE STAFF (UNDERLINED) AT THE MEETING:

Interplay of defects, microstructures and surface stoichiometry during plasma processing of GaN  
By A Ramam, S Tripathy, SJ Chua

Suppression of NiSi-to-NiSi<sub>2</sub> transition using very short-time RTA silicidation  
By D Ma, DZ Chi, WD Wand, ASW Wong, SJ Chua

Enhanced thermal stability of NiSi films on 20 KEV BF<sub>2</sub><sup>+</sup> implanted (100)Si  
By ASW Wong, DZ Chi, ME Loomans, D Ma, WC Tjiu, SJ Chua

Micro-Raman spectroscopic study of nickel silicide films  
By SK Donthu, DZ Chi, S Tripathy, ASW Wong, SJ Chua

Hydrothermal synthesis of I:V perovskite thin films  
By Gregory KL Goh

In-situ microelectron microscopy of amorphous silicon growth  
By Mark Yeadon, J M Gibson, etc.

Epitaxial growth of CoSi<sub>2</sub> on Si(100)  
By Ryan Chong, Mark Yeadon, Shue Yin Chow, Chaw Sing Ho

Oriented growth of boron nitride nanotubes from single source precursors  
By Mark Yeadon

# Patents & Publications

## Introduction

Listed on this page are the patents and publications by IMRE researchers for the period between January and March 2002.

## Patents Granted

### Piezoelectric Immunosensor

Invention describes a method and a test kit for immunosensing using piezoelectric crystals, in which the anti-IgE is immobilised onto thiolate treated surface of the crystal.

## Publications

### JANUARY 2002

- **Bubble formation due to electrical stress in organic light emitting devices**  
By Lin Ke, Soo-Jin Chua, Keran Zhang and Peng Chen  
*Appl. Phys. Letts.*  
For further information: karen-kl@imre.org.sg
- **InGaN self-assembled quantum dots grow by metalorganic chemical-vapour deposition with indium as antisurfactant**  
By J. Zhang, M. Hao, P. Li and S. J. Chua  
*Appl. Phys. Letts*  
For further information: lj-zhang@imre.org.sg
- **The influence of cold treatment on properties of temperature-sensitive poly(N-isopropylacrylamide) hydrogels**  
By Xian-Zheng Zhang, Yi-Yan Yang, Tai-Shung Chung  
*Journal of Colloid and Interface Science*  
For further information: yy-yang@imre.org.sg
- **Kinetics of thermal degradation of 6FDA-based copolyimides - I**  
By P. Santhana Gopala Krishnan, Rohit H. Vora, S. Veeramani, Suat Hong Goh and Tai-Shung Chung  
*Polymer Degradation and Stability*  
For further information: sg-krishnan@imre.org.sg
- **Polyimides from isomeric biphenyltetracarboxylic dianhydrides and the effects of chemical structure on solubility**  
By Yuejin Tong, Songlin Liu, Huaimin Guan, and Menxian Ding  
*Polym. Eng. Sci.*  
For further information: yj-tong@imre.org.sg
- **The chemical, electrochemical synthesis and properties of poly[(4-decylthiophene-2,5-diyl)(2,2'-biphenyl)(4-decylthiophene-2,5-diyl)]**  
By Ni Jing, Pei Jian and Chen Zhikuan  
*Synthetic Metals*  
For further information: zk-chen@imre.org.sg
- **Self-assembly of a hydrogen-bonded association chain liquid crystalline polymer (LCP)**  
By Xuehong Lu, Chaobin He, Clemon D. Terrell and Anselm C. Griffin  
*Macromolecular Chemistry & Physics*  
For further information: cb-he@imre.org.sg

### FEBRUARY 2002

- **Calorimetry as a tool for predicting bulk viscosity drift of polyamic acid ionic salt solutions**  
By P. Santhana Gopala Krishnan, Rohit H. Vora, Tai-Shung Chung, Shun-ichiro Uchimura, and Nori Sasaki  
*Analytical Sciences*  
For further information: sg-krishnan@imre.org.sg
- **Luminescent quantum dots for multiplexed biological detection and imaging**  
By WCW, DJ Maxwell, XH Gao, RE Bailey, MY Han, and SM Nie  
*Current Opinion in Biotechnology*  
For further information: my-han@imre.org.sg

- **Self-mending of microcracks in barium titanate glass-ceramic thin films with high dielectric constant**

By Yao Kui, Francis Eng Hock Tay, Zhu Weiguang  
*J. Am Ceram. Soc*

For further information: yao-k@imre.org.sg

- **The effect of Cu on interfacial reaction in lead-free system**

By Ka Yau Lee and Ming Li  
*2002 TMS Annual Meeting*

For further information: ky-lee@imre.org.sg

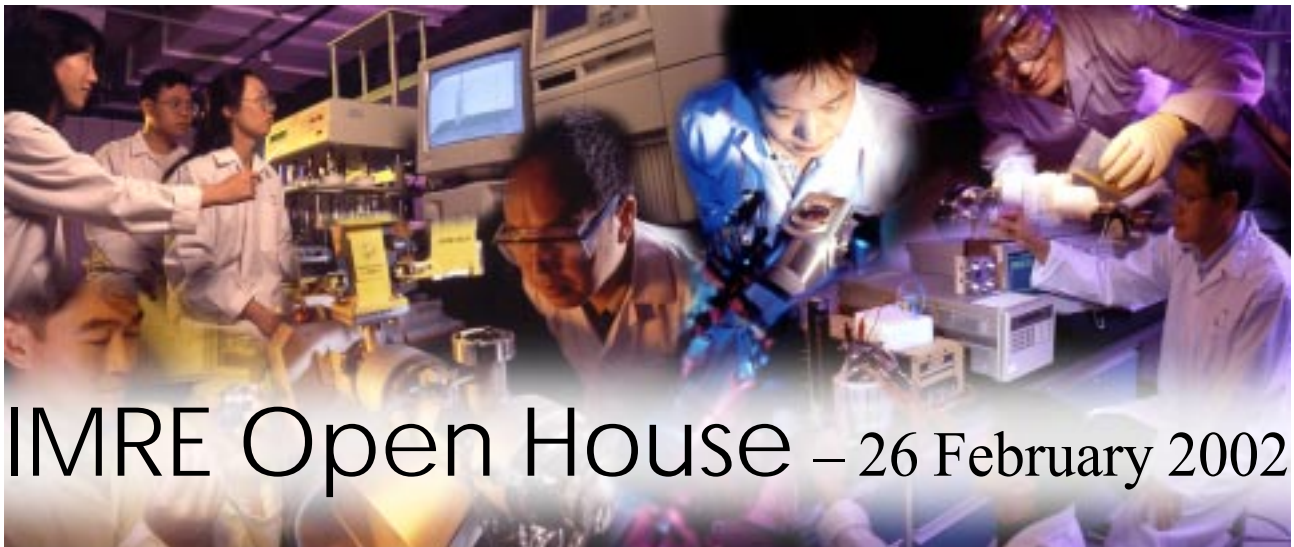
- **Failure mechanism of lead-free solder joints for flip chip packages**

By Fan Zhang, Ming Li, Bavani Balakrisnan  
*2002 TMS Annual Meeting*

For further information: f-zhang@imre.org.sg

### MARCH 2002

- **Electronic and vibronic properties of Mg-doped GaN: The influence of etching and annealing**  
By Tripathy, S.J. Chua, A. Ramam, E.K.Sia, J.S. Pan, R. Lim, G.Yu and Z. X. Shen.  
*J. Appl. Phys.*  
For further information: ram-akki@imre.org.sg
- **An improved approach for precise in-situ measurements of microflows**  
By Xuanxiong Zhang, Xujiang He, Yuan Xu and Francis Eng Hock Tay  
*Review of Scientific Instruments*  
For further information: xx-zhang@imre.org.sg
- **Electronic and vibronic properties of Mg-doped GaN: The influence of etching and annealing**  
By S Tripathy, SJ Chua, A Ramam, EK Sia, JS Pan and R. Lim, G. Yu, Z.X. Shen  
*Journal of Applied Physics*  
For further information: ram-akki@imre.org.sg
- **Two section tunable lasers using impurity free intermixing in InGaAsP multiple quantum well structures**  
By J.H. Teng, J. R. Dong, S. J. Chua, D. A. Thompson, B. J. Robinson, A. S. W. Lee  
*2002 TMS Annual Meeting & 1st France-Singapore Workshop on Microwave Optoelectronics*  
For further information: jh-teng@imre.org.sg
- **Optical waveguide switching**  
By Li Baojun, S J Chua  
*1st France-Singapore Workshop on Microwave Optoelectronics*  
For further information: bj-li@imre.org.sg
- **Self-organised quantum dots and quantum wires grown by MOCVD and MBE**  
By S. J. Chua, B.Z. Wang, J.R.Dong, X.H. Zhang, Z. L. Miao and T Htoo  
*1st France-Singapore Workshop on Microwave Optoelectronics*  
For further information: sj-chua@imre.org.sg
- **Degradation and failure of organic light-emitting devices**  
By Lin Ke, S J Chua K Zhang and N Yakovlev  
*Applied Physics Letters*  
For further information: karen-kl@imre.org.sg
- **Synthesis of single-crystalline TiO<sub>2</sub> nanotubes**  
By S. M. Liu, L. M. Gan, L. H. Liu, W. D. Zhang, H. C. Zeng  
*Chemistry of Materials*  
For further information: sm-liu@imre.org.sg
- **Growth of vertically aligned carbon nanotubes array on large area of quartz plates by chemical vapor deposition**  
By W.D. Zhang, Y. Wen, W.C. Tjiu, G.Q. Xu, L.M. Gan  
*Applied Physics*  
For further information: wd-zhang@imre.org.sg



## IMRE Open House – 26 February 2002



*Dr Low Hong Yee, a research fellow with the Molecular & Bio-Materials Lab, explaining to the student visitors some of the molecular and biomaterial research being done in IMRE*

IMRE played host to final-year engineering and honours-year science undergraduates from Singapore's two main varsities, the National University of Singapore and the Nanyang Technological University, when it held an open house, specifically targeting local graduates.

The six-storey research facility opened its doors throughout the day, from ten in the morning to five-thirty in the evening. Guided tours were also arranged to give the students a better understanding of the work being carried out in a research institute.

The 80 visitors were given a briefing on the full spectrum of materials-related research being done at IMRE. The highlights included on-going studies in the fields of optoelectronics, nanotechnology, tissue engineering, chemicals, and characterisation.

"We hope to encourage local undergraduates to take up postgraduate studies and eventually positions in research and development," said Dr Zhu Furong, a senior research fellow who is also

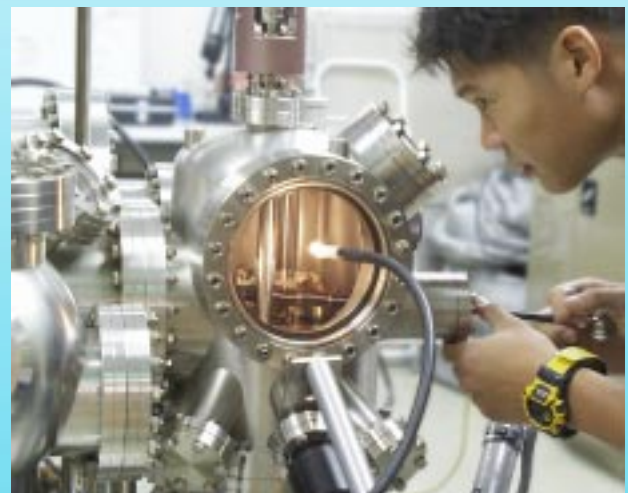
the chairman of the postgraduate students committee in IMRE.

He added that the open house presented a unique opportunity for the students to get acquainted with research as an activity and as a possible career.

The need for nurturing research talent has been given much emphasis with the call being repeated again recently during the launch of A\*STAR's and the RIs (including IMRE) new corporate identity.

IMRE's postgraduate committee will be working closely with A\*STAR to coordinate efforts in promoting the National Science Scholarships, an initiative aimed at getting the younger generation involved in science and research.

For more information on postgraduate study opportunities in IMRE, please email to [imre-pgs@imre.org.sg](mailto:imre-pgs@imre.org.sg) or visit our website at <http://www.imre.org.sg>



*IMRE's characterisation laboratory was one of highlighted during the open house.*

# Visitors and Events

## **EDB Centre Directors**

**9 January 2002**

EDB Centre Directors paid a visit to IMRE as part of a familiarisation tour of the Institute before departing to take up residency at the respective EDB offices worldwide. There they hope to promote IMRE and her capabilities to prospective collaborators using the insights and knowledge gained during the visit.

## **Scientific Advisory Board of Institute of Chemical & Engineering Sciences (ICES)**

**18 January 2002**

ICES' scientific advisory board, comprising scientists from renowned universities and prominent companies paid a visit to IMRE to collate views about the general administration and management of research institutes. The purpose of the visit was also to identify possible areas of collaboration.

## **Nanoscience & Engineering (NSE) Workshop 2002**

**23-24 January 2002**

IMRE was the venue for the NSE 2002, an event organised by A\*STAR. The 2-day workshop brought together scientists from the research institutes, varsities and industry to look into possible directions for nanoscientific research. Updates on a number of nano-related research efforts from the scientific community were also presented.

## **Delegates from the SRMS-3 Conference**

**24 January 2002**

Delegates from the Synchrotron Radiation in Materials Science (SRMS-3) Conference held in Singapore were given a tour of IMRE's facilities in an event organised together with the Singapore Synchrotron Light Source. IMRE's expertise in materials research areas like chemicals and characterisation were among those introduced.

## **IMRE Open House**

**26 February 2002**

IMRE opened its laboratories to undergraduates from the 2 local universities, the National University of Singapore and the Nanyang Technological University. This was to attract and to encourage the final-year engineering and honours-year science undergraduates to pursue postgraduate studies locally, with the eventual goal of increasing the R&D talent pool in Singapore.



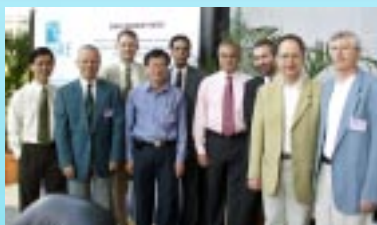
*Participants of the NSE Workshop 2002*



*NTU's MEC students being briefed by Dr Yakovlev on IMRE's characterisation equipment*



*The undergraduates from the University of Twente, Netherlands*



*The Thales Microwave Optoelectronics Workshop organising team from IMRE and Thales Airborne*

## **Thales Microwave Optoelectronics Workshop**

**6-7 March 2002**

Jointly organised by IMRE, EDB and Thales Airborne Systems, the 1<sup>st</sup> France-Singapore Workshop on Microwave Optoelectronics Technology brought together scientists in the field of optoelectronics from both countries. The workshop's goal was to look into new avenues for dealing with wide bandwidth and high data rate signals through the coupling of optoelectronics and microwave technologies.

## **Materials Engineering Club, NTU**

**22 March 2002**

Students from NTU's Materials Engineering Club (MEC) visited IMRE to get a feel of the local research scene, especially in their related field of study, materials science. The 40 students were treated to a showcase of IMRE's broad spectrum of materials research including tissue engineering, materials characterisation, LEDs and nanotechnology.

## **University of Twente, Netherlands**

**3 April 2002**

Some 30 students and their lecturers from the University of Twente, Netherlands visited IMRE as part of their Asian study tour programme. Local ▶

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varsity students attached to IMRE met them on arrival and assisted in the tour. One of the goals of the visit was to gain insights into research experiences in the different countries and to share these experiences with their counterparts.

### Hewlett-Packard Company 18 April 2002

A contingent of local HP staff and scientists from the US home office paid IMRE a visit as part of a continuing series of contacts arranged by the EDB. The HP delegation was on a fact-finding mission to look into possible collaboration with local RIs, including IMRE. The guests were given a

briefing and tour on IMRE's capabilities in some areas like LEDs, fuel cells and nanomaterials.

### Changchun Institute of Applied Chemistry 17 & 18 April 2002

A delegation led by Prof Wang Lixiang, Director of State Key Laboratory of Polymer Physics and Chemistry, Changchun Institute of Applied Chemistry (CIAC), visited IMRE. CIAC has key expertise in the areas of light emitting polymers and organic transistors. The delegates had detailed discussions with the various laboratories in IMRE and potential joint collaborations are being explored in the areas of plastic electronics and light-emitting polymers.



## New logo for IMRE

In a ceremony attended by ambassadors, corporate figures and members of Singapore's scientific community, the Agency for Science, Technology and Research (A\*STAR), formerly known as the National Science and Technology Board, launched its new logo on 15 April 2002.

The corporate planning exercise also involved all the research institutes (RIs) under A\*STAR's two administrative councils, the Biomedical Research Council (BMRC) and the Science & Engineering Research Council (SERC). As part of the exercise, the RIs will be changing their logos.

When asked about the changes, Professor Albert Yee, IMRE's Director, saw the need to establish the new corporate identity to present the RIs as part of the larger A\*STAR family. Bringing the RIs together will result in greater coordination

and utilisation of resources, as well as increased potential for collaboration and synergism.

IMRE's current logo will be replaced in stages, with the new logo fully implemented near the end of the year.



IMRE will switch to its new logo by the year end

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