Institute of Materials Research and Engineering
A*STAR

PERSPECTIVES

Research, Development and Commercialisation

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

PERSPECTIVES + IMPACT - A New Perspective!

IMRE Newsletters at a Glance

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Dear Readers!

Greetings and a Happy New Year!

IMRE's Corporate Communications would like to take this opportunity to thank you, our loyal readers, for your support of our newsletters. As most of you know, we currently have two printed publications, PERSPECTIVES (corporate news – thrice-yearly issue) and IMPACT (research-related news – quarterly issue) as well as an e-newsletter, IMRe-news.

Starting with this issue we will be combining the two printed newsletters into a quarterly issue, to give you a holistic view about the happenings in IMRE, both from a corporate and a research perspective. We will be retaining the title "PERSPECTIVES" for this combined newsletter.

The IMRe-news will continue in its present form and on a bimonthly basis.

We look forward to your continued support of our newsletters!

P/S: Please feel free to drop us a line (enquiry@imre.a-star.edu.sg) if you have any queries about our publications or any of the articles that interest you!

IMRE's R&D - Beyond Enabling Technology

We take a look at some of the technologies developed by IMRE and their potential applications in the marketplace.

Since it's inception in 1996, the process of research, re-invention and innovation has been in full swing in IMRE. And in that time, IMRE has achieved significant milestones in R&D, including the setting-up of one of the best-equipped and well staffed characterisation facilities in the region, pioneering local R&D work on organic light emitting devices as well as fuel cell technology. Following are some of our most recent breakthroughs:

Anti-counterfeiting Nano-sized Magnetic Tags

Technology

Singular ID – Nano-sized Magnetic Fingerprint Technology

IMRE's Singular ID was a finalist in the Far Eastern Economic Review's Asian Innovation Awards 2004. The Award is Asia's premier honour for individuals and companies who come up with new ideas, methods or technologies, or apply existing knowledge in creative, new ways to improve the quality of life or enhance productivity.

Description

Singular ID uses nanotechnology to create low-cost magnetic labels that have 'unique' fingerprints. These labels are prohibitively difficult to replicate, can be invisible to the naked eye, lightweight and resilient in extreme environmental conditions. The labels can also be mass-produced inexpensively.

Uniqueness / Advantage

- **Inexpensive tags**
- **Unique randomised structure** as each tag is different and virtually impossible to reproduce
- **Readable with existing equipment** such as standard magnetic read heads
- **Tags can be made extremely small** (the width of a human hair), so they can be overt or covert
- **Tags are thermally and chemically stable** and, with an additional coating, are mechanically robust
- **Cannot be detected remotely** thus preventing Singular ID tags from being located and removed, unlike radio frequency (RF) tags.
- **Not adversely affected by external magnetic fields**

Potential Applications

- Identification and authentication markers to prevent fraud
- Secure logistical and inventory tracking
- Invisible labels for precious articles such as jewellery
- Tamper-proof passports, identification cards, security passes, etc.
- Prevent pirating of goods such as audio and video CDs

Highlights

- Finalist in the Far Eastern Economic Review Asian Innovation Awards 2004
- Second Prize in the 8th Edition of The Roland Berger - INSEAD Business Plan Competition 2004

Contact

- Dr Peter Moran (p-moran@imre.a-star.edu.sg)
- Dr Adrian Burden (adrian-pb@imre.a-star.edu.sg)

Website

- www.imre.a-star.edu.sg/singular-id

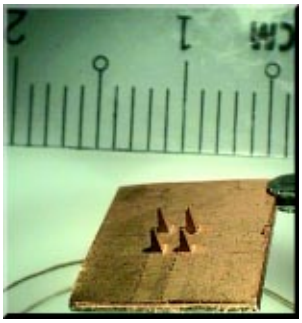
Presidential Audience - Dr Adrian Burden briefing the President of the Republic of Singapore, Mr S. R. Nathan, about IMRE's unique magnetic tagging technology at the Asian Innovation Awards 2004 ceremony.

Micro-sized Needles for Painless Injections

Technology

Microneedles

Description



Microneedles present the option of painless injections.

A novel miniature medical device for subcutaneous drug delivery using a microneedle array. These microneedles will penetrate the stratum corneum (the topmost layer of the skin), which is the major barrier that prevents particles, including drug molecules, from penetrating the skin. The short length of the microneedle restricts the penetration depth to the second layer of the skin or the viable epidermis. This layer contains living cells but few blood vessels and nerves, thus making drug delivery efficient and relatively painless. Current microneedles are either too brittle (silicon and glass micro needles) or too soft (polymer microneedles) and costly.

Uniqueness / Advantage

- **Low cost**
- **Wide range of dimensions** (100-2000 micron in length and 50 to 1000 micro in diameter)
- **Several different cross section shapes** available
- **Suitable for mass production**

Potential Applications

- Painless drug delivery injections
- Genetic engineering (injecting DNA into cells)
- Precise and controlled dispensing of chemical agents in analytical instruments
- Assist in ball grid array assembly in semiconductor industry

Highlights

- Featured in Channel NewsAsia, "Singapore Tonight" segment, 18 June 2004
- Featured in Lianhe Zaobao, 27 May 2004

Contact

- Mr Lim Chee Yen (cy-lim@imre.a-star.edu.sg)

Fluidlens - Mini Liquid Optical Lens That Allows Optical Zoom Feature

***Fluidlens* (above left) greatly reduces the size of optical systems and allows optical zoom.**

Technology

Fluidlens

Description

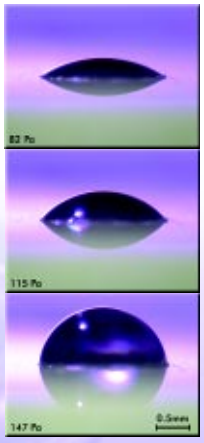
A miniature optical lens the size of a one-cent coin that uses water contained in fluidic reservoirs to achieve dynamic focusing. The lens has a 3mm - ∞ focal range and 10x zoom feature within the 1.5 x 1.5 cm^2 packaged focusing system. *Fluidlens* mimics the focusing mechanism of the human eye by changing the radius of curvature at the liquid-air interface, hence adjusting the focal length. *Fluidlens* is particularly useful in compact, small optical devices, where a non-mechanical focusing approach with the least moving parts is preferred because of the limitations of space and size.

Uniqueness / Advantage

- **Low cost -** estimated at less than a dollar in mass production
- **Miniature in size -** 1.5 x 1.5 cm^2 package with room to go smaller
- **Wide focal range** (3mm - ∞) for focusing on both near and distant objects
- **Scratch-resistant** as opposed to normal plastic and glass lenses

Potential Applications

- Telecommunications - Optical switches, fibre optic coupling, mobile phone cameras, webcams
- Data storage - CD, DVD, blue ray DVD-type drivers, barcode readers
- Analytical equipment - Portable microscopes, sensors
- Manufacturing - Laser technology
- Medicine - Endoscopes
- Military applications



Images of radius of curvature variation with pressure for a 2 mm plano-convex liquid lenses.

Highlights

- Featured in The New Paper, 26 September 2004

Contact

- Dr Saman Dharmatilleke (sd-saman@imre.a-star.edu.sg)
- Dr Isabel Rodriguez (i-rodriguez@imre.a-star.edu.sg)

For more information, or if you are interested in the licensing and commercialisation of these technologies, please contact IMRE's Business Development Office at bdo@imre.a-star.edu.sg

Another Renowned Scientist Joins IMRE Under A*STAR's Visiting Investigatorship Programme (VIP)

Professor Ananth Dodabalapur whose research on organic transistor was cited as one of the top 10 scientific breakthroughs for the year (Science Magazine – 2000) joins IMRE under the Visiting Investigatorship Programme (VIP).

Profile – Professor Ananth Dodabalapur

Professor Ananth Dodabalapur's research experience and credentials speak volumes about his expertise. A professor with The University of Texas at Austin's Electrical and Computer Engineering department, he has received numerous accolades for his research work. Most notable was his research on organic transistor circuits which was cited by Science Magazine as one of the top 10 scientific breakthroughs for the year 2000.

At 41, he has published over 100 articles in refereed journals and has more than 30 U.S. patents issued or pending office action. He is a co-recipient of the 2002 Award for Team Innovation of the American Chemical Society, and a co-recipient of an R&D 100 Award for 2001.

Since 1992 Prof Dodabalapur has investigated various aspects of the physics and technology of organic and polymer semiconductor devices. His current interests are organic transistors, organic-based chemical and biological sensors, and organic-based laser physics and optics.

Outside of research, Prof Dodabalapur is a self-confessed nature-lover who is always on the lookout for a good jungle to trek, even if they do involve being chased by wild elephants and a lot of running (in his younger days, as he puts it!).

What is the importance/impact of the project that you are doing under the VIP scheme?

As part of the VIP scheme, I will be working closely with researchers like Dr Alan Sellinger and Dr Chen Zhikuan on Molecular and Polymer Electronics focusing on Organic Solar Cells and Organic Thin Film Transistors. This research will involve synthesizing new materials all the way to fabricating functional devices, with a team made up of chemists, physicists and engineers.

There are a lot of exciting things happening now in the field of organic electronics. These occurrences happen only at certain periods in the evolution of a particular technology. For this reason, setting up a coordinated research effort in NTU, NUS and A*STAR's IMRE is an excellent opportunity to produce good quality research in organic electronics. The quality of research and infrastructure in IMRE and the universities are very good and I am looking forward to having more colleagues as key potential collaborators.

As a distinguished and experienced researcher, what do you think are some of the qualities that make a good scientist?

One of the most important qualities that mark a good scientist is passion! A good researcher must have a passion for the work that he or she is doing. So much so that they would constantly think about it, and be absorbed by it, any time, anywhere!

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What do you do in your spare time when you are not doing research?

When I have spare time, I'm still thinking of research! That's what I mean when I mentioned having a passion for your work. The research just becomes second nature to you.

Speaking of nature, I do love trekking and exploring as well, which probably goes back to my younger days when I used to explore jungles with my friends. When I was a teenager, I remember a school project to find out the scientific names of the all the trees on my school campus - my first brush with research work. You could say then that nature and research have been a big part of my life since an early age.

Do you have any words of advice for budding scientists?

For those thinking about research as a career I would advise to find out first about the area of research that you intend to pursue. The 'fit' has to be good. Only then can passion and commitment to the research work grow.

A*STAR's Visiting Investigatorship Programme

The programme is a prestigious three-year appointment for high calibre scientists with excellent academic and research credentials. It aims to:

- Attract foreign talent for participation in our local scientific capabilities development
- Provide expertise for RIs to leverage on
- Strengthen our links with the international research community

Tapping on Central European R&D Expertise

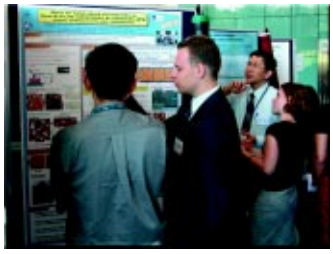
Joint workshop hopes to incubate potential partnerships between local and Central European researchers.

*Dr Lim Khiang Wee, who is also the Deputy Executive Director of A*STAR's SERC, giving an overview at the start of the workshop.*

A*STAR's Science and Engineering Research Council (SERC) conducted the first ever A*STAR-Central Europe Workshop in IMRE to establish potential future R&D cooperation with scientists from the region. Held from 18 - 19 November 2004, the workshop focused on topics in "Chemistry & Materials", bringing together local researchers and some 34 Central European scientists from Hungary, Poland and the Czech Republic.

The aim of the event was to promote scientific co-operation and use the workshop as a platform for mutual exchange as well as showcase of R&D capabilities that will enable participating scientists to explore possible areas of research collaboration. Local postdoctoral researchers and PhD students nearing completion of their thesis were also invited to attend the workshop.

"This Workshop will hopefully serve as a stepping stone for future R&D cooperation between local scientists and those from the Central European region," said Dr Lim Khiang Wee, IMRE's Executive Director. "The region has a very well-established R&D history and infrastructure that researchers and engineers here can tap on".



(Left) Participants of the workshop in discussion during the poster session and (Right) Some of the speakers taking a closer look at IMRE's characterisation capabilities during a tour.

IMRE's Role as a Materials Science and Characterisation Research Hub

*Expertise and vast experience in materials science and characterisation research makes IMRE an obvious choice for the characterisation studies hub for A*STAR's SERC.*

With an array of high-tech, state-of-the-art characterisation facilities, and an experienced and highly-qualified research team, IMRE's characterisation laboratory is one of the most comprehensive in Singapore, making it an obvious choice to be a hub for SERC's scientific characterisation studies.

In line with this, IMRE's characterisation team has been actively marketing its strengths in characterisation to its sister research institutes (RIs). IMRE recently conducted a series of presentations on its equipment and research capabilities to create an awareness of how RIs can leverage on IMRE's well-established characterisation infrastructure.

Said Dr Emma Philpott, Business Manager with IMRE's Materials Science and Characterisation Laboratory (MSCL), "Our team aims to provide high quality materials characterisation and advice to all RIs and Industry. We focus heavily on the provision of advice and discussion of the wider issues surrounding the characterisation. We put the analysis results into context and help explain what the results may mean in practical terms".

Participants being briefed on IMRE's characterisation capabilities.

Dr Philpott adds that the team continually conducts research into advanced characterisation techniques, which helps keep IMRE at the forefront of characterisation technology.

Apart from the RIs and tertiary institutions, the characterisation team has been actively engaged in providing consultancy support to local industry on a myriad of characterisation issues and research studies.

Dr Emma Philpott introducing the Materials Science and Characterisation laboratory to attendees.

For more information on the Materials Science and Characterisation (MSC) Laboratory, please contact Dr Emma Philpott at emma-philpott@imre.a-star.edu.sg.

Some of the characterisation equipment and capabilities available in IMRE:

- XPS/UPS
- TOF-SIMS/Dynamic SIMS
- TEM/SEM/FIB
- NMR/Chemical analysis
- Mechanical Testing
- X-ray analysis

For more information, you can download our **Materials Science and Characterisation (MSC) equipment** brochure from our website at www.imre.a-star.edu.sg

ICES-IMRE-Mitsui Master R&D Agreement Signed

IMRE and Mitsui in joint collaboration deal to develop proprietary products and processes.

A*STAR and Mitsui Chemicals, Inc., one of the largest chemical companies in Japan, signed a master R&D agreement for joint research collaboration. A*STAR's R & D capability is represented by IMRE and the Institute of Chemical and Engineering Sciences (ICES).

The master agreement, sealed on 16 September 2004, paves the way for researchers, scientists and engineers from IMRE, ICES and Mitsui to collaborate on R&D projects to develop proprietary products, process technologies as well as jointly publish patents and scientific papers.

"A*STAR's collaborative alliance with Mitsui Chemicals represents a win-win partnership to meeting the challenge of bringing new skills and technologies to the chemicals cluster," mentioned Prof Chong Tow Chong, Executive Director of the Science and Engineering Research Council, A*STAR, who was on hand to witness the signing ceremony.

Mitsui's R&D collaboration with IMRE leverages on the Institute's strength and capabilities in materials design, synthesis and characterisation expertise. IMRE will work with Mitsui to discover new product applications through the development of nano-structured hybrid materials.

Commented Prof Chua Soo Jin, IMRE's Deputy Executive Director, "IMRE has been working on nano-structured hybrid materials and this collaboration with Mitsui Chemicals will allow us to explore their potentials for industrial application".

The visitors from Mitsui speaking to IMRE scientists in the Materials Science and Characterisation Laboratory during a tour of IMRE's facilities.

In kick-starting the collaboration, a mini joint-symposium on Materials Research was held in IMRE and the delegates from Mitsui, led by Dr Akihiro Yamaguchi, Managing Director and Group Executive, R&D Centre, Mitsui Chemicals, Inc., took the opportunity to visit the laboratories of ICES and IMRE.

The chemicals industry in Singapore registered an increase of 23% in output and 9% in value-add to S$39.1 billion and S$5.2 billion respectively in 2003, despite the challenges of rising prices of raw materials and high energy costs globally.

IMRE Conducts Training for Singapore's OLED Manufacturers

The Institute's many years of experience and expertise in OLED technology serves as the platform for its OLED technical and practical training.

As part of the Institute's effort to lead and support the growth of the Organic Light-Emitting Diode (OLED) display industry in Singapore, IMRE has developed an industry-focused training programme that aims to equip local engineers with fundamental knowledge of OLED technology.

The programme conducted over six half-days consists of a series of lectures and hands-on practical training in the Institute's OLED laboratories, and allows participants the opportunity to develop the necessary understanding in the research, development and manufacturing of OLED devices.

IMRE's very established OLED research and development team conducting one of the technical training sessions.

The first company to benefit from the training programme was *Innoled Pte Ltd*, a subsidiary of the Singapore-listed company Eastgate Technology Ltd. Mr Peter Karlsson, Managing Director of *Innoled* said, "We are extremely glad that IMRE has decided to conduct an OLED-focused training programme. With IMRE's experience and knowledge in polymeric OLED, the programme was very helpful in addressing our company's training needs as we embark to become the first OLED manufacturer in Singapore using the conjugated polymer technology."

In order to derive maximum benefit, IMRE undertook a consultative approach to identify the companies' specific needs beforehand so as to tailor the training programme to meet their requirements. Dr Kim Shin Cheul, *Ness Display*'s Manufacturing Director noted, "We are very pleased to be able to send all our 25 new engineers for training in IMRE prior to their attachment with *Ness Display Co., Ltd.* in South Korea. To have part of the training in Singapore helps us to reduce the training time and accelerate the process of building up our mass production facility in Singapore."

The OLED training consists not only of lectures but hands-on practical sessions as well.

Dr Adrian Burden, IMRE's Senior Research Engineer further explained, "With the expertise gained through our OLED research activities over the last six years, IMRE is now in a good position to impart knowledge and expertise in this field to local industry. The training programme is an ideal platform to enable the Institute to establish a closer relationship with key local players in the OLED industry, which we believe will also lead to possibilities for future collaboration in the development of new OLED technology."

IMRE is also leading the OLED Network of Singapore (ON-Singapore) that seeks to promote and facilitate the research, development and manufacturing of OLEDs in Singapore. It provides the link between the local and the international OLED community. ON-Singapore currently has 31 local and foreign Corporate Members, including *Innoled* and *Ness Display*.

For more information about the training programme and about ON-Singapore (www.imre.a-star.edu.sg/on-singapore), please contact:

Mr Colin Leong
Business Development Manager
colin-leong@imre.a-star.edu.sg

Visits and Events

(September - December 2004)

Eager young visitors at Science 04.

Science 04 Exhibition

3-5 September 2004

As part of the month-long Science 04 event, the X-periment Exhibition was held at Suntec City. The exhibition is an annual event aimed at creating public awareness about Singapore's scientific research. IMRE set up a booth to showcase some of its research to the public. A separate event, entitled "Trails & Tales of RIs", was held on 10 September 2004 in conjunction with Science 04, where Junior College students experienced research close-up during laboratory tours organised at IMRE.

An IMRE researcher giving an introduction about IMRE's fuel cell technology.

IMRE Industry Symposium

24 September 2004

IMRE gave an introduction of its research advancements, capabilities and facilities to invited members of industry in a symposium aimed at fostering interaction and potential collaboration between industry and our researchers. The symposium included presentations on the various research areas, their highlights, research achievements and laboratory tours.

IMRE-ICES Joint Seminar in session.

IMRE-ICES Joint Seminar

6 October 2004

An IMRE-ICES Joint Seminar was held in IMRE in an effort to increase interaction between researchers from both institutes as well as those from sister RIs. The research developments and updates presented during the event included work on fuel cells, poly(aralkyl ketone)s, nanoimprinted functionalised polymers, nano- and meso porous materials, nanocomposite dendrimers for OLEDs, organo-clays, and hybrid organic-inorganic nanocomposites. Some 68 researchers from A*STAR Research Institutes attended the symposium.

Workshop participants touring IMRE's characterisation facilities.

MSC Mechanical Testing Workshop

4 November 2004

The Materials Science and Characterisation Laboratory (MSCL) organised a Mechanical Testing Workshop in partnership with the German company Zwick/Roell, one of the market-leading manufacturers of mechanical testing systems. Participants from the semiconductor, electronics and manufacturing sectors as well as tertiary and research institutes attended the workshop. Presentations included the applications of mechanical testing and materials modelling and examples IMRE's successes in this area. The workshop also served as a platform for the Asian premier of Zwick's new extensometer.

Participants arriving for the Symposium.

IMRE-NUS Chemistry Department Joint Symposium

25 November 2004

A joint symposium organised by IMRE and the Department of Chemistry at NUS brought together researchers from both institutions to foster greater R&D exchange and to facilitate networking. The biennial event serves as a platform to promote research relationships, collaboration and student co-development programmes between IMRE and NUS. The research topics discussed included synthesis and characterisation of functional polymers, nano-structured materials, nano-composites, and their applications in optoelectronics. Other topics were on nano/micro-systems for reactors and sensors, surface and interface investigation through microscopy as well as spectroscopy techniques.

Patents Filed

Method and apparatus for forming microstructures

The invention relates to a method of transdermal drug delivery using microneedles. The microneedles are fabricated using microforming technology with deformable die. The method is inexpensive and suitable for mass production. Potential applications of the microneedles, usually in the form of arrays, include administration of drugs into a living organism or extraction of body fluids from it.

Inventors: Lim Chee Yen, Xu Yuan, Hbaieb Kais, Tan Yuan Ling, Christina
Date filed: 19 Nov 04
Country filed: Patent Cooperation Treaty (PCT)

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. The structural defects in the polymers were drastically reduced, thereby increasing the device efficiency and lifetime of the light-emitting materials and devices. The proposed polymers can be used as the emissive layer for polymer light-emitting diodes and can be fabricated into LED devices through solution process.

Inventors: Chen Zhikuan, Huang Chun
Date filed: 1 Nov 04
Country filed: Patent Cooperation Treaty (PCT)

Multicolour organic light-emitting devices

The invention describes the use of an organic electroluminescent (EL) stack sandwiched by two electrodes to form a microcavity for colour tuning and efficiency enhancement. The invention can be used for making a full colour pixelated display by adjusting the thickness of the interposed transparent conducting oxide (TCO) to meet the required microcavity condition for RGB.

Inventors: Zhu Furong, Ong Kian Soo, Hao Xiao Tao
Date filed: 11 Oct 04
Countries filed: Taiwan

Flexible electroluminescent devices

The invention describes a flexible PLED/OLED consisting of a top-emitting PLED/OLED on an opaque flexible substrate. The top-emitting PLEDs/OLEDs include a thin electron injector/a conducting metal layer/an index matching layer or a semitransparent metal cathode/an index matching layer. The invention would have applications in mobile phone devices, PDAs, lighting, etc.

Inventors: Zhu Furong, Ong Kian Soo, Hao Xiao Tao
Date filed: 11 Oct 04
Country filed: Taiwan

Device and method of detecting mutations and polymorphisms in DNA

The invention relates to a method for detecting mutations in DNA involving as little as one base change or a single base addition to, or deletion from the wild-type DNA sequences with the use of resonator sensors. The method is useful for diagnosing a variety of disease states or susceptibilities and detecting the presence of a mutated oncogene.

Inventors: Su Xiaodi, Robelek Rudolf, Wolfgang Knoll, Sean O'Shea
Date filed: 22 Sep 04
Countries filed: Singapore and US

A sensor

The invention involved a method for combining surface plasmon resonance (SPR) and quartz crystal microbalance (QCM) function in one device using attenuated total reflection (ATR) based coupling techniques for SPR measurement. The complementary signals acquired by the combined device allow one to take advantage of the strengths of each function while testing the validity of some of the assumptions inherent in data analysis, thus gaining a more complete understanding of the interfacial phenomena studied.

Inventors: Wang Guangyu, Su Xiaodi, Wolfgang Knoll, Wu Ying Ju
Date filed: 15 Sep 04
Countries filed: Patent Cooperation Treaty (PCT)

An imprinted polymer support

The invention describes a method to fabricate a Nano Imprinted Modular Support (NIMS) for solid phase organic synthesis (SPOS) by taking advantage of the nanoimprint technique. The imprinted structure, NIMS, offers advantages that are not easily if not impractical to achieve through currently available technology. NIMS allows a great deal of design freedom to obtain improved performance for modular support systems.

Inventors: Low Hong Yee, Suresh Parappuveetil Sarangadharan, Karen Darmono, Kong Yen Peng
Date filed: 15 Sep 04
Country filed: Patent Cooperation Treaty (PCT)

Nanostructures and method of making the same

The invention relates to an integrated fabrication process for ordered semiconductor nanostructures on a patterned substrate surface whereby the ordered nanopatterns from a porous template is transferred to a mask-film followed by a selective growth of the semiconductor in a material deposition system. The invention could be used for the fabrication of semiconductor-based low-dimensional optoelectronic and microelectronic devices.

Inventors: Chua Soo Jin, Chen Peng, Wang Yadong
Date filed: 31 Aug 04
Countries filed: Patent Cooperation Treaty (PCT)

Reversal imprint technique

The invention involves a new imprinting technique that avoids the need to spin-coat polymer layers on the substrate. A polymer layer was spin-coated directly on a mould, and transferred to a substrate by imprinting under

suitable temperature and pressure conditions.
Inventors: Bao Lirong, L Jay Guo, Albert Yee, Huang Xudong, Stella Pang, Chen Xing
Date filed: 8 May 02 (PCT filing date)
Countries filed: US, Germany, Singapore, Japan

Method for electroless deposition of a metal layer on selected portions of a substrate

This invention provides a method for selectively metallising ceramic, metal or polymer substrates. It allows simple, accurate patterning on the microscale.
Inventors: Sunil Madhukar Bhangale, Li Zhongli, Peter Moran
Date filed: 23 Apr 03 (PCT filing date)
Country filed: Japan

Method for forming a modified semiconductor having a plurality of band gaps

This invention provides a simple and effective method for spatially selective post-growth tuning of the transition energy levels of a semiconductor heterostructure and a method for multi-level (>4) transition energy tuning across a single wafer.
Inventors: Teng Jinghua, Dong Jianrong, Chua Soo Jin
Date filed: 4 Apr 03 (PCT filing date)
Country filed: US

Microneedles and microneedle fabrication

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: 10 Nov 03 (PCT filing date)
Country filed: Japan

Patents Granted

A process for modifying chip substrate assemblies

This invention is a method in which engineering changes and repairs to high density substrates can be achieved without the need for lithography.
Inventors: Syamal Kumar Lahiri, Harvey Phillips
Date granted: 29 Oct 04
Country granted: Singapore

Method of forming selective electroless plating on polymer surfaces

This invention provides a method for plating polymer surfaces to the metallisation of printed circuit boards and flexible substrates.
Inventors: William Chen, Peter Moran, Harvey Phillips
Date granted: 29 Oct 04
Country granted: Singapore

Vibratory in-plane tunnelling gyroscope

This invention relates to a gyroscope comprising: a proof mass; a frame supporting the proof mass; a connection arrangement connecting the proof mass and the frame, the connection arrangement having a first stiffness in a first direction and a second stiffness in a second direction substantially perpendicular to the first direction, one of the stiffness being significantly greater than the other stiffness; and a pair of elements adapted to sense relative motion there between in either the first or the second direction.
Inventors: William Chen, Francis Tay, Xu Yuan, Chua Bee Lee, Holden Li
Date granted: 29 Oct 04
Country granted: Singapore

Procedure for encapsulation of electronic devices

An encapsulation procedure for an organic light emitting diode (OLED) device, especially for thin and therefore flexible substrates, is disclosed. The device is sealed hermatically against environmental and mechanical damage. The procedure includes the use of a thin cover lid holder and a substrate holder that are designed to handle thin substrates without damaging them.
Inventors: Chua Soo Jin, Mark Auch, Ewald Guenther
Date granted: 12 Oct 04
Country granted: US

Injectable drug delivery systems with cyclodextrin-polymer based hydrogels

This invention provides injectable controlled released drug delivery formulations which include cyclodextrin, a polymer capable for forming hydrogel with cyclodextrin, a secondary polymer capable of complexing and/or conjugating the drug and altering the properties of the hydrogel and a drug in a pharmaceutically acceptable injectable aqueous fluid.
Inventors: Li Jun, Hanry Yu, Kam Leong
Date granted: 30 Sep 04
Country granted: Singapore

Support for bending test of flexible substrates

A support for facilitating the bending test of flexible substrates is disclosed. Adhesive plastic is applied on the substrate to keep the shards together after breakage, thereby eliminating the process of collecting the shards and fitting them back together for failure analysis.
Inventors: Mark Auch, Ewald Guenther, Chua Soo Jin, Chen Zhong
Date granted: 17 Aug 04
Country granted: US

RESEARCH

IMRE is working to monolithically integrate a micromachined tunable Fabry-Perot filter based on InP with a p-i-n photodiode for WDM applications around 1.55 mm for use in fibre optic communications as well as NIR spectroscopy of gases for detection and blood glucose monitoring.

Optical Tuning and Coupling in InP-based Photonic Devices

By Dr Ramam Akkipeddi
Team members: MA Shah, V Shanmugan, J Arokiaraj, Y Cao, SJ Chua, JR Dong, SL Teo and G Chowdhury
Collaborators: A/Prof Francis Tay (NUS) and Mr Andojo Ong (NUS)

Conventional MicroElectroMechanical Systems (MEMS) are based on silicon or polymer materials using the standard IC processing techniques and in the last decade or so these have found applications in areas such as micro-fluidics, accelerometers, gyroscopes, etc. The inherent limitation of silicon material in not being able to emit light has motivated us to consider MEMS made of III-V materials to integrate light-emitting/detecting devices for novel tunable and coupling applications. MEMS based on compound semiconductors such as InP and GaAs are gaining increasing relevance for tunable photonic devices such as those used in Wavelength Division Multiplexing (WDM) systems. The key advantage lies in the ability to integrate heteroepitaxial quantum devices with micromechanical elements. With this aim, our group is working to monolithically integrate a micromachined tunable Fabry-Perot filter based on InP with a p-i-n photodiode for WDM applications around 1.55 μm. The emphasis is also on reconfigurable OADMs (Optical Add Drop Multiplexers) based on novel fabrication approaches.

The core objective of combining novel movable structures based on MEMS, with InP based photonic devices, for tuning and coupling applications, encompasses work in three areas. The first one relates to the optimisation of the fabrication process. Heterostructures of suitable composition and thickness were grown. For structural layer (InP), dry etching has been found to be suitable while for releasing the structures wet etching technique is used. While dry etching has been optimised to obtain nearly vertical side walls on InP structures, wet etching on the other hand has been optimised with respect to temperature, etch-rate and etch-selectivity. Since release of microstructures is the last step in their fabrication, the wet etchant has been chosen such that it does not affect other components such as bond-pads, structural layer, dielectric sidewalls of platform etc. In Optical MEMS, the mirror properties, such as reflectivity and stop-band width are very crucial. To meet these stringent requirements dielectric-type Distributed Bragg Reflector (DBR) type of mirrors have been used instead of conventional metallic mirrors. Owing to the sensitivity of mirror optics to the thickness of constituent layers, the mirror processing has been optimised with feedback from Optical simulations. The MATLAB code for these optical simulations has been developed within our group. The processed device complete with all components is obtained by sacrificial wet etching and drying of the structures. Evaporation drying of the microstructures after the wet etching step poses a problem commonly known as 'stiction' wherein the forces due to surface tension of the rinsing solution act on the microstructures. This problem has been sidelined using a technique that has been perfected in IMRE by processing the structures in submerged condition and applying specially designed hardware in its operation. The structures are then released by sublimation drying. Figure 1-1 shows a released and freestanding structure.

The second one relates to the integration of a tunable optical filter with Fabry-Perot (F-P) cavity for realising a tunable photo-detector device. To achieve an integrated Photodetector-MEMS device, a Photodetector and a MEMS-based filter actuator were fabricated in isolation. Preliminary characterisation of a MEMS-based filter actuator has demonstrated a membrane deflection of > 300 nm with a pull-in voltage of 6 volts, as shown in Figure 1-2. Efforts are ongoing to successfully integrate these two devices in a monolithic configuration.

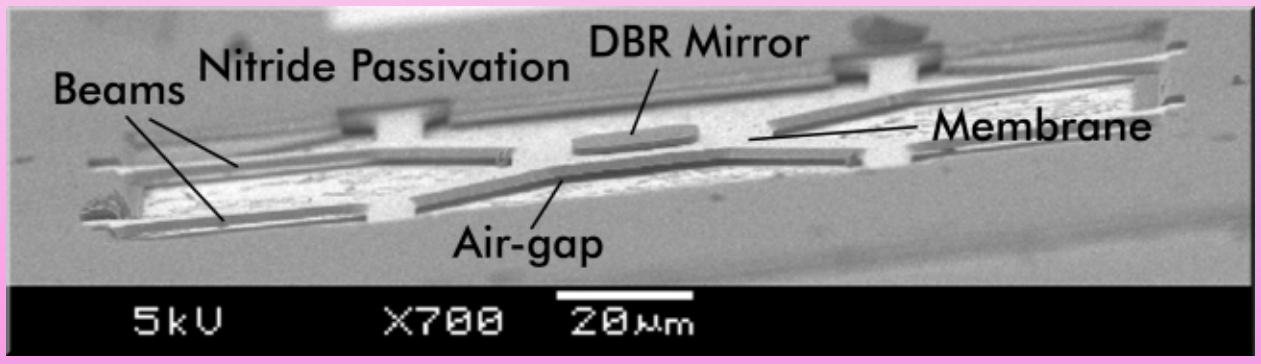


Figure 1-1. A freestanding branched beam type microstructure with a DBR Mirror on top of membrane.

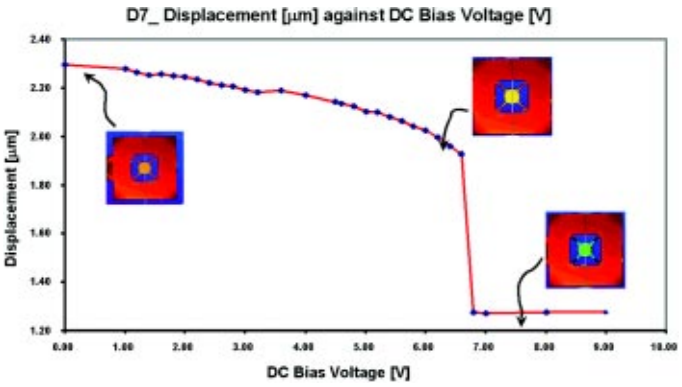


Figure 1-2. Dynamic measurements on InP based ES actuator. The total displacement is > 300 nm on the InP membrane. The change in colour of the membrane indicates the relative movement from the idle state.

The third area is towards achieving a reconfigurable Optical Add-Drop multiplexer (OADM) device. Coupling of optical field with wave-guides and optical devices is a challenging issue and the physical separation is a key parameter for optimising the evanescent fields. Two new architectures have been proposed to realise the function. In one, the concept of Add/Drop is introduced by combining vertical and Y-branch coupling of optical signals and is realised by wafer bonding. In another approach, the vertical coupling is limited to a small section of the epilayer stack and the waveguide ports are, separated by a simple sacrificial layer etching technique. In addition, the group has acquired expertise in simulation techniques such as coupled-field electromechanical simulation of MEMS using ANSYS, simulation of wave propagation in waveguides using Opti-BPM and simulations using MATLAB for cavity-confined micro-optics.

Applications for this research include fibre optic communications employing Wavelength Division Multiplexing (WDM) for wavelengths around 1.55 μm, NIR spectroscopy of gases for detection and blood glucose monitoring.

Dr Akkipeddi Ramam *has been in the field of semiconductors for the last 20 years. He started his career with the Defence R & D labs in India working on GaAs based millimeter wave (mmW) devices and Monolithic Microwave Integrated Circuits (MMICs). He is currently a Deputy Cluster Manager (Research) for the Opto and Electronics cluster in IMRE and has been involved in the fabrication of GaN-based blue LEDs/Lasers for the past 5 years. His interests are mainly in the fabrication techniques of III-V based opto-electronic devices. Presently, he is looking into new approaches for combining InP-based photonic devices with micromachining concepts.*

IMRE has developed the capability to fabricate InAs Quantum Dots on GaAs substrates emitting at the 1.3μm telecommunication window using a molecular-beam epitaxy (MBE) technique.

InAs Self-assembled Quantum Dots for Photonic Devices

By Dr Chia Ching Kean

Team members: CK Chia, SJ Chua, JR Dong, ZL Miao, JH Teng, S Tripathy, BC Foo and SL Teo

Semiconductor quantum dots (QDs) are zero-dimension nanostructures behaving rather similar to atoms with discrete electronic energy and density of states. These are superior structures from which laser diodes are fabricated because of their unique properties such as 3-dimensional carrier confinement and discrete energy states. Potential improvements in laser properties using QDs as recombination media include low wavelength chirping effect and low threshold current density. Our research team has developed the capability to fabricate InAs QDs on GaAs substrates emitting at the 1.3μm telecommunication window using a molecular-beam epitaxy (MBE) technique.

A typical atomic force microscopy (AFM) image of an InAs QDs uncapped layer grown by MBE is shown in Figure 2-1(a). High dot density of up to $2x10^{11}$ cm^{-2} can be obtained. We have successfully fabricated four types of InAs self-assembled QD structure emitting at the 1.3 μm telecommunication window on (100) GaAs substrates using MBE, i.e., dot-in-a-square well, dot-in-a-triangular well, dot-in-a-parabolic well and dot-in-a-GaAs matrix structures. The photoluminescence (PL) spectra measured from these structures were depicted in Figure 2-1(b). All these QD structures are expected to give different unique properties when fabricated into laser diodes. The dot-in-a-square well configuration ensures ground state lasing at 1.3 μm from the QDs. The triangular or parabolic well can potentially ease the quantum-confined Stark effect when under bias as in the case of a square well. Structures with InAs QDs embedded directly in a GaAs matrix can suppress well-like behaviour and is expected to give better temperature insensitivity threshold current density.

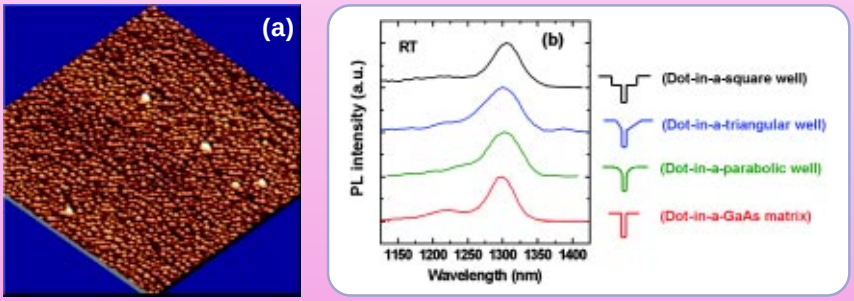


Figure 2-1. (a) 1 μm x 1 μm AFM image of a typical InAs QD structure grown on GaAs by MBE. The sample was grown at 520°C and has a high dot density of $2x10^{11}$ cm^{-2}. (b) Room temperature PL spectra of the as-grown InAs QDs embedded in a $In_{0.12}Ga_{0.88}As$ square well, a $In_xGa_{1-x}As$ (x = 0 to 0.4) triangular well, a $In_xGa_{1-x}As$ (x = 0 to 0.4) parabolic well, and a GaAs matrix. All structures are emitting at the 1.3μm telecom window at room temperature.

We have demonstrated the tuning of the QD bandgap energy due to group-V elements exchange in 1.55 μm InAs/InP QDs grown by metal-organic chemical vapour deposition (MOCVD), by rapid thermal annealing (RTA) and laser annealing techniques.

Quantum Dot Intermixing for Monolithic Photonic Integration

By Dr Chia Ching Kean
Team members: CK Chia, SJ Chua, JH Teng, JR Dong, S Tripathy, BZ Wang, BC Foo and SL Teo

In recent years, much research interest in quantum dot (QD) nanostructures have been generated by the prospect of achieving monolithic integration of photonic devices based on QDs. Post-growth intermixing is one of the effective ways to engineer the bandgaps of the semiconductor quantum well (QW) and QD structures, allowing active-passive components to be monolithically integrated. Various intermixing techniques such as impurity free vacancy disordering, impurity-induced disordering, plasma-assisted induced disordering and laser-induced intermixing have been widely utilised for QW and QD intermixing.

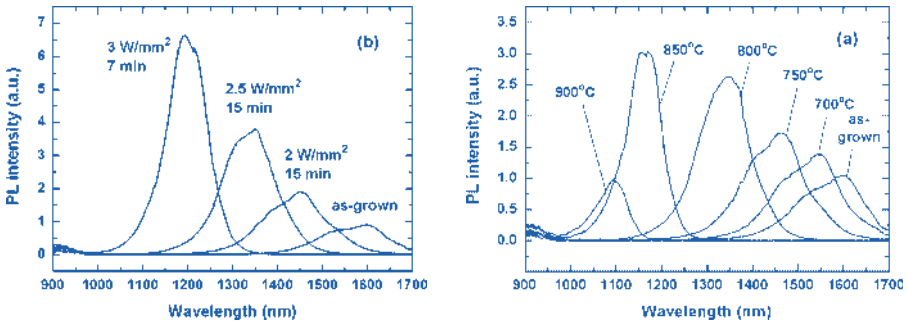


Figure 3-1. (a) Room temperature PL spectra for InAs/InP QD samples capped with 500nm SiO_2 before and after annealing. The annealing duration for each temperature was 30s. (b) Room temperature PL intensity as a function of wavelength InAs/InP QD samples under different laser annealing conditions.

We have demonstrated the tuning of the QD bandgap energy due to group-V elements exchange in 1.55 μm InAs/InP QDs grown by metal-organic chemical vapour deposition (MOCVD), by rapid thermal annealing (RTA) and laser annealing techniques. In all cases, substantial energy shift was observed as shown in Figure 3-1(a) for RTA, and in Figure 3-1(b) for laser-induced intermixing. Typically, a maximum blueshift of about 200 nm can be obtained in QW structures after intermixing. However, our team has demonstrated that a blueshift of more than 500 nm can be obtained in the QD structures.

A large blueshift is preferred in the passive region (for example in passive waveguides) for monolithic integration of photonic devices so that light emission from the active devices such as lasers will not be absorbed in the waveguide region. A waveguide in photonic circuits is analogous to a wire in electronic circuits. One of the distinguishable differences between the intermixed QW and QD structures is that the PL intensity increased for intermixed QD structures, whereas for QW structures the PL intensity tends to reduce after intermixing, implying a degradation of the QW material quality after intermixing.

Our investigation suggests that intermixing is more pronounced in QDs as compared to QWs. Application of monolithic photonic integrated QD-based photonic devices in the next generation high speed optical communication network is feasible through post-growth intermixing such as impurity free vacancy disordering and laser annealing techniques.

Dr Chia Ching Kean *received his PhD from the University of Sheffield, UK. He is currently a Research Scientist in IMRE and an Adjunct Assistant Prof with the National University of Singapore. His research interests include low dimensional photonic devices and monolithic photonic integration.*

Upcoming Seminars / Workshops / Symposia

Date	Event	Location	Remarks
28 Feb - 2 Mar 05	University of New South Wales - Singapore Research Workshop	IMRE Seminar Room 1	By Invitation
17 Mar 05	ON-Singapore Reception	IMRE Seminar Room 1	By Registration
26 Apr 05	MSC Chemical Analysis Workshop	IMRE Seminar Room 1	By Registration

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

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