Institute of Materials Research and Engineering
A*STAR

PERSPECTIVES

Research, Development and Commercialisation

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IMRE's Liquid Lens Technology Breakthrough

An image taken using a mobile phone fitted with the liquid lens.

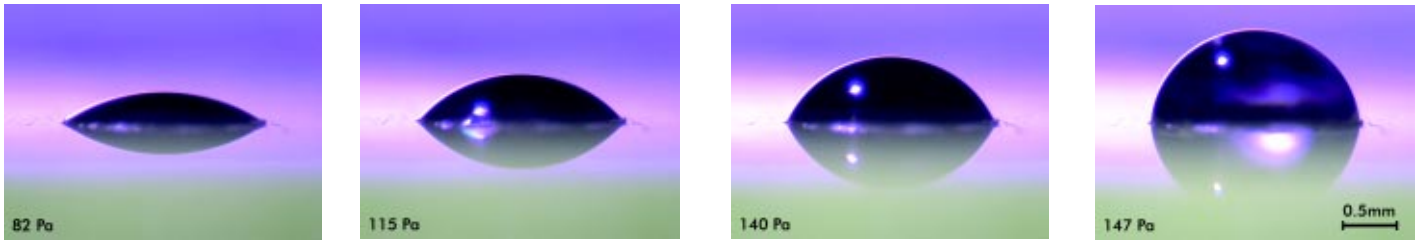
Breakthrough in lens technology will significantly impact applications in optical systems such as digital and mobile phone cameras.

A team of scientists from IMRE have come up with a breakthrough in lens technology which will significantly impact applications in optical systems and precision instruments such as digital cameras and mobile phone cameras. The technology has been successfully licensed through A*STAR's commercialisation arm, Exploit Technologies, to homegrown company, PGS Precision Pte Ltd.

IMRE's patented liquid lens technology leveraged on the Institute's materials science knowledge to form and retain the shape of the lens, which is needed to focus an image.

"Not only can the lens form a concave and convex lens on a single device, it requires little or no electrical voltage in focusing or zooming. This helps greatly in conserving battery power, especially in devices like mobile phones," elaborated Dr Saman Dharmatilleke, IMRE's research scientist who led the project.

PGS estimates that the low fabrication costs of the lens can significantly impact applications in optical systems and instruments that require precise, compact focusing with zoom



Fluid motion – Changing the shape of the liquid lens helps it focus.

mechanisms. It paves the way for smaller and more compact consumer electronics goods such as digital and mobile phone cameras.

"This licensing agreement provides PGS with a fast track to innovative technology that will give our company a competitive advantage in the marketplace," explained Mr Albert Boh, Chairman of PGS Precision Pte Ltd. "We are now in a position to help our customers integrate cutting edge optical devices into their products that current conventional lens manufacturing processes cannot attain."

For more information about the liquid lens, please visit:
www.imre.a-star.edu.sg/liquidlens


THE BUSINESS TIMES

A*Star unit makes lens breakthrough

By JEAN CHUA

IT could be years before you and I can use the applications, but that doesn't stop the creators from being really excited about ... potentially be ... smaller ...

IMRE's technology enables product designers and engineers of gadgets ... lenses — digital camera ... storage ... example ...

square centimetres, and can go smaller.

As a ... step to getting the technology ... market, IMRE has licensed ... to local firm PGS ... talks with ... manufacturers ...

THE STRAITS TIMES

Scientists here create smart lens

日経産業新聞

Nikkei Sangyo Shimbun

電気使わぬ液体レンズ

小型化簡単に

联合早报

水可制成摄像镜片

The liquid lens has received extensive coverage in the local and international media with features in the major dailies and magazines, and online technology journals.

Singular ID Offered SEEDS Funding

Singular ID Pte Ltd, IMRE's first spin-off company which develops tiny anti-counterfeiting magnetic tags, was recognised as a SEEDS Enterprise during a ceremony held in conjunction with the Global Entrepolis@Singapore in September 2005.

SEEDS or Start-up Enterprise Development Scheme is a co-financing scheme managed by the Economic Development Board (EDB) of Singapore for start-ups in the "seed" stage of enterprise formation. Under this programme, the EDB will match a dollar for every dollar raised from qualifying third party investors, up to a maximum of $300,000 per company.

"We are pleased with the progress that we have been making since spinning-off from IMRE, and now look forward to making our evaluation kit available during the first half of 2006" said Dr Adrian Burden, Chief Executive Officer for Singular ID Pte Ltd.

The company which was launched in June 2005, had earlier secured a third party investment from Advance Nanotech, Inc., a US-based venture capital firm specialising in funding nanotechnologies.

The inexpensive, forge-proof Singular ID tags make use of a blend of micro and nanotechnologies and can be used as security markers on a wide range of items including luxury bags, pharmaceutical packaging and machine parts, such as aircraft components.

For more information about Singular ID, please visit
www.singular-id.com

Dr Adrian Burden, CEO of Singular ID Pte Ltd, receiving the certificate recognising Singular ID as a SEEDS Enterprise from Dr Vivian Balakrishnan, Minister For Community Development, Youth and Sports and Second Minister for Trade and Industry, at the SEEDS ceremony on 29 September 2005.

Art in Science – Images from IMRE

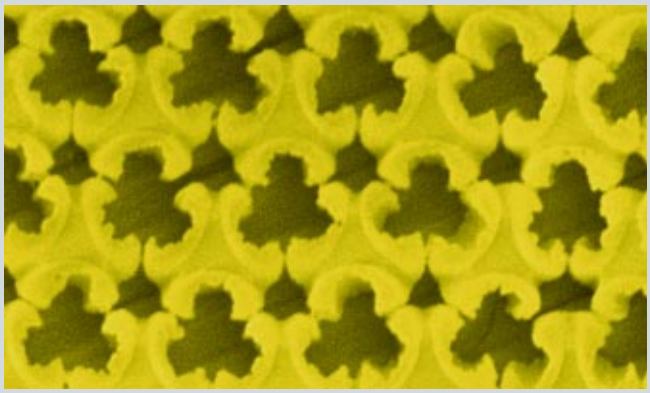
The beauty of materials lies in the "eye" of the Scanning Electron Microscope! It brings out the brilliance of materials, which may at times look quite ordinary and dull to the naked eye!

This work of art (*right*) was taken by Mr Zheng Yuebing, a Research Fellow from IMRE's Materials Science and Characterisation group, as part of his research on nanotechnology. Mr Zheng's stunning image of a gold membrane was one of 12 international submissions shortlisted for the 2005 cover competition in *Materials Today*, a well-respected journal in materials science and technology.

The image of a gold membrane with hierarchical nanopore arrays was taken with IMRE's Scanning Electron Microscope (SEM). It shows two different types of regularly arranged nano-sized (10^{-9} m) pores that are found on the surface of a gold membrane.

"These characterisation studies are important as such membranes can be used as templates or masks for making hierarchical nanostructure arrays including nanodots and nanoholes on substrates," said Mr Zheng who participated in the annual competition for the first time.

The formation of different types of nano-sized structures on the same substrate has many potential applications such as in white quantum dot light emitting devices. These structures can also be used as a platform to directly investigate the effects of size and shape on the properties of nanostructures.



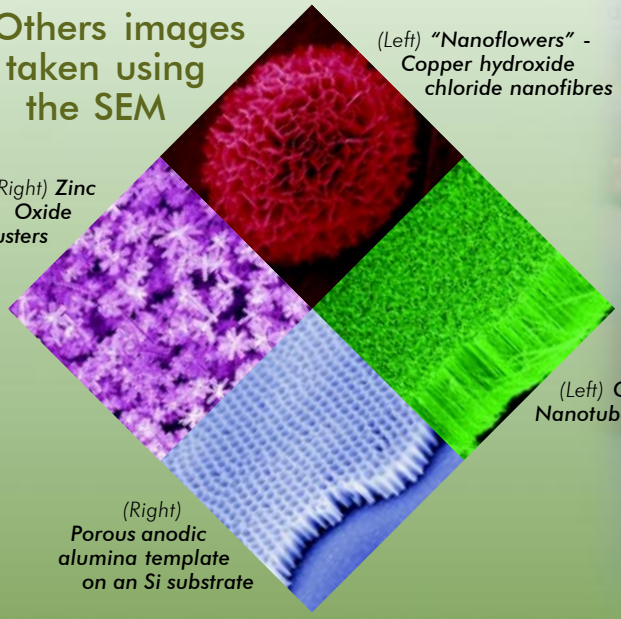
Scanning electron microscope (SEM) image shows details of a novel gold membrane with hierarchical nanopore arrays. The gold membrane has potential applications as templates for fabricating hierarchical nanostructure arrays.

While enjoying the benefits of materials in our daily lives, let us not forget to appreciate the art in materials science through these brilliant images which are often breathtaking and a sight to behold!

Scanning Electron Microscope (SEM)

- An SEM forms an image of the surface of materials by scanning it with a fine electron beam.
- Both secondary and backscattered electrons that bounce off the surface are then collected to give information about the surface shape and atomic weight of the sample.

Others images taken using the SEM



(Left) ***"Nanoflowers" - Copper hydroxide chloride nanofibres***

(Right) ***Zinc Oxide Clusters***

(Left) ***Carbon Nanotubes***

(Right) ***Porous anodic alumina template on an Si substrate***

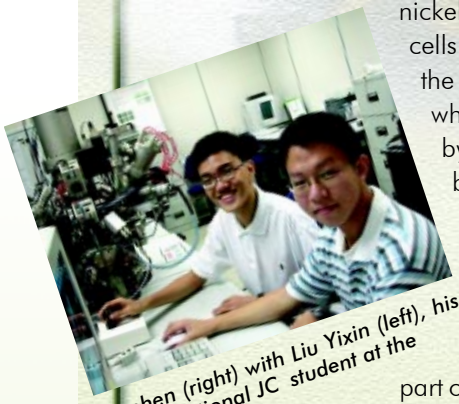
A Stint in IMRE Made All the Difference

A junior college student discovers that there is more than meets the eye in research and finds a calling in materials science!

Scientific terms or jargon like *Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS)* are so technical that they can be a big turn off to any lay person, not least our teenagers in schools.

That was exactly how Stephen Tay, a former National Junior College student now undergoing his National Service, felt when he first heard about the term *TOF-SIMS*.

"My classmate, Liu Yixin and I were given a project on TOF-SIMS, which we thought was going to be boring as it was about simple metals like aluminium, nickel and palladium, but not cells or bacteria," explained the enthusiastic 18-year old who was then more taken in by research in the biomedical sciences given the media attention and interest in the field.



Stephen (right) with Liu Yixin (left), his fellow National JC student at the TOF-SIMS.

But his interest took a turn when he was on attachment at IMRE as part of the Singapore Science and Engineering Fair competition, jointly organised by A*STAR and the Singapore Science Centre.

"The experience turned out to be fantastic! Finding out that a slight defect could greatly affect the chemical and physical characteristics of a material was really fascinating."

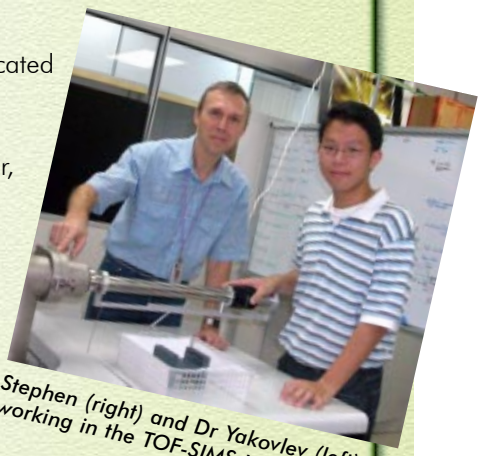
Juggling between lab work at IMRE and school work can be quite taxing for a college student. Despite the mental and physical demands of running from his college to the lab, it was at IMRE that he first discovered his interest in research work.

"It was rewarding to find out that skewed results do not always mean an experiment has failed," said Stephen who was explaining how the measured profile of aluminium did not come out as predicted but instead discovered that the "culprit" was the Nickel/Palladium layer which acted as a diffusion barrier!

"The joy and excitement of discovery? It's beyond words!"

- Stephen Tay, 18-year old, soon-to-be undergraduate in materials research

Stephen was under the mentorship of Dr Nikolai Yakovlev, an IMRE Research Scientist whose many years of experience with the *TOF-SIMS* has made him a highly respected authority of this sophisticated research equipment.



Stephen (right) and Dr Yakovlev (left) working in the TOF-SIMS Lab.

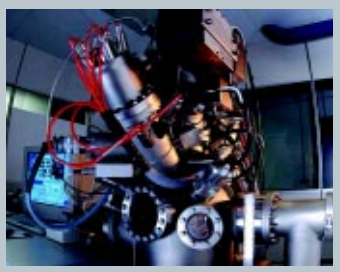
Stephen had high praises for his supervisor, "He was patient with us and would always challenge us to approach problems from different angles."

Commenting on the *TOF-SIMS*, Stephen said, "It was definitely challenging. The concepts were all very foreign to me at first. But with Niko's patience and guidance, I succeeded and can even operate the machine by myself now!"

"This attachment has given me an insight into a research career. There may be bumps along the road but patience and determination keeps a scientist going until the results are achieved."

"The joy and excitement of discovery? It's beyond words!" said Stephen, who has enrolled in the Nanyang Technological University's School of Materials Science and Engineering to pursue his undergraduate degree in materials research.

Time-of-Flight Secondary Ion Mass Spectrometry



TOF-SIMS allows determination of chemical composition of materials and the distribution of chemical species through the depth of the sample.

- It uses a pulsed primary ion beam to desorb and ionize atoms and molecules from the surface of a sample.
- The resulting secondary ions are accelerated into a mass spectrometer, which measures their "time-of-flight" from the sample surface to the detector to determine the mass of the ions.
- Because each element has it own mass, analysis of the mass spectrum allows us to determine what elements are in the sample.
- Depth profiles are obtained, when the sample is gradually sputtered and mass spectra are measured from deeper and deeper layers.

Future Technology, Here Today!

Insights from IMRE's NSS Scholar, Ms Shireen Goh, on her recent trip to the 2005 World Exposition held at Aichi, Japan.

During my attachment at IMRE, I was fortunate enough to be selected to accompany an A*STAR delegation on its visit to the 2005 World Exposition in Aichi, Japan. The event is the 21st century's first world exposition, which received more than 22 million visitors over a period of six months.

The Aichi World Expo showcases some of the world's latest leading-edge technologies and breakthroughs that have significant impact on our future lifestyles.

I had the opportunity to see some of these technologies first-hand! Here are some of them:

Another life-like robot - A seal which looks and acts like one, and responds to touch and voice commands. A must for the next generation of pet lovers.

***The Earth Vision** is a 360 degree immersive projector system which gives viewers an all-round panaromic view of a movie or video clip. The theatre takes the form of a hollow globe with a transparent glass bridge for the viewers to stand on while enjoying a spectacular "being there" experience!*

Single-seater i-unit – A single occupancy vehicle that was designed to conserve energy by reducing oil consumption and lessen road congestion.

The future of transport? Intelligent Multimode Transport Systems (IMTS) talk to one another on expressways to improve traffic flow and reduce accident rates.

***Life-like humanoids or androids** may no longer be fiction - Four realistic robots that look, feel and talk like humans.*

Laser Dream Theater - Three different lasers in the wavelength of pure red, blue and green generate images to produce richer colours and images allowing breathtaking panoramic images of the Grand Canyon and Niagara Falls.

***Ms Shireen Goh** is a National Science Scholarship (NSS) recipient and is on the 2005 A*STAR Chairman's Honours List. She is a former student of Hwa Chong JC and ASEAN scholar. She has completed her undergraduate studies from Cornell University in Applied and Engineering Physics and will be pursuing her postgraduate studies in the coming year.*

The National Science Scholarship (NSS) is offered by Singapore's Agency for Science, Technology and Research (A*STAR). The scholarships seek to nurture Singapore's bright, young and passionate research talents for the challenges of a research career in Science. More than just excellent grades, A*STAR looks for individuals who want to change the world with their zest for Science.

On the Homefront

Here's a snapshot of some groundbreaking research from IMRE's labs:

- **White Light Emitting Diodes** - Next generation lighting devices that can outlast and outshine conventional bulbs and lamps, but using only a fraction of the energy. www.imre.a-star.edu.sg
- **Liquid Lens** - Lenses made out of liquid that are used to miniaturise cameras and give better quality image. www.imre.a-star.edu.sg
- **Singular ID Anti-Counterfeiting Technology** - Miniature magnetic authentication tags developed using nanotechnology that can be used to preserve the integrity of genuine products. www.singular-id.com

If you want to find out more about A*STAR's scholarship, research and Research Institutes, please visit the A*STAR website at www.a-star.edu.sg

Patents (Jun 05 – Oct 05)

Listed below are summaries of some recent patents filed and granted by IMRE. If you want to know more about our patents, please write in to enquiry@imre.a-star.edu.sg

Patents Filed

Electroconductive curable resins
The invention relates to the electroconductive polymer compositions which have potential applications in making aircraft parts, automobiles and electronic components, etc.
Inventors: Masaya Kotaki, He Chaobin, Wang Ke

Hierarchical nanopatterns by nanoimprint lithography
The invention involves a method for creating ordered three dimensional hierarchical structures by nanoimprinting in various polymer films and has potential applications in MEMS, NEMS and micro- or nano-optic devices and displays.
Inventors: Low Hong Yee, Zhang Fengxiang

Optically-active nanoparticles comprising fluorescent polymers and uses therefore
This invention seeks to produce optically-active nanoparticles and has potential applications in bioimaging, for tracking a delivered drug or gene and for detecting chemical or bio-species.
Inventors: Chen Zhikuan, Li Xu

Poly(arylenevinylene) and poly(heteroarylenevinylene) light emitting polymers and polymer light-emitting devices
The invention involves conjugated polymeric materials, their preparation methods, and their application in polymer light emitting diodes.
Inventors: Chen Zhikuan, Huang Chun

Reliable contacts
The invention relates to a method to prevent or inhibit the occurrence of agglomeration in nickel monogermanide film and may be adapted to existing Ni silicide processing platforms without much modification.
Inventors: Chi Dongzhi, Lee Ka Yau, Rinus Lee, Liew Siao Li, Yao Hai Biao

Template-assisted nanostructure formation
The method relates to the self-assembly of molecules, after which the template may be stripped from the substrate, leaving nanostructures.
Inventors: Melissa Sander, Tan Le-Shon

Variable focus microlens
The invention relates to a method to change the curvature of a lens formed by a liquid droplet to achieve a wide focal range for use in optical devices in telecommunications, data storage, sensing, manufacturing and medicine.
Inventors: Isabel Rodriguez, Peter Moran, Khaw Aik Hau, Saman Dharmatilleke

Patents Granted

Cationic water-soluble conjugated polymers and their precursors
The invention is a water-soluble conjugated cationic polymer that has different quaternization degree, and hence different water-solubility as well as charge transporting properties.
Inventors: Liu Bin

Laminates for encapsulating devices
The invention relates to a method of encapsulating flexible and thin organic light emitting-diode devices.
Inventors: Guenther Ewald, Wang Wei, Chua Soo Jin

Method and apparatus for forming a metallic feature on a substrate
A method of forming a metallic feature on a substrate such that the raised region of the stamp causes a corresponding indented region in the substrate and at least some of the catalytic particles are transferred to a selected area of the substrate.
Inventors: Peter Moran, William Chen

Multilayer substrate metallization for IC interconnection
The invention involves a new substrate metallization for Pb-free soldering on Si die
Inventors: Zhang Fan, Li Ming

Visits and Events

Science 05 – X-periment Exhibition
2-4 September 2005

*Visitors to the A*STAR and Singapore Science Centre-organised Science 05 exhibition comprised mainly the young.*

Visit by delegates from *"UK-SINGAPORE Partners in Science: Materials for the new Millennium"*
12-13 September 2005

IMRE researchers and their respective UK counterparts met for laboratory tours and discussions during the visit by 24 delegates from the workshop.

ON-Singapore Symposium
14 September 2005

OLED-related companies such as Osram and Solomon Systech, presented OLED updates and advancements.

A*STAR SERC Inter-Research Institute (RI) Poster Symposium
19 September 2005

*The Inaugural A*STAR SERC Inter-RI Poster Symposium had a total of 105 posters submissions.*

IMRE Industry Symposium
30 September 2005

Participants being briefed on how IMRE's research could be applied to industry to benefit their products and processes.

Visit by Republic Polytechnic
30 September 2005

40 students from Republic Polytechnic being briefed on IMRE's characterisation work during their Science 05-related visit.

RESEARCH

Semiconductor Nanostructures Fabricated by Selective Area Epitaxy

by Dr Chen Peng

Achieving uniform size and a regular array of semiconductor nanostructures using a technique based on pattern transfer of nanopatterns will improve optoelectronic devices like quantum dot laser diodes and single-electron transistors.

Low dimensional semiconductor structures such as quantum dots and wires give rise to physical phenomena that have been applied in optoelectronic and electronic devices, leading to improved functionalities, such as quantum dot laser diodes and single-electron transistors. Quantum dot lasers and single-electron transistors are important components in high-speed and high-efficiency operation devices, such as 10-gigabit-per-second quantum dots laser

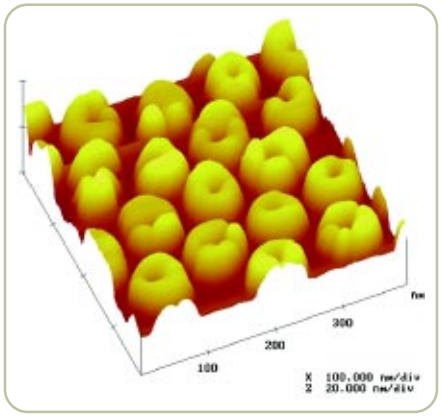


Figure 1. AFM three-dimensional view of the InGaN nanorings

from Fujitsu Limited for compact, low-cost, and low power-consumption optical transmitters targeting optical metro-access systems and high-speed optical LAN. To date, the formation of nanostructures is mostly controlled by the Stranski-Krastanow (SK) mode through self-organised processes, which results in random distribution of the sizes and locations of the nanostructures.

In order to achieve a regular array of nanostructures over large areas, the growth surface must be modified to promote nucleation at specific sites. Although direct patterning by lithography enables the fabrication of well-ordered and uniform-size nanostructures, post-lithography processing techniques, such as dry etching, usually cause additional damage to the crystal integrity of the patterned nanostructures. Achieving uniform size and a regular array of semiconductor nanostructures has proven to be a challenge for scientists.

In IMRE's study, an integrated process to fabricate controllable arrays of semiconductor nanorings and nanodots on patterned surfaces is presented. This approach is based on the pattern transfer of nanopatterns to a SiO_2 layer, followed by selective epitaxial growth of InGaN onto an underlying GaN substrate using metalorganic chemical vapour deposition (MOCVD). Using this approach, crystalline InGaN nanorings, nanodots and nanowires with diameters of 50~80 nanometers have been achieved.

The formation mechanism of the nanostructures is based on the initial stage of selective growth and restricted atom migration in a confined area. This approach takes advantage of top-down technology to produce ordered nanopatterns in the SiO_2 film forming as the mask for subsequent MOCVD growth. It also takes advantage of MOCVD epitaxial growth technology to fabricate high quality semiconductor crystals.

Strong photoluminescence obtained at room temperature from the non-capped nanostructures indicates strong confinement of the electrons in the nanostructures, resulting in strong electron-hole coupling and extremely high recombination efficiency. This approach enables the fabrication of dense, uniform arrays of epitaxial nanostructures. By using the dense and uniform size nanostructure arrays, the advantages of the low dimensional semiconductor structures will be fully brought to play to enhance the functionalities of devices greatly.

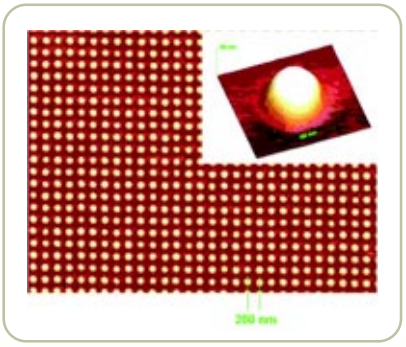


Figure 2. AFM three-dimensional view of the InGaN nanodots.

Dr Chen Peng *obtained his PhD degree, majoring in microelectronics and solid-state electronics from Nanjing University, China in 2001. He has been working as a research scientist at IMRE since 2002. He has authored 80 publications with over 130 citations, and holds five US/PCT patents. His research interests focus on the areas of wide bandgap semiconductor materials and devices.*

Article adapted from author's publication, "InGaN nanorings and nanodots by selective area epitaxy," published in Applied Physics Letters 87, 143111 (2005). It was selected for the October 10, 2005 issue of Virtual Journal of Nanoscale Science & Technology.

Diary of Upcoming Events @ IMRE

18 - 20 January 2006
2nd MRS-S Conference on Advanced Materials
IMRE Seminar Room 1

26 - 27 January 2006
IMRE Scientific Advisory Board (SAB) Meeting

For enquiries about IMRE's events, please write in to events@imre.a-star.edu.sg

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