Institute of Materials Research and Engineering
A*STAR

PERSPECTIVES

Research, Development and Commercialisation

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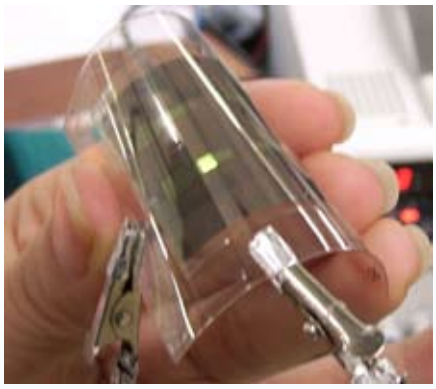
Materials - Technology for Tomorrow
IMRE Celebrates!
1997 - 2007

Plastic Electronics
- Easier, Cheaper, Flexible

Making electronic components out of easily processable polymers is proving revolutionary to an industry dependent on traditional silicon components.



Plastic electronics are cheaper to process.

Silicon Valley – named after the large number of silicon chip innovators and manufacturers and synonymous with the high-tech computer industry – underscores the importance of silicon as a material in all things electronic. The computer chips, transistor arrays and integrated circuits that power electronics are currently made from silicon.

However, for many applications which do not require high switching speeds, certain polymers or plastics may prove to be easier to process and cheaper alternative materials. From Tupperware to high-strength composite aeroplane fuselage parts, polymers have now found a purpose as electronically active materials in an emerging electronics technology called plastic electronics.

Polymers are by nature simpler and easier to process compared to the harder, more rigid silicon. Polymers generally do not conduct electricity but they can be made semiconducting or even conductive so that they can be used to create active components for use in electronics. Polymers can be dissolved in solvents to form inks, enabling processing via common printing techniques such as offset, gravure, and inkjet printing, to name a few. Thus, in theory, with appositely designed polymers and other soluble materials, special inks with specific electrical properties can be formulated to permit the printing of electronic components. This would dramatically lower the costs of electronics if high throughput roll-to-roll manufacturing processes much like those employed in printing newsprints can be adopted. The advantages are clear – cheaper transistors and components and subsequently, electronic devices because of much lower capital investments in manufacturing facilities and production processes.

> "The advantages are clear – cheaper transistors and components and subsequently, electronic devices because of much lower capital investments in manufacturing facilities and production processes."

Polymer electronics have a number of high-value potential applications, which are currently being researched in IMRE. These include organic solar cells, sensors, display backplane, organic light emitting diodes, smart labels, etc.

"Organic, polymer, plastic and printed electronics have been loosely used interchangeably to refer to an emerging electronic technology in which the electronically active components are fabricated from organic or polymer materials, preferably by low-cost printing processes," says Prof Beng Ong, the programme director for A*STAR SERC's polymer and molecular electronics devices research.

"The active materials (i.e., semiconductors or conductors) in the devices are tailor-designed organic or polymer materials with desirable electrical properties that enable new-generation electronics."

The market for organic/polymer and printed electronics is expected to exceed $300 billion in the next 20 years from the current $1.18 billion.

Interview with Prof Beng Ong

What is the objective of the polymer and molecular electronics devices (PMED) programme?

This is a thematic strategic initiative of SERC and is aimed at (i) building competencies in plastic electronics and advance science & technology knowledge in this field; (ii) developing critical component technologies for PMED to enable design of low-cost, high-value electronic devices; and (iii) eventually building a plastic or printed electronics industry that will contribute to the creation of a knowledge-based economy in Singapore.

What is the potential for plastic electronics in Singapore?

Singapore has a great pool of scientific talents (chemists and chemical engineers, materials scientists, physicists, and electrical engineers) who have the necessary expertise and experience to tackle and circumvent the challenges of developing this emerging technology and bringing it to successful fruition. IMRE is an example of this, with excellent materials R&D talents and well-rounded materials research programmes covering all facets of materials/process science and technology ranging from organic, inorganic, composite, hybrid materials, and nanotechnology. The R&D infrastructure in Singapore is top-notch, and the strong financial and moral supports from the Government should help inject enthusiasm into and provide strong impetus to the plastic electronics research. I hope that through our strong concerted effort, in strategic alliances with foreign MNCs and research organisations, we would be able to transform this technology concept from laboratory into commercial reality in a fast-paced time-to-market manner, thus creating an industry of its kind and high-value jobs in Singapore.

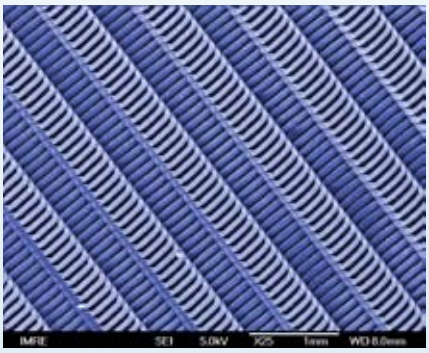
What are some of the challenges for the PMED programme?

Foremost is the challenge of coordinating a large team of researchers in various different disciplines to cut down on redundancy and focus on building critical competencies and developing vital technologies towards achieving programme objectives. Second are the technical challenges of developing the following: (i) materials and process innovations that enable printed, functionally capable electronic components; (ii) high throughput printing processes for fabricating these components; and (iii) matured and hardened materials and process technologies to prepare for downstream product development and manufacturing implementation with strategic partners like EDB, SPRING, SMEs,MNCs, etc.

Professor Beng Ong is a very accomplished researcher in materials science and polymer electronics and has been recognised many times over for his achievements in these fields. He was a Senior Fellow and Corporate materials strategist of Xerox Corporation and Manager of its advanced materials and organic electronics division where he led a research team in developing high-performance, nanostructured materials that enable printing flexible transistor circuits at low temperatures and in open air. He is among Xerox's most prolific researchers, with over 140 U.S. patents and numerous foreign equivalent patents to his credit. In 2004, he was named by Scientific American magazine to its prestigious annual list that recognises outstanding acts of leadership in science and technology from the past year – the 2004 Scientific American Top-50. He was named "Business Leader" in chemicals and materials for his work in advancing printed electronics. Most recently, two of the projects that he had managed previously at Xerox, namely Printed Electronics Technology and EA Toners, had won the coveted Nanotech Nano-50 Awards for technology breakthrough and successful nanotechnology product commercialization respectively.

Nanoimprint Lithography (NIL) for Mainstream Industry

IMRE and ETPL lead efforts to explore partnerships with industrial partners and promote industrial use of this versatile and cost-effective technique for building nanostructures.



Tiny patterns produced using nanoimprint lithography.

Nanoimprint lithography (NIL) is a simple, low cost, high throughput and high resolution technique used in making nanometer scale patterns, which form the basis of electronic circuitry, advanced photonics, LEDs and fluidic devices. Primarily used in research work, NIL technology today is extending beyond the laboratory bench to become a manufacturing floor technology. Some optical components and electronic products are being mass-produced using factory-scale nanoimprinters. Globally, several multi-million dollar initiatives have already been launched to imprint wafer-level, 35 nm features for semiconductor devices using NIL technology.

To promote the technology, IMRE and Exploit Technologies (ETPL), A*STAR's commercialisation arm, organised a symposium on 30 March 2007. Representatives from NIL-related industries converged to share recent advancements made in key NIL technology areas such as imprinting tools, mould fabrication, new resist chemistries and production processes. A number of companies representing the entire value chain of NIL technology including Obducat, Advanced Technology Corporation, Molecular Imprints, MicroChem, EV Group and Kyodo International Inc, presented their latest developments at the symposium.

"The key advantage of NIL lies in its potential as a less expensive fabrication tool for nanostructure patterning compared to current optical techniques," explains Dr Low Hong Yee, the research scientist who oversees the nanoimprint programme in IMRE. Current nanofabrication techniques such as e-beam writing and deep-UV lithography are very slow and expensive processes.

"A standard nanoimprint lithography process involves stamping a polymer film or polymer precursor at an applied pressure, elevated temperature and or UV exposure using a hard mould, thereby copying the surface pattern of the hard mould onto the polymer film," adds Dr Low.

"It's like making waffles using a waffle iron!"

The NIL technology at IMRE focuses on developing NIL process for the fabrication of truly 3-dimensional (3-D) structures. Unique imprinting techniques such as reversal

imprinting, combinatorial-mould imprinting and sequential imprinting at below the glass transition temperature of polymers allows one to fabricate complex 3-D structures with less processing steps compared to conventional photolithography techniques.

For more information on nanoimprint lithography, please visit http://www.imre.a-star.edu.sg/nanoimprinting or write to nanoimprint@imre.a-star.edu.sg

Why nanoimprint lithography?

- Simpler processes and steps
- Less expensive
- Capable of building complex 3-D structures easily
- High degree of resolution-fine feature can be achieved very accurately

A*STAR Grand Challenge Winners from IMRE

*IMRE scientists were among those who won prizes for A*STAR's Grand Challenge, a competition open to all A*STAR scientists to stimulate and encourage novel research ideas and projects.*

Dr Alan Sellinger (left) with his award.

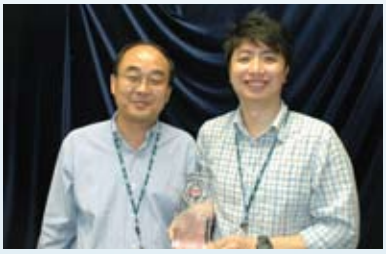
Dr Alan Sellinger won for his proposed research topic on "Cost Effective Harnessing of CO_2 as an Approach to Slow Down the Green House Effect". Dr William Birch and Ms Tjong Vinalia won for their joint proposal with scientists from the Institute of Molecular and Cell Biology (IMCB) on "Re-Generation of Tissues from Adult Stem Cells". The aim of the Grand Challenge is to stimulate creativity and innovation in A*STAR scientists, for example, by looking at how the research done here can be used to address significant problems faced by the world.

*Ms Tjong Vinalia(left) and Dr William Birch (2nd from left) posing for a group photograph with A*STAR Chairman, Mr Lim Chuan Poh (centre) and the team from IMCB.*

TSMC Prizes -

2 out of 3 top prizes by IMRE students

The students came out tops against some 100 counterparts from 5 other countries.



Mr Rinus Lee (right) with his IMRE co-supervisor, Dr Chi Dongzhi (left).

Two students attached to IMRE for their postgraduate studies were winners at the 2nd Taiwan Semiconductor Manufacturing Company (TSMC) Outstanding Student Research Awards. In a prize ceremony on 29 June 07, NUS postgraduate students, Mr Rinus Lee Tek Po and Mr Zheng Yi who are attached to IMRE, were among 24 winners to receive awards for their outstanding research performance in the area of semiconductor and/or related research work.

Mr Lee and Mr Zheng are both being co-supervised by IMRE scientists, Dr Chi Dongzhi and Prof N. Chandrasekhar, respectively. Mr Lee won 1st prize with Mr Zheng took 2nd prize in the "Physics, Chemistry of Material for Nano-Scale Devices" category.

Mr Lee's project relates to the development of novel silicide materials with specifically engineered properties for nano-CMOS technologies. These new materials are integrated into state-of-the-art multiple-gate field effect transistors (MuGFETs) with minimal dimensions - as small as 25 nm - to elucidate the relation between material properties and device performance in the nanometer regime.

Mr Zheng is working on BEEM studies of HfO_2, which is being touted as the next generation dielectric for the semiconductor industry. It is expected to replace silicon oxide in the 45 nm technology that is currently undergoing trials. His work involves determination of important physical parameters such as band offsets of HfO_2 with metal gates, effective mass of carriers, and stressing studies on HfO_2 to understand its electrical breakdown behaviour, which are important in device modelling studies.

A total of 101 research papers were submitted by students from Taiwan, China, Singapore, India and Japan, with 25 of these papers coming from outside Taiwan. The purpose of the TSMC Outstanding Student Research Award is to recognise exceptional semiconductor related research carried out by graduate students. TSMC is the world's largest dedicated independent semiconductor foundry.

A*STAR Thematic Strategic Research Programme (TSRP)

Mr Rinus Lee's work is related to Dr Chi Dongzhi's (IMRE) project for developing new silicide/germanide materials and processes for future nanoscale MOSFET devices. The project is part of the A*STAR "Nanomanufacturing: Nanoelectronics – The Next Wave" Thematic Strategic Research Programme (TSRP), one of many TSRP projects that aim to develop enabling capabilities in specific focus areas that has strategic impact on Singapore's technological development. Mr Lee's work – co-supervised by NUS and IMRE - is the key link between Dr Chi's project and that of NUS' Asst Prof. Yeo Yee Chia's TSRP project on "Nanoscale Transistors with Enhanced Performance for CMOS Manufacturing".

To find out more about A*STAR's TSRPs, please visit: http://www.a-star.edu.sg/astar/sciengr/action/sciengr_funding_strategic_research.do

Singapore Science and Engineering Fair 2007 Prizes for Junior College Students Attached to IMRE

IMRE JC student attachments demonstrate their mettle by garnering a number of awards at the national level science competition.

IMRE researchers and some of the SSEF 2007 winners.

The hard work and long hours in the laboratory paid off for several junior college teams who were attached to IMRE for research projects when they were awarded prizes at SSEF 2007. This is the seventh year for the SSEF which serves as a platform for future scientists to showcase their research projects, some done under the guidance of A*STAR's research institutes. The SSEF is affiliated to the annual INTEL International Science and Engineering Fair (ISEF) and winners of SSEF will be invited to represent Singapore to participate in ISEF. The winning IMRE-mentored teams include:

Lin Ern Sheong, Stella Rizalina Sasha (NJC)
Gold
Effects of Tensile Stress on the Formation and Growth of Nickel Monosilicide (NiSi) Using Thin Film on Si (001)
Supervisor: Dr Dennis Tan

Ritwik Grover (NJC)
Silver
Probing Residual Stress in GaN And Zno Free-standing Micro-Structures Using Raman Spectroscopy
Supervisor: Dr S Tripathy

Yoon Ji Wei, Karen Chin Lee Yong, Tan Xing Yu (NJC)
Silver
Preparation and Characterisation of Rare-earth Modified Multiferroic BiFeO3 Ceramics
Supervisor: Dr Santiranjan Shannigrahi

Ong Zhong Liang (NJC)
Silver
Secondary Ion Mass Spectrometry of Adsorbed Molecular Layers
Supervisor: Dr Nikolai Yakovlev

Ho Zi Wei, Kng Junlong Clemence (NJC)
Bronze
Magneto-optical Study of Thin Cobalt Films
Supervisor: Dr Nikolai Yakovlev

Teo Jia Hui (VJC)
Bronze
Deformation of Ionomeric Polymer Metal Composites (IPMC) Due to Ion Migration
Supervisor: Dr Julian Chia

Soh Shean Han, Wang Xiuyi (HCI)
Bronze
Exploring PLGA Polymer Beads Encapsulating Quantum Dots and Drug Camptothecin
Supervisor: Dr Han Mingyong / Dr Khin Yin Win

Han Dong (NJC)
Merit
Study of Passivation Layer on High Electron Mobility Ge Substrate for the Nanoelectronic Devices
Supervisor: Dr Wang Shijie

IMRE Staff Clinch Inaugural STAR Employee Awards

*The awards were created to recognise outstanding A*STAR employees who have contributed to the development and advancement of the A*STAR family.*

Mrs Evelyn Lau (left) receiving her award from former A*STAR Chairman, Mr Philip Yeoh (right).

IMRE's Mrs Evelyn Lau, Director for Corporate Services and Mr Chong Fook Weng, Senior Information Technology Manager were honoured for their hard work and dedication when they received A*STAR's inaugural STAR Employee Awards. Mrs Evelyn Lau heads the Corporate Services departments of IHPC and IMRE, and has made other significant contributions such as organising the Scientific Staff Development Award Ceremony. Mr Chong Fook Weng received the STAR Innovation (Team) Award on behalf of the SERC IT Shared Services team which he leads. This award is to recognise staff achievements in promoting innovation and continuous improvements. The shared services team comprises members from across SERC's research institutes.

*Mr Chong (seated, third from right) with the SERC IT Shared Services team comprising IT staff from SERC's many research institutes. The shared services team will be managing the IT resources for A*STAR's SERC when SERC moves into its new home at Fusionopolis next year.*

To find out more about Fusionopolis, please visit http://www.a-star.edu.sg/astar/fusionopolis/index.do

Visits and Events

Introduction to Scanning Probe Microscopy
11 April 2007

IMRE's Dr Wulf Hofbauer gave a talk on "The World of Scanning Probe Microscopy" to 250 students from Anderson Junior College where he introduced the unique microscopy technique.

Dr Wulf Hofbauer introducing scanning probe microscopy to Anderson JC students.

Students trying out science experiments using household materials after the Meet-the-Scientist talk.

Meet-The-Scientist Session
20 April 2007

"Fun with Household Materials" was presented by Dr Davy Cheong and Dr Wang Wei to students and the public at the Science Centre. The researchers introduced materials science and experiments to demonstrate the materials research concept, using common household items.

Scanning Probe Microscopy Symposium (SPM) 2007
23 May 2007

IMRE organised a symposium for the local SPM community to present and share recent scientific advances in instrumentation development and applications of various SPM techniques.

Participants at the IMRE's SPM Symposium.

Anglican High School Student Attachment
29-30 May 2007

Anglican High School students attending a laboratory tour as part of their attachment.

A two-day attachment programme was organised for 16 students from Anglican High School as part of IMRE's outreach efforts to introduce students to research and give an insight into research work.

Delegates from Nano Biz Meet 2007
26 June 2007

Fifteen keynote speakers and delegates from the Nano Biz Meet 2007 toured IMRE's characterisation and R&D facilities. Nano Biz is a 2-day event focusing on the development and commercialisation of nanotechnology.

Optoelectronics Student Exchange Workshop
27 June 2007

IMRE organised the workshop together with the National University of Singapore and National Taiwan University to encourage more academic interaction and technological collaboration through presentations on one another's respective work in optoelectronics.

Visitors from NUS and National Taiwan University being briefed about IMRE's facilities.

Visit by Physics Nobel Laureate
4 July 2007

Nobel Laureate Claude Cohen-Tannoudji being briefed on IMRE's research.

1997 Physics Nobel Laureate Claude Cohen-Tannoudji visited IMRE and was briefed on IMRE's work in nanotechnology and characterisation. He was in Singapore attending the International Conference on Materials for Advanced Technologies 2007.

Patents

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

Patents Filed

Particles Having Oligomeric Ionomer, Proton-exchange Composite Having Such Particles, and Methods of Forming

The invention relates to the design of novel ionmer-grafted silica nanoparticles which are incorporated into a sulfonated perfluoro-polymer (SPFP) membrane matrix of a proton exchange membrane (PEM). These nanoparticles can enhance the proton-conductivity at high temperatures and give rise to superior electrochemical performances over the native SPFP PEM in the single fuel cell driven by hydrogen and methanol, respectively.

Inventors: Hong Liang, Liu Zhaolin, Zhang Xinghui, Guo Bing

Hydrophobic Quantum Dots-loaded Polymeric Particles as Bioimaging Tags and Target Carriers for Diagnostics, Delivery, and Controlled Release

The invention relates to the development of water soluble and stable QD incorporated in amphiphilic polymeric nanoparticles which project their potential use as imaging as well as drug delivery vectors.

Inventors: Han Ming Yong, Khin Yin Win, Ng Lai Ying, Ye Enyi

Enhancing Visual Contrast of Light-emitting Displays and a Method of Fabricating the Same

The invention relates to the achievement of high contrast in OLED/PLED displays by fabricating an OLED using optical destructive transparent conductive oxide (TCO) anode with a desired gradient of refractive index on a transparent substrate possessing a surface reflection suppressing feature.

Inventors: Zhu Fu Rong, Tan Li Wei, Liew Pooi Kwan, Ong Kian Soo

Debonding of Semiconductor Layers Through the Effects of Field Directed Electrochemical Reactions

The invention explores a way to control the debonding of GaN-based epitaxial structures from the sapphire substrate. Debonding allows an epilayer to be structurally decoupled from the substrate, but otherwise still adhere together to facilitate handling and further processing.

Inventors: Ng Tuoh Bin, Chua Soo Jin

Ultraviolet (UV) Detectors

The invention relates to the development of UV detectors using a photovoltaic ferroelectric thin film as the sensing element. The invention could be potentially applied as a low cost UV detector for personal health care, either as a separate device or integrated with personal digital assistants, for e.g. mobile phones, watches or integrated with other personal wears.

Inventors: Yao Kui, Gan Bee Keen

Pattern Size Reduction in Nanoimprint Lithography

The invention relates to a method of fabricating nanometer size surface pattern through the use of micrometer size surface relief patterned mold using Nanoimprint Lithography. The invention can be applied to integrated circuit (IC), MEMS/NEMS, optical components and LEDs.

Inventors: Low Hong Yee, Karen Chong

Patent Granted

Method and Solution for Forming Anatase Titanium Dioxide, and Titanium Dioxide Particles, Colloidal Dispersion and Film

The invention relates to a simple and efficient method for the preparation of the transparent anatase TiO2 thin film. The method consists of a unique approach of the growth of nanocrystalline TiO2 in colloidal dispersion state and the formation of TiO2 photocatalytic thin film without calcinations to boost catalytic activity.

Inventors: Hong Liang, Liu Zhao Lin, Jiang Hui Xin, Guo Bing

RESEARCH

Wider Emission Band for Better Broadband Light Sources

IMRE has demonstrated an ultrawide band quantum dot light emitting device after broadening its emission bandwidth by using a post-fabrication laser annealing technique.

WHO

Dr Chia Ching Kean and Dr Dong Jianrong

*To view their profiles, please visit
http://www.imre.a-star.edu.sg/rnd/Researchers.asp

WHAT

"Ultrawide band quantum dot light emitting device by postfabrication laser annealing"

WHERE

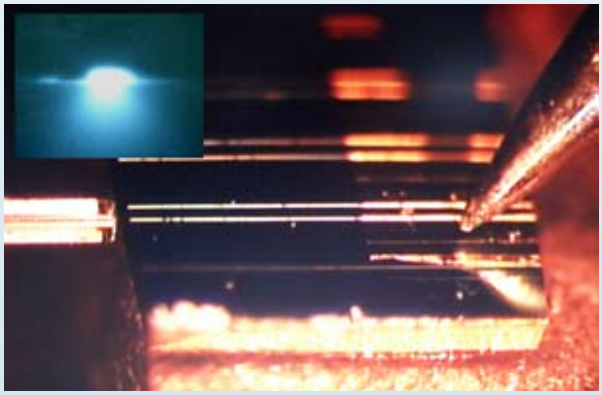
Published in February 2007 in the Applied Physics Letters Volume 90, 061101 (2007).

WHY

The paper describes an ultrawide band quantum dot (QD) light emitting device (LED) with a bandwidth of 360nm covering 1284–1644nm spectral range that was demonstrated using a postfabrication laser-irradiation technique. The integrated light output of the QD LED was increased by four times after laser annealing. This was because of the improved homogeneity of the QDs and enhanced lateral electrical and optical confinements at the active region after laser-induced intermixing.

OPPORTUNITIES

A broad emission band is desirable for light emitting devices (LEDs) used in bio-imaging such as in optical coherence tomography system because it can produce higher resolution images. The broadband light source is also useful for application in fibre-to-the-home system where it allows a wider selection of operating wavelengths.



A device under test with an electrical probe on the right and an optical fiber aligned in front of the ridge on the left. Inset shows the typical emission from the device captured by an IR camera.

Organic Blue Light Emitter for Organic Light Emitting Diodes (OLEDs)

IMRE plans to scale up the production of organic blue light emitters for use in OLEDs. Using fluorescent oligomeric materials, the OLED devices are potentially longer-lasting, more efficient and lower in cost to produce.

WHO

Dr Chen Zhikuan

*To view his profile, please visit
http://www.imre.a-star.edu.sg/rnd/Researchers.asp

WHAT

"Blue light emitting materials"

WHERE

IMRE Organic Blue Emitter of OLED factsheet

WHY

IMRE has developed fluorescent deep blue light emitting oligomeric materials with device efficiency of 8% and are materials with definite molecular weight. These materials combine the merits of solution processability of light emitting polymers and the high purity of small molecules, to offer higher efficiency, lifetime, and lower cost for OLED devices.

OPPORTUNITIES

IMRE's blue emitting materials are solution-processable, and are well suited for low temperature processes such as spin-coating and inkjet printing. This allows OLED displays to be fabricated on both rigid as well as flexible substrates. Besides application in full colour displays, the blue emitters could also be used for high efficiency and low power consumption lighting application. The current device efficiency is only from singlet excitons. When blended with a phosphorescent light emitting material with a suitable energy level, it is possible to obtain light emission from all the singlet and triplet excitons of the blue emitters. This may increase the fluorescent efficiency by as much as 4 times. IMRE is currently scaling up the production of the organic blue emitters and are seeking collaborative opportunities and partnerships.

For more information on business opportunities and technical details, please contact Mr Colin Leong (colin-leong@imre.a-star.edu.sg) or Dr Chen Zhikuan (zk-chen@imre.a-star.edu.sg), respectively.

Real Time Observation of Bamboo-like Carbon Nanotubes

The growth dynamics of bamboo-like multiwalled carbon nanotubes (BCNTs) via catalytic decomposition of C2H2 on Ni catalyst was probe in real time using an in situ ultra-high vacuum transmission electron microscope.

WHO

in-situ UHVTEM (MERLION) team led by Dr Foo Yong Lim

*To view his profile, please visit
http://www.imre.a-star.edu.sg/rnd/Researchers.asp

WHAT

"Dynamical Observation of Bamboo-like Carbon Nanotube Growth"

WHERE

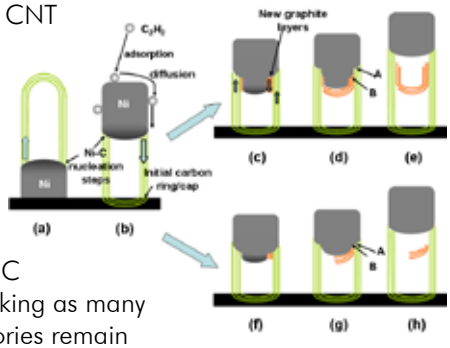
Published in Nano Letters

WHY

The key motivation of in-situ UHVTEM studies is to unravel reaction mechanisms and pathways in nanostructure growth. This will allow scientists and engineers to implement growth techniques/conditions to selectively control the growth of 'designer' nanostructures for nanotechnological applications. This is a departure from the usual black-box engineering approach in embracing nanotechnology.

OPPORTUNITIES

The extraordinary thermal, electronic, magnetic, and mechanical properties of carbon nanotubes (CNTs) make them important materials for applications such as nanoelectronic devices, hydrogen storage devices, biological probes, atomic probes, optical switches, and fuel cells. Despite substantial strides made in the development of new CNT based devices and prototypes for nanotechnological applications, a complete understanding of the growth mechanism of these C nanostructures is lacking as many of the proposed theories remain to be verified. Among the common methods used for fabrication of CNTs, chemical vapour deposition (CVD) of CNTs is the process of choice for industrial adoption due to its scalability and low cost. Often, CVD growth using the same experimental growth conditions yields different morphologies or types of tubes, making complete and detailed understanding of the reactions difficult. This is further exacerbated by the ambient pressure or low vacuum growth conditions that convolute data with contaminants, thus making the growth process more complex to comprehend. For C-based nanostructures, understanding growth pathways is the basis for large-scale industrial production of high-quality CNTs with controlled helicity, length, and diameters for technological applications. IMRE has designed in-situ experiments to replicate/mimic the real CVD environment; without the contamination effect by operating in a system with ultrahigh vacuum (UHV) based pressure to probe the BCNT growth.



Snippets

ART & D - INFOCUS MAGAZINE FEATURE

Scientific images from IMRE made up an article in the March 2007 issue of infocus Magazine, formerly known as the proceedings of the Royal Microscopical Society (RMS).

IMRE-SALUX MOU ON EL DISPLAYS

IMRE and Salux signed an agreement in May 2007 to jointly develop electroluminescent (EL) displays. IMRE will use its flexible substrate and encapsulation technique know-how, gained from its extensive research in Organic Light Emitting Diodes (OLEDs), to develop the EL displays.

Diary of Upcoming Events @ IMRE

IMRE SEMINAR SERIES

Watch out for IMRE's regular fortnightly research seminars!

IMRE Seminar Room 1
2007 Schedule: 12 Dec, 26 Dec

To find out more about IMRE's events, please visit **www.imre.a-star.edu.sg/events**.

Alternative you can write in to us at
events@imre.a-star.edu.sg
(Quote "Ref:NEWS" in your email)

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