

PAGE 1 - 2

At the Frontier of OLED Development

PAGE 2

Protective Polymer Coat that  
Preserves the Shine of Precious  
Metals

PAGE 3

IMRE's Fuel Cells Rolling on

PAGE 3

Transmission Electron Microscopy  
(TEM): More than just an Imaging  
Tool

PAGE 4

IMRE Attachment Students Win 4  
Awards

PAGE 4 - 5

A\*STAR Graduate Scholarship –  
Attracting the Next Generation of  
Scientists

PAGE 5

Discovering the Materials World –  
Presentation to Schools and Junior  
Colleges (JCs)

PAGE 5 - 6

Visits and Events

PAGE 6 - 7

Patents and Publications

PAGE 8

IMRE's Publications Highlighted in  
International Journals

PAGE 8

Upcoming Seminars / Workshops /  
Symposia (May-Sept 2004)

CONTENTS

## At the Frontier of OLED Development

**IMRE's continuing work and successes with organic light-emitting devices (OLEDs) has put the Institute in the forefront of OLED development.**



Prototypes of IMRE-fabricated OLED devices. (Front, centre) A polymer light-emitting passive matrix display surrounded by a number of different coloured OLEDs.

With the amount of public and scientific interest generated in OLEDs it is little wonder that research teams around the world have been working feverishly to perfect the technology. Locally, IMRE has gained a solid reputation for its experienced OLED scientists and engineers as well as innovative research.

Apart from conventional OLEDs, IMRE's work includes research on new technologies like top-emitting OLEDs (TOLEDs), flexible OLEDs (FOLEDs) and passive matrix displays.

A conventional OLED has a bottom-emitting structure where the electrical components (anode, cathode and polymer substrate) are located on one face of the device resulting in light emitting only from one surface. A top-emitting device is instead made with either an opaque or a transparent base and has a relatively transparent top electrode so that light can emit from the top surface as well.

In the case of FOLEDs, the use of thin flexible substrates will significantly reduce the weight of flat panel displays and provide the ability to bend a display into any desired shape. Most current OLEDs are based on rigid substrates, such as glass, which limits the "mouldability" of the device. FOLEDs will also make it possible to mass produce displays by continuous roll processing, much like a newspaper printing press, which lowers manufacturing costs.

We are currently working on combining the best of the two technologies to design and fabricate FOLEDs using a TOLED architecture.

OLEDs offer seemingly endless possibilities for application in a wide range

(Continued on page 2 ►)

### TOLEDs

TOLEDs have two typical configurations:

**Inverted OLED** – when the device structure has a transparent anode or cathode on top of the organic light emitting layer.

**Transparent OLED** – devices with both a transparent anode and cathode on a transparent substrate.



(Left) An IMRE TOLED device.

(Continued from page 1)



Prof Chua Soo Jin, IMRE's Deputy Director (Industry) (left) talking with one of the participants.




The inaugural ON-Singapore reception was a magnet for companies interested in developing OLEDs locally.

of products from computers to information display systems to wearable computer screens. Our accomplishments with TOLEDs and FOLEDs could open the possibility of fabricating OLED-based multi-colour rigid or flexible displays.

### Inaugural ON-Singapore Reception

Not content with only developing OLEDs through R&D, IMRE has taken the lead in synergising the efforts of OLED-related companies here by initiating the setting up of a network of companies and organisations interested in supporting the research, development and manufacturing of OLEDs in Singapore.

On 3 March, IMRE organised the inaugural OLED Network of Singapore (ON-Singapore) reception, which saw participation from about 50 members of organisations that are directly or indirectly related to OLED manufacturing and research. Local and overseas industry players such as Ness Display Co Ltd, Cambridge Display Technology and Innoled Pte Ltd presented overviews and updates on the current status of OLED activities in Singapore. 

### About ON-Singapore

The OLED Network of Singapore (ON-Singapore) is an initiative spearheaded by the Institute of Materials Research and Engineering (IMRE), with the support from the Singapore Economic Development Board (EDB). This Network aims to bring together industries and research organisations that are interested in developing OLED technology in Singapore. For more information about ON-Singapore events and membership, please visit our website at [www.imre.a-star.edu.sg/on-singapore](http://www.imre.a-star.edu.sg/on-singapore).

## Protective Polymer Coat that Preserves the Shine of Precious Metals

**IMRE, in a tie-up with Advago, is developing an invisible polymer coat that protects and preserves the gleam of precious metals**

A research collaboration between IMRE and Advago (S) Pte Ltd seeks to develop a special polymer coat that will give jewellery that brighter, longer-lasting shine.

Our research team comprising of Dr Hong Liang, Dr Liu Zhaolin, and Ms Jiang Huixin from the Molecular and Performance Materials cluster are involved in the nine-month long project, which began in October 2003. The project focuses on the development of a protective polymer coating for jewellery, leveraging on Advago's knowledge of market needs and trends, as well as IMRE's expertise in materials research and development.


Made using a simple chemical process, the transparent polymer coat is a modified resin that has better heat



Mr Chong Pin Chin (seated, 2<sup>nd</sup> from left), Managing Director of Advago in a firm handshake with Prof Chua Soo Jin (seated, 3<sup>rd</sup> from left), IMRE's Deputy Director (Industry) after the signing of the agreement in October 2003. Also present at the signing were Ms Yvonne Chan (seated, left), Operations Manager for Advago, Dr He Chaobin (seated, right), Cluster Manager for the Molecular and Performance Materials Cluster, and the project team, (standing, left to right) Dr Hong Liang, Dr Liu Zhaolin and Ms Jiang Huixin.

resistance, mechanical durability and adhesion. The coating can also be easily applied to surfaces and is cheap to produce.

Since the start of the project, the team has helped Advago solve several technical issues in the course of using the polymer coating formulated by IMRE. Advago has also expressed a keen interest to further develop additional enhancement features to give the added edge and quality to its jewellery products.


Advago is an expanding local enterprise offering gold, platinum and diamond jewellery products and jewellery design services for both local and overseas markets. 

# IMRE's Fuel Cells Rolling on

## Latest fuel cell prototype fitted onto a bicycle

IMRE, together with our collaborator, Gashub Power Pte Ltd, has applied its latest fuel cell prototype to a bicycle. Designed and assembled by Ngee Ann Polytechnic, with support from GasHub, the bicycle's power unit is energised by a 200W fuel cell stack built on IMRE's proprietary proton exchange membrane (PEM), the "heart" of the device. The bicycle can travel at an average speed of about 20km/h.

IMRE had earlier demonstrated its fuel cell technology know-how by unveiling a fuel cell-powered skate scooter that was featured in Channel News Asia's nightly news segment on 12 December 2003 and subsequently in The Straits Times on 13 December 2003.


IMRE is currently in a research collaboration with Gashub Power where our expertise in membrane electrode assembly, fuel cell assembly and design, and the PEM are being used to build a number of prototype fuel cell stacks. These may be used for testing and application in a host of devices, including as a potential power source for a mainframe computer. 



An IMRE fuel cell (above) fitted on the specially designed bicycle (right).



## CONGRATULATIONS!

The "Fuel Cell-Powered Bicycle" project will be conferred a special award at the Polytechnic Student Research Programme Award ceremony after being judged as one of the three best Ngee Ann Polytechnic student projects for the academic year. The winning student team of Yap Keat Huat and Zhang Jing Xuan will receive their award at the ceremony on 27 May 2004. The project was supervised by Dr Gan Leong Ming (IMRE), Mr Han Ming (IMRE), Mr Avier Lim (GasHub Power), Mr Tay Seng How (Ngee Ann) and Mr Ang Koo Soon (Ngee Ann). 

### Fuel Cells on Channel i's New Frontier Series

IMRE's fuel cell research will be featured in an upcoming episode of *New Frontiers*, Channel i's new 13-part weekly TV infotainment series featuring cutting-edge inventions and technology in Singapore. The episode will air on Channel i at the following date and time:

**Date: 12 May 2004 (Wednesday)**

**Time: 7.00pm on Channel i**

*Don't miss it!*

## Transmission Electron Microscopy (TEM): More than just an Imaging Tool



Dr Chris Boothroyd, Deputy Cluster Manager with IMRE's Materials Science and Characterisation Laboratory, giving the first presentation on TEM.



The participants of the TEM workshop.


***Our Materials Science and Characterisation Laboratory (MSCL) kicked off its first in a series of planned workshops that are designed this year to highlight and showcase IMRE's characterisation capabilities and research expertise to industry.***

Best known as a technique for imaging materials up to one million times magnification, TEM has the capacity to serve also as a powerful analytical tool. A TEM workshop held on 11 March by IMRE's Materials Science and Characterisation Laboratory on one of the essential and fundamental materials research tools helped to illustrate this fact.

Apart from giving users an appreciation about the various techniques associated with the TEM, the workshop gave examples of how these techniques can be applied to help solve industry-related and research problems. The workshop also covered the practical considerations to note, especially for new TEM users.

The *in-situ* TEM, a unique system housed in our characterisation laboratory was also introduced. This system allows materials to be grown by evaporation or react with gases while being observed and videoed at the same time and at high magnification, making it one of only a handful of systems worldwide capable of doing so.

The workshop was well attended by about 100 participants from the electronics, chemicals and polymers industry.

The next workshop will be the **Surface Analysis Workshop on 2 July 2004**. For more information, please visit our website for regular updates and registration details on upcoming events. 

# IMRE Attachment Students Win 4 Awards

*Four students from National Junior College (NJC) who were attached to IMRE have won four awards for their science projects which were based on their research work done here.*

Students from National Junior College (NJC), who were attached to IMRE for six months since May 2003, have won four prestigious awards for their science projects, which were based on their research work done here. These four outstanding students were conferred two bronze and two merit awards during the Singapore Science & Engineering Fair 2004 (SSEF).

The recipients of the SSEF awards are:

## Bronze Medal

- **LIM CHIEN KAI and WONG XIAN NENG, MOSES**

For the project entitled "XPS Characterisation of Oxide Dielectric Thin Films for Application in Nanoelectronics"

Supervisors: **Dr Wang Shijie** and **Dr Pan Jisheng**

- **ZHAO HAOBO**

For the project entitled "GaAs-based Thermal Bimorph Microactuator for MEMS"

Supervisor: **Dr Akkipeddi Ramam**



Moses Wong (left) and Lim Chien Kai (right) from NJC, one of the teams that won the Bronze Medal.

## Merit Award

- **LOI KOK YEN VICTOR**

For the project entitled "Electromechanical Characterisation of Piezoelectric Thin Films with a Laser Scanning Vibrometer"

Supervisor: **Dr Yao Kui**

- **TAY EN RONG, STEPHEN and LIU YIXIN**


For the project entitled "Investigation of Multilayer Heterostructure using SIMS"

Supervisor: **Dr Nikolai Yakovlev**



An IMRE researcher (left) demonstrating laboratory techniques to students from NJC's STaR programme.

The students were part of IMRE's link-up with NJC's Science Training & Research (STaR) Programme that saw eight IMRE researchers supervising 14 students on a variety of projects that ranged from optoelectronics to micro devices. The attachments were for a period of six to nine months during which the students gave regular oral presentations on the status of their projects at their college. The projects were subsequently presented in the NJC STaR symposium for eventual selection to the SSEF and the National Science Talent Search (NSTS).

The SSEF is a national-level competition organised by the Ministry of Education, A\*STAR and Singapore Science Centre. SSEF winners will then be eligible to participate in the NSTS which is organised by A\*STAR. 

# A\*STAR Graduate Scholarship - Attracting the Next Generation of Scientists

*Proactively seeking to encourage more students to pursue further studies in science, IMRE and fellow science and engineering Research Institutes (RIs) came together and organised an event targeted at final year undergraduates from our local universities.*

IMRE and fellow RIs from A\*STAR's Science and Engineering Research Council came together and organised a succession of networking sessions to encourage more students to pursue further education in science. With the support of the A\*STAR Graduate Academy (AGA), introductory presentations in the various research areas and networking sessions with the researchers from each RI were arranged on 30 January and 4 February at the National University of Singapore (NUS) and the Nanyang Technological University (NTU), respectively. As an added attraction for the students, the A\*STAR Graduate Scholarship (AGS) scheme was presented and the students were briefed on how the scheme would be able to assist them in furthering their education, such as getting a doctorate degree at NUS and an additional two-year postdoctoral fellowship in a renowned overseas university or research laboratory related to the students' chosen field of study.

The RIs also organised subsequent visits for the undergrads on 5 and 6 February, to give them a more hands-on approach to scientific research work.



Undergraduates from NTU being briefed on IMRE's materials characterisation capabilities.

(Continued on page 5 ►)

(Continued from page 4)

At IMRE, the students were able to see some of the results of our research work such as our miniature sensors and micro-sized devices. Also generating a lot of interest was our work on prototype fuel cells using IMRE's patented and highly efficient proton-exchange membranes, and a tour of our state-of-the-art Materials Science and Characterisation Laboratory. In the lab, the students were clearly and keenly impressed with our full range of instrumentation in many areas of materials growth, fabrication and characterisation.

To learn more about the AGS scheme, visit A\*STAR's website at [www.a-star.edu.sg](http://www.a-star.edu.sg)



An IMRE researcher (far left) demonstrating some of IMRE's research prototypes.

## Discovering the Materials World – Presentation to Schools and Junior Colleges (JCs)

*Bringing research closer to students, IMRE is actively reaching out to the young of Singapore to get them excited about science and technology.*

IMRE organised a presentation to a total of 75 upper secondary and JC students from some of Singapore's top schools on 14 April 2004 at the National Junior College. The students who attended the talk were introduced to research and what it was like being a researcher.

Apart from getting the students excited about science and technology, and sharing with them experiences in research and development, the event was also an opportunity to provide more information on A\*STAR's National Science Scholarships (NSS) scheme.

Prof Alfred Huan, Dr Peter Moran and Dr Alan Sellinger, senior research staff of IMRE, each gave presentations and introduction about the nature of research using their respective research areas as examples. A mini exhibition was set up featuring some

of our research prototypes and demonstrations, thereby offering an added depth and practicality to the presentations and helping the students relate better to our research works. The students were also enthused by the interaction session which gave them a chance to network and intermingle with the speakers and our researchers.

IMRE is looking forward to holding more of such events. If you would like to be a part of this experience, please contact Ms Chua Sze Sze at [sze-chua@imre.a-star.edu.sg](mailto:sze-chua@imre.a-star.edu.sg)



Mr Han Ming (left), an IMRE Research Engineer, showing secondary and JC students a bicycle fitted with an IMRE fuel cell.



Students talking to some of IMRE's researchers during a mini exhibition after the main presentations.

## Visits and Events

### SERC-RI AGS Networking Sessions and Laboratory Tours

30 January, 4 February and 5-6 February 2004

IMRE and other SERC RIs held joint networking sessions and laboratory tours to actively promote the A\*STAR Graduate Scholarship (AGS) to undergraduates from NUS and NTU. Starting with overview presentations on the research conducted at the various RIS, the students were then invited on a tour of the RI R&D laboratories where they were able to experience the research environment in the local RIs. (See article on Page 4)

### Scientific Advisory Board (SAB) meeting and IMRE-SAB Postgraduate Students Workshop

12-14 February 2004

IMRE's SAB met on 12-13 February in its annual meeting to review and make recommendations on the direction of

IMRE's research. The SAB members who attended included Prof Edward Kramer, Prof Otto Lin, Prof Buddy Ratner, Prof William Tang, Prof Julius Vancso and Dr Masami Tatsumi. In conjunction with the IMRE-SAB meeting, postgraduate students from the SAB members' home universities attended a workshop on 13-14 February together with IMRE graduate students to foster closer interaction and exchange experiences and ideas related to research work.



Prof Buddy Ratner (right), a member of IMRE's Scientific Advisory Board, judging one of the posters put up during the IMRE-SAB Postgraduate Students Workshop.

(Continued on page 5 ▶)

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*Dr Su Guanng, President of Nanyang Technological University visiting the IMRE booth during Asian Aerospace 2004.*

## Asian Aerospace 2004

**24-29 February 2004**

IMRE, IHPC and SIMTech participated in the annual event where IMRE highlighted its aerospace-related research projects including the magnetic

tagging technology, POSS nanoclay composite materials and an overview of our characterisation capabilities.

## Inaugural ON-Singapore Reception

**3 March 2004**

IMRE organised the first meeting that brought together members of the OLED Network of Singapore (ON-Singapore), an initiative launched by IMRE, A\*STAR and EDB, to coordinate the efforts and resources of companies interested in OLED research and commercialisation in Singapore. *(See article on Page 1)*

## MSC TEM Workshop

**11 March 2004**

The Materials Science and Characterisation (MSC) cluster organised the first in a series of workshops that are designed to highlight our materials characterisation expertise and facilities.

This first workshop focused on the techniques and analytical prowess of Transmission Electron Microscopy (TEM). *(See article on Page 3)*



*Participants attending the TEM Workshop.*

## IMRE-Aixtron Seminar

**12 March 2004**

A seminar jointly organised by IMRE and Aixtron introduced MOCVD technology, including process technologies and applications in compound semiconductors, oxides and OLEDs.

## Presentation to Secondary Schools and Junior Colleges (JCs)

**14 April 2004**

IMRE conducted a presentation on R&D works at National Junior College to students from several top schools and JCs in Singapore. Senior researchers, Prof Alfred Huan, Dr Peter



Moran and Dr Alan Sellinger were on hand to introduce IMRE and share their experiences with the students. *(See article on Page 5)*

*Students from JCs and secondary schools attended the talk.*

# Patents and Publications

## Patent Granted

### Chemical Modification of Polyimide

This invention describes the chemical cross linking modification of the polyimide outer layer of dual-layer hollow fibres.

**Inventors:** Liu Ye, Wang Rong, Li Dongfei, Neal Chung

**Date granted:** 9 December 2003

**Country granted:** US

## Patents Filed

### Silicide Formed From Ternary Metal Alloy Films

The invention relates to a method for fabricating semiconductor structures and more particularly to a method of forming a high quality and reliable NiSi silicide on a silicon semiconductor device. The proposed process is commercially applicable to the fabrication of 0.1 $\mu$ m and sub-0.1 $\mu$ m CMOS silicon devices.

**Inventors:** Chi Dongzhi, Rinus Lee, Chua Soo Jin

**Date filed:** 15 March 2004

**Country filed:** US

### Method And Moulds For Use In Fabricating Side-Ported Microneedles

The invention describes several methods for fabricating tapered (or straight) hollow microneedles. These methods can be used to make metallic needles with sufficient strength and ductility. The invention has the advantage that the fabrication cost is lower than those techniques reported in literature and has potential application for transdermal drug delivery.

**Inventors:** Xu Yuan, Chen Meima, Li Zhongli, Lim Chee Yen, Tan Pei Ying

**Date filed:** 12 March 2004

**Country filed:** Filed under Patent Cooperation Treaty (PCT)

### Microcapsules For Encapsulation Of Cells And Bioactive Material

The invention involved novel anionic polyelectrolyte tetra-copolymers with photo-crosslinkable 4-(4-methoxycinamoyl)phenyl methacrylate (MeOCPMA) monomer. The tetra-copolymers were used to form photo-crosslinkable microcapsules with modified collagen for rat hepatocytes encapsulation. The microcapsules with mechanical strength dramatically enhanced could be used for the development of hepatocyte microencapsulation technology for bioartificial liver assist devices.

**Inventors:** Li Jun, Quek Chai Hoon, Harry Yu, Gan Leong Ming, Kam Leong

**Date filed:** 9 March 2004

**Country filed:** US

### A Multi-Layer Composite Film And A Method For Forming A Multi-Layer Composite Film

The invention relates to the design of a multilayered composite film as a barrier substrate for flexible electronics devices and displays, such as organic light-emitting device (OLED) displays and liquid crystal device (LCD) displays. The invention provides the enhancement of the barrier for such composite films against moisture and oxygen permeation.

**Inventors:** Cheng Cheow Tong, Yeo Ching Bing, Low Hong Yee, Chi Dongzhi, Satoshi Tomioka, Junichi Ohsako

**Date filed:** 19 January 2004

**Country filed:** Singapore

## Publications (FEBRUARY 2004)

- **Microemulsion processing of silica-polymer nanocomposites**  
PY Chow, LM Gan  
*Journal of Nanotechnology* 4(1/2): 197-201, 2004  
Contact: [lm-gan@imre.a-star.edu.sg](mailto:lm-gan@imre.a-star.edu.sg)
- **AFM characterization of nanoscale ribbons grown from a series of oligo(p-phenyleneethynylene) derivatives**  
J Xu, C Z Zhou, H Y Lim, N T S Chung, Z K Chen  
*Langmuir*, 20(3): 950-956, 2004  
Contact: [zk-chen@imre.a-star.edu.sg](mailto:zk-chen@imre.a-star.edu.sg)
- **Processing-induced clay dispersion and its effect on structure and properties of polyamide 6**  
TX Liu, WC Tjiu, CB He, SS Na, TS Chung  
*Polymer International*, 53: 392-399, 2004  
Contact: [liu-tx@imre.a-star.edu.sg](mailto:liu-tx@imre.a-star.edu.sg)
- **Nonenzymatic glucose detection using multi-walled carbon nanotube electrode**  
JS Ye, Y Wen, WD Zhang, LM Gan, GQ Xu, FS Sheu  
*Electrochemistry Communications*, 6:66-70, 2004  
Contact: [wd-zhang@imre.a-star.edu.sg](mailto:wd-zhang@imre.a-star.edu.sg)
- **Application of multi-walled carbon nanotubes functionalized with hemin for oxygen detection in neutral solution**  
JS Ye, Y Wen, WD Zhang, HF Cui, LM Gan, GQ Xu, FS Sheu  
*Journal of Electroanalytical Chemistry*, 562:241-246, 2004  
Contact: [wd-zhang@imre.a-star.edu.sg](mailto:wd-zhang@imre.a-star.edu.sg)
- **Synthesis and characterization of naphthyl-substituted poly(p-phenylenevinylene)s with few structural defects for polymer light-emitting diodes**  
NHS Lee, ZK Chen, W Huang, YS Xu, Y Cao  
*Journal of Polymer Science Part A: Polymer Chemistry*, 42(7): 1647-1657, 2004  
Contact: [zk-chen@imre.a-star.edu.sg](mailto:zk-chen@imre.a-star.edu.sg)
- **A one-pot synthesis of oleic acid end-capped temperature- and pH-sensitive amphiphilic polymers**  
XM Liu, LS Wang  
*Biomaterials*, 25(10): 1929-1936, 2004  
Contact: [xm-liu@imre.a-star.edu.sg](mailto:xm-liu@imre.a-star.edu.sg)
- **Characterization of graded InGaN/GaN epilayers grown on sapphire**  
TL Song, SJ Chua, EA Fitzgerald, P Chen, S Tripathy  
*Journal of Vacuum Science Technology A*, 22(2): 287-292, 2004  
Contact: [sj-chua@imre.a-star.edu.sg](mailto:sj-chua@imre.a-star.edu.sg)
- **Organic light-emitting device performance improvement by inserting a thin parylene layer**  
L Ke, RS Kumar, K Zhang, SJ Chua, ATS Wee  
*Synthetic Metals*, 140(2-3): 295-299, 2004  
Contact: [karen-kl@imre.a-star.edu.sg](mailto:karen-kl@imre.a-star.edu.sg)
- **Chemical states and electronic properties of the interfaces between aluminium and a photoluminescent conjugated copolymer containing europium complex**  
QJ Cai, QD Ling, S Li, FR Zhu, ET Kang, W Huang, KG Neoh  
*Applied Surface Science*, 222: 399-408, 2004  
Contact: [fr-zhu@imre.a-star.edu.sg](mailto:fr-zhu@imre.a-star.edu.sg)
- **Developing the technological infrastructure in Singapore to seed and support OLED manufacture**  
A Burden  
ASID 2003, Nanjing, China  
Contact: [adrian-pb@imre.a-star.edu.sg](mailto:adrian-pb@imre.a-star.edu.sg)

## Publications (MARCH 2004)

- **Poly(naphthyleneethiophene)s and poly(naphthylenevinylene)phenylenevinylene)s: Effect of naphthalene positional isomers on the light-emitting properties of their polymers**  
CZ Zhou, WL Wang, KK Lin, ZK Chen, YH Lai  
*Polymer*, 45(7): 2271-2279, 2004  
Contact: [zk-chen@imre.a-star.edu.sg](mailto:zk-chen@imre.a-star.edu.sg)

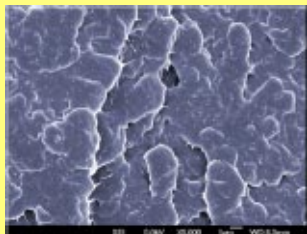
- **Inclusion complexes formed by biodegradable poly( $\epsilon$ -caprolactone)-poly(tetrahydrofuran)-poly( $\epsilon$ -caprolactone) triblock copolymer and cyclodextrins**  
Li J, Chen B, Wang X, Goh SH  
*Polymer*, 45: 1777-1785, 2004  
Contact: [jun-li@imre.a-star.edu.sg](mailto:jun-li@imre.a-star.edu.sg)
- **Nanoindentation and morphological studies on nylon 66 nanocomposites: Effect of clay loading**  
L Shen, IY Phang, L Chen, TX Liu, KY Zeng  
*Polymer*, 45(10): 3341-3349, 2004  
Contact: [lu-shen@imre.a-star.edu.sg](mailto:lu-shen@imre.a-star.edu.sg)
- **Micromachined III-V multimorph actuator model and design using simulated annealing (SA)-based global optimization**  
A Ongkodjojo, FEH Tay, R Akkipeddi  
*The Technical Proceedings of the 2004 Nanotechnology Conference and Trade Show (NSTI-Nanotech 2004)*, 1:374 - 377, Boston, Massachusetts, USA  
Contact: [an-ong@imre.a-star.edu.sg](mailto:an-ong@imre.a-star.edu.sg)
- **SIMS study of plumes generated from laser ablation of polymers**  
ZL Li, SZ Yow, L Liu, N Yakovlev, Y Sun, EJ Swenson, PM Moran  
*Applied Physics A: Materials Science & Processing*, 78(4), 611-616, 2004  
Contact: [zl-li@imre.a-star.edu.sg](mailto:zl-li@imre.a-star.edu.sg)
- **Frequency coupling and energy trapping in mesa-shaped multi-channel quartz crystal microbalances**  
F Shen, P Lu, SJ O'Shea, KH Lee  
*Sensors and Actuators A*, 111(2-3):180-187, 2004  
Contact: [s-oshea@imre.a-star.edu.sg](mailto:s-oshea@imre.a-star.edu.sg)
- **Sub-micron InGaN ring structures for high efficiency LEDs**  
HW Choi, PR Edwards, C Liu, CW Jeon, RW Martin, IM Watson, MD Dawson, S Tripathy, SJ Chua  
*Physica Status Solidi (C)*, 0(7): 1-4, 2004  
Contact: [tripathy-sudhiranjan@imre.a-star.edu.sg](mailto:tripathy-sudhiranjan@imre.a-star.edu.sg)
- **Influence of Be on N composition in Be-doped InGaAsN grown by RF plasma-assisted molecular beam epitaxy**  
SY Xie, SF Yoon, SZ Wang, ZZ Sun, P Chen, SJ Chua  
*Journal of Crystal Growth*, 260(3-4): 366-371, 2004  
Contact: [p-chen@imre.a-star.edu.sg](mailto:p-chen@imre.a-star.edu.sg)
- **Growth of InAs quantum dots on shallow spherically shaped craters prepared on GaAs (001) substrates: An extended set of vicinal surfaces**  
YB Zheng, SJ Chua, CHA Huan and ZL Miao  
*Journal of Crystal Growth*, 263(1-4):161-166, 2004  
Contact: [yb-zheng@imre.a-star.edu.sg](mailto:yb-zheng@imre.a-star.edu.sg)
- **Interpretation of anomalous temperature dependence on anti-Stokes photoluminescence at GaInP<sub>2</sub>/GaAs interface**  
SJ Xu, Q Li, JR Dong, SJ Chua  
*Applied Physics Letters*, 84(13): 2280-2282, 2004  
Contact: [jr-dong@imre.a-star.edu.sg](mailto:jr-dong@imre.a-star.edu.sg)
- **The contribution of phonon scattering to high-resolution images measured by off-axis electron holography**  
CB Boothroyd, RE Dunin-Borkowski  
*Ultramicroscopy*, 98(2-4):115-133, 2004  
Contact: [chris-b@imre.a-star.edu.sg](mailto:chris-b@imre.a-star.edu.sg)
- **Piezoelectric ceramic thick films deposited on silicon substrates by screen-printing**  
K Yao, XJ He, Y Xu, MM Chen  
*Smart Structures and Materials*, SPIE Conference, San Diego, CA, USA  
Contact: [k-yao@imre.a-star.edu.sg](mailto:k-yao@imre.a-star.edu.sg)
- **Addressing materials and process-integration issues of NiSi silicide process using impurity engineering (invited paper)**  
DZ Chi, RTP Lee, SJ Chua  
*The Fourth International Workshop on Junction Technology*, Shanghai  
Contact: [dz-chi@imre.a-star.edu.sg](mailto:dz-chi@imre.a-star.edu.sg)

# IMRE's Publications Highlighted in International Journals

Listed below are some of IMRE's publications most recently highlighted in international journals:

## "Carbon Nanotubes Reinforced Nylon 6 Composite Prepared by Simple Melt Compounding"

by WD Zhang, L Shen, IY Phang and TX Liu.  
Materials Today, Page 19, April 2004 issue



SEM image showing the overall morphology of failure surface for PA6 nanocomposite containing 1% wt percentage CNTs.

### Abstract

In this communication, multiwalled carbon nanotubes (MWNTs)/nylon 6 (PA6) nanocomposites have been prepared by simple melt-compounding. Scanning electron microscopy (SEM) observation on the fracture surfaces of MWNTs/PA6 sample indicates that a homogeneous dispersion of carbon nanotubes (CNTs) throughout PA6 matrix has been successfully achieved. Mechanical tests show that, compared with neat PA6, the tensile modulus, the tensile strength and the hardness of the composite are greatly improved by about 115 %, 120 % and 67 %, respectively, with incorporating only 1 wt % MWNTs. Close inspection by SEM shows a strong interfacial adhesion between CNTs and PA6 matrix, which is responsible for the significant enhancements in mechanical properties.

For more information, contact [Dr Zhang Wei De \(wd-zhang@imre.a-star.edu.sg\)](mailto:wd-zhang@imre.a-star.edu.sg)

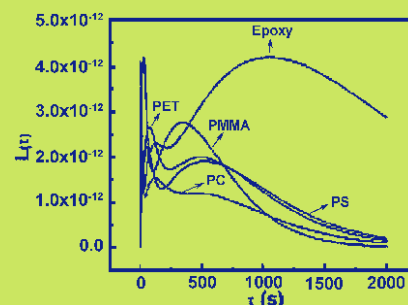
## "Analysis of Nanoindentation Creep for Polymeric Materials"

by S Yang, YW Zhang and KY Zeng.  
Journal of Applied Physics, Volume 95, Issue 7, pp. 3655-3666, April 1, 2004

### Abstract

This article presents studies on nanoindentation creep for polymeric materials at room temperature. A semi-empirical method has been established from a generalised Kelvin model. This model includes the elastic-viscoelastic-viscous effects on indentation creep. It is shown that this method can fit the experimental creep data well, to give the exact changes of creep behavior during nanoindentations for numbers of amorphous polymeric materials. A method has also been proposed to determine the elastic modulus based on this model; the elastic modulus determined from this method is independent of the holding and unloading processes of nanoindentations. Creep deformation is further used to derive creep compliance and retardation spectrums for the polymeric materials studied, which are very useful to predict other mechanical properties of polymeric materials.

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Data used in the analysis of nanoindentation creep for polymers.

## Upcoming Seminars / Workshops / Symposia (May-Sept 2004)

Date	Event	Location
12 May	OLED Symposium	IMRE Seminar Room 1
21 May	Symposium on Molecular and Performance Materials	IMRE Seminar Room 1
June (TBC)	IMRE - IME Joint Symposium	TBC
2 July	Materials Science and Characterisation - Surface Analysis Workshop	IMRE Seminar Room 1
28 July	IMRE - SIMTech - IME symposium on Materials & Process Integration for Micro & Nano Systems	SIMTech Auditorium
Aug (TBC)	Materials Science and Characterisation Chemical Workshop	IMRE Seminar Room 1
Sept (TBC)	IMRE Industry Symposium	IMRE Seminar Room 1

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