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National Nanotechnology Center (NANOTEC, Thailand)

Vietnamese Academy of Science and Technology (VAST, Vietnam)

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## ***Greetings from ANF Secretariat, Singapore***

July 2015

Dear ANF members,

Greetings! We are pleased to offer you another issue of ANF Annual Report 2015 edited based on the 3 ANF newsletters published between Oct. 2014-Jul. 2015. It covers our usual topics including Research Breakthroughs, Commercialization, Education/Research Programs, and Partnerships/Collaborations. We see consistently strong support from Taiwan and Thailand providing us with very interesting information to share, moderate support from Indonesia, Iran, Malaysia, and New Zealand. We are aware that there have been active happenings in the rest of the member countries, but we are yet to gain support to help us fill in the content in our newsletter.

We would like to seek your suggestions on how to improve ANF network members' nanotechnology information dissemination. We need to grow our national, regional and global reach. We hope each member organization could contribute to this growth. ANF provides a unique platform for collaborations in various activities in the field of nanotechnology as well as marketing. We hope all of us could take advantage of this platform and benefit from it.

Look forward to productive discussions with you during the ANF summit 2015 in Singapore!



Lerwen LIU

Founding Secretary of Asia Nano Forum on Behalf of the Secretariat Office in Singapore

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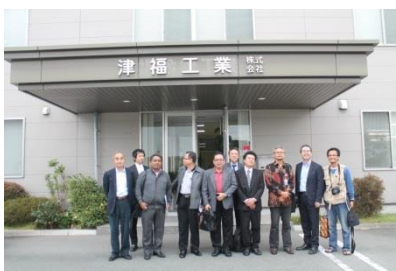
## NEWS

### ✧ Partnerships/Collaborations

#### Indonesia (Source: MNI)

- ◆ *Nano Center Indonesia – PT PERINUS (Indonesia Fisheries Corporation) Program for Adapting Nanobubble Technology*

Indonesia as the largest archipelago in the world has sea area of about 5.8 million km<sup>2</sup> that contains great potential of fisheries and marine resources that have to be used as the foundation of economic



development. In contrary, more than 20 million tons spoiled fishes dumped to the sea each year during shipping to nearest port from fishing spot. By conventional preservation, fish could be preserved only up to 2 days.

In order to prolong fish shelf life time during shipping, nanobubble technology becomes a new preservation method. Nano Center Indonesia, Indonesia's leading research institution on nanotechnology, and PT Perikanan Nusantara (Perinus), a state-owned enterprise deals with fishery business, collaborate for adapting this technology. PT Perinus as the only one stated-owned fisheries enterprises concern about Indonesia fisheries and has goal to optimize Indonesia economic development based on fisheries product. Nano Center Indonesia has been trusted for facilitating this project.

This joint program initiated by visiting Nanox co. ltd., which is company that already successful to commercialize nanobubble technology, in Kitakyushu, Japan. Nanofresher, one of Nanox co. ltd. machine based on nanobubble technology, picked interest of Nano Center Indonesia and PT Perinus. By using nanofresher, water dissolved oxygen (DO) can be reduced to 0.7 mg/L by dissolving nitrogen. Because of low DO in water, fish can be preserved up to 8 days. This result can give enormous beneficial for economic development in Indonesia based on marine and fisheries.

By support from Nanox co. Ltd., Nano center Indonesia and PT Perinus brought home one nanobubble machine to be field tested in Indonesia. Recently, Nano Center Indonesia and PT Perinus team have been field testing Nanofresher as new preservation method in Bitung, Sulawesi Utara. For future project, Nano Center Indonesia and PT. Perinus will test this machine to help accelerate aquaculture in Indonesia based on nanobubble technology.

- ◆ *Nanobubble Technology Performance Test by Nano Center Indonesia and Perinus co. ltd. in Bitung*

After a visit to Nanox co. ltd. last year, a team made by Nano Center Indonesia and Perikanan Nusantara (Perinus) co. ltd., in research collaboration with Japan companies, conducted a nanobubble technology performance test, on its ability to preserve fishes and marine products. This test was done in Bitung, North Sulawesi. Bitung was chosen because of its marine products abundance. Some unique and famous marine products in



Bitung are skipjack fish and yellow fin tuna. Performance test on these fishes shows that by using nanobubble technology as preserving method, the freshness of fish can be maintained up to ten times longer than using conventional method.

Fish Freshness Testing

### Malaysia (Source: Nano Malaysia)

- ◆ *Joint development programme between NanoMalaysia and IBM*

August 2014 – As part of the joint development programme between NanoMalaysia Berhad and IBM, a third team of three researchers have been sent to IBM Almaden's research lab to conduct research on anti-microbial coating and drug delivery applications. The joint work on platform development and testing will be an iterative process, to identify the most viable materials candidate. These researchers will explore novel candidates to antimicrobial films, and gels, exploiting living polymerization, polymer modification chemistry, etc. The team will provide synthesis, characterization and early microbiology testing feedback to Malaysia regarding the novel candidates.

- ◆ *MoU was exchanged between NanoMalaysia and Steinbeis Malaysia Foundation*

August 2014 - A Memorandum of Understanding was exchanged between NanoMalaysia Berhad and Steinbeis Malaysia Foundation to form collaborative efforts to tap into Malaysia's nanotechnology research and development community to create, promote and commercialize nanotechnology invention and innovation that has patentable Intellectual Property (IP).

- ◆ *MOU was exchanged between NanoMalaysia and NanoCommerce Sdn. Bhd*

October 2014 – A Memorandum of Understanding was exchanged between NanoMalaysia Berhad and NanoCommerce Sdn. Bhd. to form a collaboration to venture into the production of synthetic nanosilica zeolites derived from rice husk ash. The exchange of the MoU was held during the 10th World Islamic Economic Forum (WIEF) in Dubai and was witnessed by the Right Honorable Prime Minister of Malaysia, Dato' Seri Najib Tun Razak.

- ◆ *MOU was exchanged between NanoMalaysia and SIRIM QAA International*

October 2014 - A Memorandum of Understanding was exchanged between NanoMalaysia Berhad and SIRIM QAS International to develop a programme with standard protocols to verify nanotechnology elements in processes and products. The exchange was witnessed by the Minister of Science, Technology and Innovation, Datuk Dr. Ewon Ebin, the Deputy Minister of Science, Technology and Innovation and the Secretary General of the Ministry of Science, Technology and Innovation. NanoMalaysia was represented by its CEO, Dr. Rezal Khairi Ahmad whereas Pn. Khalidah Mustafa, the Managing Director represented on behalf of SIRIM QAS International. The certification programme, known as NANOVerify programme and carries the NANOVerified brand of nanotechnology product claims will be jointly implemented and developed in Malaysia with the hope of being the answer to building consumers' confidence and for setting industrial standards for nanotechnology related products.

### Singapore (Source: IMRE)

- ◆ *Tradeshaw and visit to research institutes in Germany to exchange ideas*

Delegates from IMRE showcased our technologies at the IDTechEx tradeshow in Berlin, held in April 27-28. Over 2500 industry participants and 170 exhibitors from leading companies around the world were invited to present their technologies. The team from IMRE also visited and exchanged ideas on innovation with representatives from Institute for System Innovations (Fraunhofer ISI), research institutes for photonic systems (Fraunhofer HHI), startups (Heliatek) and MNCs (Excelitas and Re-hau) across Germany.

### Taiwan (Source: IANTP)

- ◆ *NPNT-UC Joint Workshop on Nanotechnology, Taiwan*

Professor Sir Mark Welland, the director of the Nanoscience Centre, University of Cambridge (UC) and the research team visited National Program on Nanotechnology (NPNT) and together held a join workshop in Taiwan this October. The joint workshop was held at the National Chiao-Tung University (NCTU) on 1st October. This workshop was to enhance the



closed relationship between NPNT and UC. The speakers from both sides have given speech in several topics related in nanoelectronics and nanobio, which also created a lively interaction with all the attendees.

### ◆ *Austrian-Taiwan Joint Workshop on Nanotechnology, Taiwan*

NPNT invited the Austrian professors and researchers with recommendation from Austrian Ministry for Transport, Innovation and Technology (bmvit) together have a joint workshop during the 2014 Taiwan Nano exhibition in Taipei. The workshop provided a discussion platform with the several topics, such as Polymeric Materials, Diamond-like Carbon and EDA in order to initiate possible further collaborations for both sides.



### ◆ *NPNT, Taiwan continue to join the M-ERA.NET Call 2014*

NPNT is one of the observers and the first partner from Asia for M-ERA.NET --- the European joint strategic program, which is developed by a network of national and regional funding organizations, systematically advised by external high-level experts selected from the European RTD community. Taiwan has join M-ERA.NET since Call 2012. The current result, M-ERA.NET Call 2013 selected 25 full proposals for funding, and Taiwan is participating in 2 of the projects, while Call 2014 is now in the pre-proposals checking stage.

### ◆ *Taiwan-Canada Collaboration in Nanotechnology*

Dr. Arthur Carty, the Executive Director of Waterloo Institute of Nanotechnology (WIN) and officers of Canadian Trade Office in Taipei visited Taiwan's Innovation and Application of Nanoscience Thematic Program (IANTP) this February. The bilateral meeting was held at Institute of Physics, Academia Sinica and aimed to enhance the close relationship. The collaboration between Taiwan and WIN began in 2010 Roundtable Meeting. There are currently four ongoing collaboration projects.

### ◆ *Taiwan-US Joint Program on Nanotechnology*

Taiwan's Ministry of Science and Technology (MOST) and US Air Force Office of Scientific Research / Asian Office of Aerospace Research and Development (AFOSR/AOARD) continue the Joint Program in basic research for Nanoscience and Nanotechnology under Taiwan's Innovation and Application of Nanoscience Thematic Program (IANTP). The first phase of Taiwan-US Joint Program initiated in 2011 in conjunction with Taiwan's National Nanoscience and Nanotechnology Program was very successful in furthering discoveries in nanoscience and nanotechnology and strengthening mutual collaborations.

### ◆ *Taiwan continues to join the M-ERA.NET Call 2015*

Taiwan is one of the observers and the first partner from Asia for [M-ERA.NET](#) --- the European joint strategic program, which is developed by a network of national and regional funding organizations, systematically advised by external high-level experts selected from the European RTD community. Taiwan has joined M-ERA.NET since Call 2012. There are currently 8 full proposals from Taiwan submitted for Call 2014 under review, while the Call 2015 opens on 3 February 2015.

## Thailand (Source: NANOTEC)

### ◆ *MOU Signing Ceremony between NANOTEC (Thailand) and H-GUARD (Korea)*

On November 26, 2014 NANOTEC (Thailand) and Bionano Health Guard Research Center (H-Guard) (Korea) has recently signed a collaborative research agreement on the topic of "Integrated dialogistic platform technology of tropical infectious disease" The Signing ceremony was signed between Dr. Sirirung Songsivilai, Director on behalf of NANOTEC and Professor Bong Hyun Chung, Director on behalf of H-Guard.



### ◆ *The 5th NANOTEC-NRI Nanomaterials Joint Research Meeting in Thailand*

NANOTEC and Nanosystem Research Institute (NRI) organized the 5<sup>th</sup> NANOTEC-NRI Nanomaterials Joint Research Meeting on 24 February, 2015 at NANOTEC, Thailand Science Park. The meeting was aimed to initiate the collaboration on nanomaterials for sustainable energy and strengthen the collaborative research on electrochromic devices. The collaboration concept between NANOTEC and Nanosystem Research Institute (NRI) was initiated in 2011 during the Asian Network Research Summer Camp for Graduate Course Students and Young Researchers in Japan with Formal agreement signing in 2013. Since then, several scientific meetings and exchange of visiting researchers has taken place between two agencies.

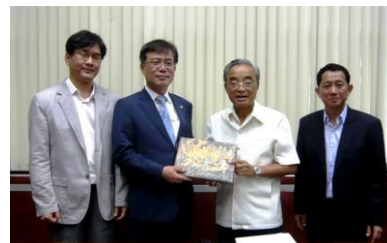


### ◆ *The Visit of SKKU Professors*

Recently, Prof. Ji-Beom YOO, Executive Vice President of Sungkyunkwan University's (SKKU) Natural Science & Engineering Campus, and Prof. Sung-Joo Lee, Chair of SKKU Advanced Institute of Nanotechnology (SAINT) visited to Thailand with an aim to participate in the Ph.D. scholarship selection meeting.

The Ph.D. scholarship resulted from the visit to Korea of HRH princess Maha Chakri Sirindhorn in 2013. The princess led a group of senior officers from Ministry of Foreign Affairs and senior executives from PTT Group to visit SKKU Natural Science Campus. The purpose of the visit was to observe and to learn a fruitful collaboration between SKKU and Samsung.

It was recognized as a successful model for university-private sector linkage. Subsequently, SKKU agreed to grant Ph.D. scholarship to Thai graduate students and researchers.



### ◆ *The Renewal of Second Phase of Collaboration on BL 5 (XAS Beamline)*

The National Nanotechnology Center (NANOTEC), Suranaree University of Technology (SUT) and Synchrotron Light Research Institute (SLRI) took an opportunity to announce the renewal of their collaboration to operate X-ray Absorption Spectroscopy (XAS) Beamline (BL) 5 at SLRI at Korat province on 15 May 2015.

Since the implementation of a joint collaboration with the aim of investing in the construction of BL 5 in 2019, researchers from these three agencies have been used BL 5.2 on numerous research projects which involved in the chemical and structural analysis.



The second phase of the collaboration will primarily concentrate on adding X-ray Photoemission Spectroscopy (XPS) to BL 5.1 in order to enhance the capability of XAS Beamline technology for additional practical use. Traditionally, XAS technique is utilized to determine chemical speciation and local structure (type of neighboring atom, coordination number, inter-atomic distance) of the absorbing atom.

In addition, the activities in the second phase of the collaboration are expected to increase an interest of researchers and private sectors in the technology and to improve the national economic competitiveness.

## ✧ **Commercialization**

**Australia** (Source: DIISRTE)

◆ *\$188.5 Million Industry Growth Centres*

Innovation policy in Australia is now focused on establishing five Industry Growth Centres which will be designed to encourage business-university collaborations. The Australian Government has committed AUD\$188.5 million funding for the Industry Growth Centres to deliver the Initiative in five growth sectors in which Australia already has a competitive advantage, these are:

- Advanced Manufacturing;
- Food and Agribusiness;
- Medical Technologies and Pharmaceuticals;
- Mining Equipment, Technology and Services; and
- Oil, Gas and Energy Resources.

Overarching activities that all Growth Centres will complete include:

- Development and implementation of a roadmap to lift sector competitiveness;
- Provision of advice to Government on how to best reduce regulatory burden within their sector; and
- Development of annual industry knowledge priorities to help inform the research sector of industry needs and commercialisation opportunities.

For further information about the Initiative refer to [link](#)

**Indonesia** (Source: MNI)

◆ *PT. Nanotech Inovasi Indonesia (Nanovasi) : First Nano Inorganic Pigment Manufacturer in Indonesia*

Coating is one of science that already widely applied in daily life especially paint. Paint has been used not only for protective purpose but also decorative purpose. Pigment as one of paint components plays important role either to give color, have protection function,

or both of it. For protective purpose, pigments used usually come from inorganic material such as iron oxide, etc.



Milling process of Nanovasi co. ltd. pilot plant and product

International painting company recently interest to take Indonesia as one of promising market in Southeast Asia. Good side of it is many domestic paint company rise and grow to compete with international product. Though, paint sector in Indonesia rise rapidly but not many of raw material can be supplied independently from Indonesia especially pigment. To fulfill inorganic pigment needs are still imported from China or other countries.

Because of this cause, Nanotech Inovasi Indonesia (Nanovasi) co. ltd. was established on early 2014. Nanovasi co. ltd. aims not only as an ordinary inorganic pigment manufacturer but also as inorganic pigment manufacturer based on nanotechnology. By applying nanotechnology on manufacturing inorganic pigment, Nanovasi co. ltd. hopes nano inorganic pigment can give all merits that nanotechnology has for paint application and also to compete with other pigment industries that already established before.

Nanovasi co. ltd. recently establish its first factory in Gunung Putri, Bogor. First products will be launch is black and red inorganic pigment based on iron oxide. This color is chosen to be produced because of massive needs of this color from many paint company in Indonesia. This Black oxide and red oxide were planned to be launched in Q1 2015.

**Iran** (Source: INIC)

◆ *Iranian Scientists Convert Curcumin Existing in Turmeric into Edible Nanodrug*

TEHRAN (INIC)- The Iranian enterprise Exir Nano Sina Company succeeded in the production of an edible nanodrug by using the API in turmeric plant.

Curcumin (diferuloyl methane) is a polyphenol that is classified as one of the diarylheptanoids. This substance is the active part of a perennial plant known as turmeric. Turmeric is cultured in India, Southeast of Asia, China and the tropical zones in Asia. Many studies carried out in the past 50 years showed a few important effects of curcumin. Generally speaking, the most important biological effects of turmeric and curcumin are its anti-inflammation, anti-tumor and antioxidant specifications.

Many studies suggest that curcumin has anti-oxidant and anti-angiogenesis effects, prevents cell proliferation and aggression and can be used in the treatment of wounds, diabetes, Alzheimer's, Parkinson's, cardiovascular diseases, microbial diseases, lung diseases and arthritis.

Clinical studies showed that curcumin does not have any toxic effect and is completely safe even when it is consumed 12 grams per day for three months.

Due to the lipophilic nature of curcumin, the sorption of this substance is very low in normal forms of eating such as powders, capsules and tablets. Like other lipophilic materials, very small amount of curcumin turns into missile in a natural manner and is absorbed after being eaten. However, when it is encapsulated in nano-missiles, all of the curcumin is trapped in the hydrophobic part of curcumin nano-missiles. The spherical nano-missiles are about 10 nm in size and they increase the solubility of curcumin in water more than 100,000 times.

After being eaten, softgel capsules containing curcumin nano-missiles break in the acidic environment of stomach, and the drug is released. The nano-missiles are stable at least for six hours in the acidic environment of stomach, and they reach the small intestine without being opened.

◆ *First Home-Made Edible Herbal Nanodrug Presented to Pharmacies across Iran*

The first edible herbal nanodrug produced in Iran under the title of SinaCurcumin is being distributed in the pharmacies across Iran

TEHRAN (INIC)- The first edible herbal nanodrug produced in Iran under the title of SinaCurcumin is being distributed in the pharmacies across the country by the medical distributing companies after the acquirement of necessary certificates from Food and Drug Organization of the Ministry of Health, Treatment and Medical Education.

"SinaCurcumin edible herbal nanodrug contains curcumin as API, which is extracted from turmeric and it has many useful effects such as prevention of the proliferation of malignant cells in the body, anti-oxidant properties, reducing inflammation in joints, and protective effects on liver in cases like fatty liver," Dr. Mahnaz Qomi, the producer of the drug and Managing Director of Exir Nano Sina Company, stated.

Turmeric has been used in traditional and modern medicine and it is consumed as additives in cooking different meals. Curcumin existing in turmeric has very low sorption by the digestive system. However, its sorption has significantly increased by using nanotechnology and by encapsulating it in nano-missiles.

The drug is presented to consumers in the form of soft gelatin capsules in packages containing 50 capsules without the need for prescription. According to the recommendation of the producing company, the consumption of one capsule per day is appropriate for the adults. No toxic effect has been yet reported for this drug in the tests.



The production of the drug is the result of cooperation between the Knowledge-Based Exir Nano Sina Company and Minoos Pharmaceuticals Company.

◆ *Iran Proposes Compilation of 2 Int'l Standards in Nanotechnology*

The Secretariat of Iran's ISO/TC 229 Nanotechnologies has sent two international standards to the 33 permanent members of the International Standard Organization (ISO) committee to vote and comment on them.

Titles of the two standards are as follows:

- a. Nano-enhanced air filter media using nanofibres -- Characteristics, performance and measurement methods
- b. Nanotechnologies -- Nanoclays -- Characteristics and measurements

Iran has been producing filters improved by nanofibers, including power plant filters, heavy and light machinery filters and respiration masks since a few years ago. In fact, a new class of filters has been presented by using nanotechnology. These filters are produced in Iran at a large scale and a few international companies produce these filters too.

The other proposed standard is the standard for the characteristics of nanoclay. The draft of the standard has been compiled by Standard Committee of Iran Nanotechnology Initiative Council in association with an academic team. This standard presents the most important parameters and characteristics of nanoclay by taking into consideration its applications, and different methods to measure those parameters. The two standards should pass various stages of the standard compilation before they are published.

Iran has so far led the compilation of three international standards in the field of nanotechnology and is among the nine countries that have been the leader of standard compilation in the field of nanotechnology in International Standard Organization (ISO).

◆ *INIC, Ministry of Industry Ink Agreement to Commercialize Nanotechnology*

Iran Nanotechnology Initiative Council (INIC) of the scientific and technological department of presidential office signed an agreement with the department of Education, Research and Technology of the Ministry of Industry, Mine and Trade to commercialize nanotechnology.

The aim of the agreement is to obtain the determined share of Iran from the global nanotechnology market and develop knowledge-based economy, improvement and adoption of advanced technologies, including nanotechnology, by the country's industries.



After endorsing the agreement, Dr. Sa'eed Sarkar, the INIC Secretary-General, stated that "nanotechnology has three stages. The first stage is the production of nanomaterials, and a wide range of nanomaterials are produced in the country. The second stage is the adoption of nanotechnology by the industries in the country, which increases the quality and competitiveness of the products. The third stage is the production of new products based on nanotechnology such as fabrics, glass and smart drugs".

"Works are being carried out very well at research and development levels, and we are among the leading countries in the field of science. However, we cannot obtain our final goal without the adoption of nanotechnology by the industries in the country," he added.

Also for his part, Dr. Ali Asqar Tofiq, the Ministry of Industry, Mine and Trade Deputy for Education, Research and Technology stated that "insufficient efforts have been made in the commercialization of nanotechnology, and we need to create the atmosphere for the industrial society to get familiar with this technology".

Among the common plans in this agreement, mention can be made of establishment of a joint workgroup to compile operational regulations, carrying out the required researches related to the adoption of advanced technologies, including nanotechnology by industries, common cooperation in the promotion of nanotechnology in industries, provision of support for the production of pilot plants for semi-industrial production of products in order to prove the technology and to develop its applications in the field of nanotechnology, helping the monitoring of technology and market to provide the ground for the adoption of technology by industries, carrying out the required researches related to market development aiming at creation of required infrastructure for the adoption of technology by industries, and provision of financial support for projects with high priority in the field of nanotechnology.

### ◆ *Iran Nanotech China Center (INCC) Starts Work in Suzhou Industrial Park*

Iran Nanotech China Center (INCC) opened on 12 May 2015 in the presence of Iranian and Chinese authorities in Nanopolis Center located in Suzhou Industrial Park.

In this ceremony, a Memorandum of Understanding (MoU) was signed between Iran Nanotechnology Initiative Council (INIC) and Nanopolis Center, aiming at development of cooperation between Iran and China in the field of nanotechnology.

Ali Morteza Birang, the head of the scientific and technological department of presidential office for international affairs, delivered a short speech in the ceremony and stated that opening of this center is the beginning of international cooperation between the two countries in the field of nanotechnology. The deputy head of Suzhou Industrial Park for science and technology, for his part, pointed to the fact that Suzhou has connected China to Iran as the beginning of the Silk Road in the past. According to him, the opening of this center in Suzhou creates a new path of nanotechnology between the two countries.

Also, Secretary of Iran Nanotechnology Initiative Council (INIC) Dr. Sa'eed Sarkar believes that there is an ideal opportunity for cooperation between the INIC and the Nanopolis Center. The Head of Nanopolis Center also expressed the hope that setting up the center would result in the development of cooperation between the two countries and the presence of Iranian companies in Nanopolis Center.

It must be pointed out that the three countries of Finland, the Netherlands and Czech Republic have established international centers in Suzhou Industrial Park. Iran is the fourth country to establish an office in this center to have international cooperation.

Iran Nanotech China Center started its activity in the city of Suzhou in March 2015.

### ◆ *Production of Industrial Nano-Membrane for Water, Wastewater Purification Device in Iran*

Ab Roobesh Rosoob (Mahsar) Engineering and Productive Company produced and presented to the market water and wastewater purification devices using nanotechnology.

This device works based on the harmodynamic method and has a high efficiency in water purification process. It has been used in various parts, including purification of wastewater of oil wells in South of Iran.

Devices for physical purification of water through harmodynamic method have numerous applications in various industries such as petroleum, gas, petrochemicals, water and wastewater, medical industries, hygiene and electronics.

Ab Roobesh Rosoob (Mahsar) Engineering and Productive Company produced industrial harmodynamic wastewater purification device and presented it to the market. The device is able to purify industrial wastewaters, including waters contaminated with inorganic and herbal oils, dye pigments, biological pollution, organic and inorganic solutions and suspended particles.

The quality of the products produced by plants and industries can be improved by using this technology. Some of the common applications of harmodynamic wastewater purification device can be used in laboratories, electronics and pharmaceutical industries, including desalination of seawater and its conversion to drinking water, desalination of well water and production of ultrapure water. Concentration of fruit juice, milk, or sugar solutions, concentration of coffee, tea, aminoacids and other organic materials are among the other applications of the device.

The managing director of the company stated that the production of the devices to purify wastewater of dairy products with a capacity of 300 cubic meters per day and purify wastewater of starch with a capacity of 200 cubic meters per day are among the other achievements of the company.



Separation process is carried out in the device through pressure system. The solution passes through the polymeric nanomembrane that keeps the fluid on one side the vessel due to the pressure, and only the pure fluid diffuses into the other side of the vessel.

### ♦ *Iranian Foodstuff, Agricultural Industries Welcome Nanotechnology Packaging Bags*

The Iranian Baspar Pishrafteh Sharif Company used nanotechnology to design specific packaging bags and presented them to the market.

The bags significantly reduce the waste and loss of foodstuff and agricultural products during the conservation and transportation. The company claims that this technology enables the export of foodstuff and agricultural products to farther areas.

Baspar Pishrafteh Sharif Company was established in 2012 by a group of university graduates of Sharif University of Technology to help farmers, producers of foodstuff and the exporters active in this field. The products of the company are advanced packaging bags (active and smart) and advanced granules for the production of foodstuff packaging containers.

According to Dr. Rasoul Lesankhosh, the CEO of Baspar Pishrafteh Sharif Company, the products of the company have been presented to the market under the commercial name of Sapack. The products can control the environment inside the packaging bags and prevent the diffusion of gases such as oxygen, carbon dioxide and ethylene.

“Among the other advantages of Sapack, mention can be made of humidity control and prevention of the growth of fungi and bacteria inside the bags. Therefore, the product can block the harmful ultraviolet light,” he explained.

Sapack has so far been successfully used for the packaging of dried fruits, meat, chicken and fresh pistachio. In fact, Sapack has provided the possibility for exporting fresh pistachio for the first time to the Persian Gulf littoral Arab states.

Sapack increases the durability of foodstuff and agricultural products at least up to 60%. In some cases like the fresh pistachio, the durability increases up to 20 times.



### **New Zealand** (Source: Univ. of Canterbury)

#### ♦ *Award*

Dr. Fred Samandari, one of MacDiarmid institute Board members who, as part of the Wireless Network Partnership took out the BNZ Supreme Award as well as the Minter Ellison Rudd Watts Research & Business Partnership Award.

Dr. Ian Brown, Associate Investigator at Callaghan Innovation and Dr. John Kennedy Principal investigator at GNS Science, was also an award winner as part of the Titanium powder metallurgy technologies creating a platform for high value manufacturing in NZ team who took out the AJ Park Commercialisation Collaboration Award.

#### ♦ *Start-up company : Photonic Innovation*

Ojas Mahapatra, a former PhD Student in Simon Brown's group at UC, is now CEO of Photonic Innovations, a start-up that is developing technology that originated from the University of Otago. Ojas has just featured in Unlimited magazine and the company has recently featured in a number of awards. Awards: Finalists in NZ Innovators awards, 2014, Winner of Rising Star award, Deloitte fast 50 awards, 2014, Finalists in Indian Newslink Business awards, 2014. Link to Unlimited: <http://digimag.unlimitedmagazine.co.nz/?iid=108233&startpage=16#folio=16>

### **Singapore** (Source: IMRE)

#### ♦ *'Smart' packaging that extends shelf-life and reduces food wastage*

IMRE recently signed an agreement with key industry partners to develop and test a new packaging material for industry use. The companies which have come onboard are Mitsui Chemicals Asia Pacific, Ltd (Japan), Toyo Ink SC Holdings Co., Ltd (Japan), Dai Nippon Printing Co., Ltd (Japan), Piaget Chemicals & Manufacturing Pte Ltd (Singapore) and Dou

Yee Enterprises (S) Pte Ltd (Singapore). The companies are part of the IMRE-led Industrial Coatings and Packaging (ICAP) consortium.

Dr Li Xu, the principal scientist leading the R&D said, “We want to develop a protective plastic that is as effective as metallised plastic films in the market, but at 20 percent lower cost.”

“Improvements to mundane materials like the plastic wrapping in your local supermarket are often taken for granted but technology proves that such innovations could significantly change the world we live in,” said Prof Andy Hor, Executive Director of IMRE. “Our new material will help reduce food wastage considerably, and allow consumers to more accurately identify when food actually spoils.”

The newly developed packing plastic incorporates nanotechnology that is based on non-toxic ferric compounds. The plastic also has a unique dual purpose high-barrier plate silicate sheet, which effectively blocks moisture and oxygen from seeping into the packaging, and scavenges oxygen to create an anaerobic environment that makes perishables last longer than they would in regular plastic packaging. IMRE has also developed a sensor strip that can help detect minute chemical concentrations associated with the freshness of meat, fish or poultry to give a more accurate indication of food spoilage and expiration.

The phase two of the consortium, which was launched on 17 November 2014, will further explore, develop, advance and test new materials for food packaging. The researchers at IMRE are also working to adapt the packaging material to applications in other areas like electronics and medical packaging.



The new plastic packaging material (left) is as good as metallised plastic films but costs 20 percent less, can be used for a variety of perishables to extend shelf-life (middle). The packaging can be coupled with other IMRE technology like a ‘freshness’ sensor (right) that can tell more accurately when meat goes bad

## ◆ *Cool’ materials technology for new eco-friendly buildings*

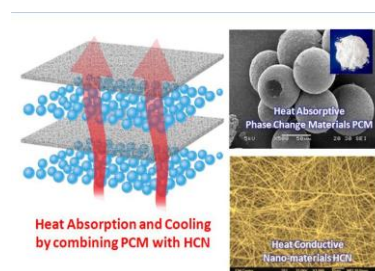
Local construction company, Sunhuan Construction Pte Ltd, has licensed IMRE’s phase change materials (PCM) technology for use in constructing green buildings. The ‘smart’ PCM technology helps passively cool the building by absorbing the heat in the day and releasing it at night.

Under a joint project on “Nanostructured phase change materials in concrete-based construction materials for passive-cooling and green building applications”, Sunhuan Construction will incorporate IMRE’s proprietary PCM technology in the company’s new 10-storey headquarters in Tuas.

“This will be the first building in Singapore that will use such advanced technology to passively cool the building,” said Dr Shah Kwok Wei, the lead IMRE researcher for the PCM technology. The PCMs will be integrated into the walls of the building to help dissipate heat, reduce daytime temperatures within the building, and decrease energy usage from artificial cooling components like air-conditioning and fans. Construction on the new building began at the end of September.

## ◆ *IMRE and Kibing tie-up on glass technologies*

IMRE’s expertise in materials such as titanium dioxide (TiO<sub>2</sub>), phase change materials, nano silver, and polymer composites are some of the R&D being explored to create high value coatings for advanced glass surfaces in collaboration with Kibing. IMRE is also helpingcontact



Kibing chart their R&D directions in glass technologies as well as advising the company on the setting up of an R&D centre in Singapore. The Zhuzhou Kibing Group Co, Ltd is one of the leading glass manufacturers in China and already has two affiliated companies in Singapore.

◆ *In good hands with IMRE's Personal Care experts*

IMRE signed a Memorandum of Understanding (MoU) with homegrown beauty and wellness retailer, Estetica, on 12 February. This partnership would enable Estetica to further expand its R&D capabilities for development of skin care products.

"A\*STAR provides opportunities for our local SMEs to get ahead through business-friendly licensing schemes, ready-to-go technology platforms and research expertise to translate R&D to industry's use. We're excited to be collaborating with Estetica in the dynamic field of personal care," said Dr Loh Xian Jun, Head of Research Planning for IMRE. He is also spearheading this collaboration with Dr Ye Enyi, the lead scientist for this project.



Estetica will be working closely with A\*STAR scientists to develop new formulations for personal care products by tapping into IMRE's vast polymer bank.

"This partnership with Estetica also marks the birth of innovative made-in-Singapore beauty-care formulations that meet Asian needs," said Prof Andy Hor, Executive Director of IMRE.

◆ *FDK inks agreement for R&D on next-generation batteries*

IMRE signed a Research Collaboration Agreement (RCA) with FDK Corporation on 14 May to embark on a project to improve the performances of all solid state batteries by reducing internal resistances of the materials via optimisation of coating composition and sintering temperature. The partners will collaborate further on all solid lithium-ion batteries - arguably the next-generation batteries.



"We are very happy and excited to have a great partner like A\*STAR IMRE to work on new generation of battery development. I believe this collaboration is instrumental in helping us achieve a leading position in industry," said Mr Hitoshi Matsushima, Corporate Senior Vice President and Group President of Electronic Device Business Group, FDK Corporation.

FDK is a Japan-based company in the manufacturing and sales of electronic-related materials and products, specialising in battery development and manufacturing. This is the third research agreement between IMRE's Advanced Energy Storage Lab and FDK Corporation.

◆ *Joint lab with leading glass manufacturer*

IMRE Executive Director, Prof Andy Hor, led a team of delegates to China to discuss a possible joint lab collaboration with Kibing Group. Kibing is a leading glass manufacturer in China and owns several production sites across China. This new partnership could potentially further enhance IMRE's capabilities in functional coatings and enable IMRE to develop deeper innovative value in the growing sector of green building industry in Singapore.



**Taiwan** (Source: IANTP)

◆ *nanoMark Progress*

52 certification standards

43 Companies with 2377 products

The nanoMark enhances the overall enterprise competitiveness. The nanoMark has been promoted for 10 years and has cumulative fruitful results. From 2004 to date, 52 certification standards have been set up. In the same time, there are already 43 companies, 2377 products that passed the nanoMark certification. More than 90% of the products are building materials. The results of a market research indicated that not only can the nanoMark help the companies who have passed the nanoMark certification increase their "corporate image", gain customer affirmative and promote "market sales", it can even increase the selling price of their products by 20%.



## Vietnam (Source: VAST)

### ◆ OIC NEW – a Leading Nanotechnology Company

New Technology Nhat Hai (OIC NEW) is a leading company, specializing in R &D, Technology transfer; Production and Distribution of nano products (Nano Iron, Copper Nano, Nano Silver Nano Calcium, Titanium Dioxide Nano, Nano Silicon Dioxide, Nano Chitosan, Nano Curcumin etc...) in Vietnam. OIC is now collaborating with the Vietnam Academy of Science and Technology to set up the first nano chitosan for agriculture and health care products.



*OIC has signed MOU of Technology transfer with Mugen Ltd (Japan)*

## ✧ New Education/Research Programs

## Australia (Source: DIISRTE)

### ◆ Nanotechnology Entrepreneurship Workshop for Early Career Researchers, 10-11 June 2015, Griffith University Gold Coast, Queensland, Australia.

The Australian federal Department of Industry and Science, in partnership with the Australian Nanotechnology Network and Griffith University and industry leaders are hosting a Nanotechnology Entrepreneurship Workshop for Early Career Researchers.

The aim of this workshop is to provide a forum for early career researchers (ECRs) and postgraduate students working on nanotechnology research to interact with industry leader and learn about how to commercialise Nanotechnology. Industry leaders will share experiences in commercialising technologies. ECR and PhD students will have a chance to present their ideas to industry leaders about commercialising their research.

Further information and contact details for the Nanotechnology Entrepreneurship Workshop can be found at: [http://www.ausnano.net/content/ecrphd\\_15](http://www.ausnano.net/content/ecrphd_15)

## Indonesia (Source: MNI)

### ◆ 3rd International Conference on Advanced Material and Practical Nanotechnology

3<sup>rd</sup> International Conference on Advanced Material and Practical Nanotechnology (ICAMPN) had already successfully organized by Indonesia Society for Nanotechnology (MNI) last August. 3<sup>rd</sup> ICAMPN was attended by more than 110 participants from 8 different countries. Countries that contributed in this event either as participants or speakers were Indonesia, Malaysia, Singapore, Japan, South Korea, India, Germany, and Canada.

First day of event was opened by speech about nanotechnology by Prof.

Teruo Kishi (NIMS Japan) and Dr. Nurul Taufiqu Rochman (LIPI, MNI Indonesia). Prof. Teruo Kishi spoke about development of nanotechnology around the world especially Japan. Dr. Nurul Taufiqu Rochman was continuing speech



from Prof. Teruo Kishi and spoke about nanotechnology in Indonesia and its potential in the future. These two experts gave detailed descriptions of nanotechnology and how it will develop in the recent future.

Second day of event was opened by speech from Prof. Freddy Boey (NTU Singapore) and Dr. Ika Dewi Ana (UGM Indonesia). These two experts talked about success story of how nanotechnology research can be applied and commercialized. Prof. Freddy Boey was opening the day by giving speech about his research and products which is already commercialized. Dr. Dewi Ika Ana was giving speech about her research product about biomaterial which is ready to be commercialized.

Chairman of 3<sup>rd</sup> ICAMPN, Dr. Ikhlasul Amal, gave his speech as closing statement. He expressed his gratitude toward all institutions and organizations which were already support 3<sup>rd</sup> ICAMPN including ANF which already helped to promote this event to its networking.

### ♦ *Nano World Indonesia*

Indonesian Society for Nano (Masyarakat Nano Indonesia - MNI), as a forum for nanotechnology researchers and professionals, considered that students also play a pivotal role in the development of nanotechnology in Indonesia. By doing research on campus or via participation in conferences and seminars, students have strong potential to contribute. It motivated MNI to create Nano World Indonesia (NWI), a forum for students who are interested to learn and have a more active role in nanotechnology development. By March 2015, more than 500 students from 20 universities all over Indonesia have already been registered as members of NWI. MNI and NWI invite more and more students from all universities in Indonesia, either state or private universities, to join NWI and build this new interesting field together.



### **Iran** (Source: INIC)

#### ♦ *Int'l Nano School Held in Tehran, Isfahan, Kashan, Shiraz*

EHRAN (INIC)- The three-day International Nanotechnology School was held by the Center for Pharmaceutical Research of Shahid Beheshti University of Medical Sciences and Iran Nanotechnology Initiative Council at the Center for Pharmaceutical Research of Tehran University of Medical Sciences on 2-4 March 2015.

The aim of the course was to establish a school to gather high school students and university professors once a year to organize a three or four-day-long course with the participation of the best nanotechnology professors from across the world. In this course, basic concepts of nanotechnology and various laboratorial, scientific and theoretical methods were discussed in the fields of production of goods, commercialization and intellectual properties.

Three courses were held in this school for three days at the three levels of school students, university students and university professors with the participation of 200 participants from various cities of the country. Lecturers from five countries the United States, Canada, Australia, South Korea and Britain in association with six Iranian lecturers organized the courses as teachers. The invited lecturers have registered patents and nano products in the market.

This course was also held in form of one-day course in the three cities of Kashan, Isfahan and Tehran with the participation of the same lecturers. The Center for Pharmaceutical Research of Shahid Beheshti University of Medical Sciences seeks to organize the course in association with Iran Nanotechnology Initiative Council in different parts of the world next years.

This course is among the programs of ANFC2015, which is being held on Kish Island on 8-11 March 2015.

#### ♦ *Sharif University of Technology to Hold Graphene Summer School*

The Department of Physics, Sharif University of Technology, is due to hold Graphene Summer School on 26-28 April 2015 with the participation of the Noble Prize winner in physics, Prof. Novoselov.

In this three-day school, other keynote speakers, including Prof. Koshino from , Prof. Hassan from , and Prof. Grueneis from will deliver speeches on the following scopes:

- Electronic and optical properties of 2D materials and their heterostructures

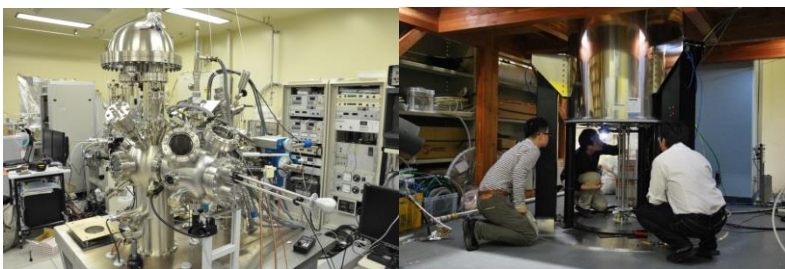
- Electronic properties of functionalized 2D materials: graphene, boron nitride, transition metal dichalcogenides and phosphorene
- Physics of graphene and its edge states
- Introduction to quantum cluster methods

This school will be held by Sharif University of Technology for the second time. The first school was held in October 2014 on Structural Electrons. For more information about registration, visit the school's website at <http://physics.sharif.ir/~pam/index.php/activities/future-activity/pams2>.

## Japan (Source: AIST)

### ◆ Nanotech Career-up Alliance - "A New Human Resource Development Program"

Nanotech CUPAL was established based on the subsidized project "The construction project for the consortium of the fostering of science and technology personnel" in FY 2014. The Tsukuba Innovation Arena for nanotechnology (TIA-nano),



including AIST, NIMS, University of Tsukuba, and KEK, and Kyoto University's nanotechnology Hub have collaborated and launched the following projects, NIP (Nanotech Innovation Professional) and NRP (Nanotech Research Professional), with the aim of enhancing the career of nanotech researchers and improving their mobility.

Targets of NIP courses are young researchers and doctoral students, and its aim is to foster specialists who have a high proficiency to contribute to innovation through accumulation of expertise and know-how on advanced equipment. A platform will be provided to endue them with various advanced level essential technologies that will serve as a foundation on research and development in nanotechnology by means of hands-on training courses. Through opportunities to acquire a new position and by networking with other participants from private companies as well as with industry-academia-government collaborative project members, each participant will finally be able to set a goal for developing his/her career in NIP courses.

This fiscal year's first three introductory courses on advanced measurement technologies were held at National Institute for Material Science (NIMS): the TEM course (April 22 to 24) with 9 participants, the surface analysis course (May 26 to 28) with 3 participants, and the structure analysis course (June 16 to 18) with 10 participants. ([Website](#))

## Malaysia (Source: Nano Malaysia)

### ◆ National Graphene Action Plan 2010

July 2014 - Minister in the Prime Minister's Department has launched the National Graphene Action Plan 2020 (NGAP 2020) jointly developed by NanoMalaysia Berhad, Performance Management and Delivery Unit (PEMANDU) and Agensi Inovasi Malaysia (AIM). The launch was witnessed by the Minister of International Trade and Industry, and the Deputy Minister of Science, Technology and Innovation. This strategic alliance between NanoMalaysia, PEMANDU, and AIM has undoubtedly created a dynamic synergy to exploit newly emerging technologies, strengthen Malaysian's industries, and to establish Malaysia as a global player in technologically-driven areas of economic importance. With NanoMalaysia given the mandate as the lead agency, a Graphene Action-plan Team was formed within the entity to drive the execution of this strategy.

## Singapore (Source: IMRE)

### ◆ Research Focus – Consumer Care Technology Programme

This programme targets areas such as sustainable and green materials, developing materials with high efficacy and also intelligent encapsulation for active ingredients, in the development of new materials for the consumer care industry. The

programme's platform technology develops capsules that deliver active ingredients to specific targeted surfaces, such as skin, hair or fabrics. Technologies to improve the efficacy of these active ingredients, to improve deposition efficiency and selectivity, and to customize green materials for use in consumer care products also form a large part of the work done by the programme.

- Functional polymers – Using less to do more

The programme carries out studies to understand the structures, properties and relationship of complex colloids, all of which have critical impact on the performance of consumer care products. The knowledge obtained guides the design, identification and development of suitable polymer materials that result in cost effective formulations with enhanced efficacy and stimuli-responsive properties. The group develops suitable polymer materials for better rheology modification, enhanced and targeted deposition, skin care, imaging, and added functionalities such as antimicrobials and antifungal. IMRE also explores naturally derived products as alternative, and eco-friendly materials, for the consumer care industry.



- Encapsulation and delivery systems – Protected, delivered and targeted

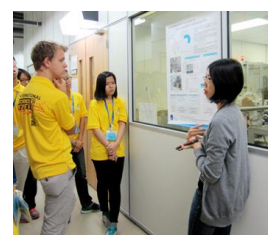
The programmes's platform encapsulation systems provide multiple solutions for applications at various levels. At the basic level, the IMRE technology is capable of storage, protection and controlled release of various active species such as dyes, vitamins, fragrances, flavours, lipids and oils. At the intermediate level, intelligent systems are being developed and coupled with molecular self-assembly processes to achieve triggered delivery mechanisms. At the advanced level, IMRE focuses on developing targeting capsules, which can be applied in products for skincare, haircare, fabric care, food products and dietary supplements.

- Porous films

This research studies the fundamental processes self-assembly for porous film fabrication. Such assemblies may have uses in cell-arrays, as micro-reactors, and even in the formation of inverse-opal photonic crystals. This facile and economical approach may be applied for the formation of various polymer films, including biocompatible polymers for cell-culture. We may also utilise this material for patterning 3-D microstructures.

### ◆ *International Science Youth Forum*

Thirty one facilitators and students visited IMRE as a part of the 7th International Science Youth Forum (ISYF) programme, organised by Hwa Chong Institution. ISYF is a collaboration between NTU, MOE and A\*STAR and the annual event involves top science students and educators from 17 countries around the world such as USA, Canada, Turkey, Estonia, Australia, Japan, Korea, etc. During the visit, the students found out more about IMRE's R&D efforts and were taken on a tour of IMRE's characterisation laboratories.



### ◆ *MoU renews programme for NJC's young scientists*

"Talent development is about learning and creating knowledge. It's what ultimately drives science, and scientists, said Dr Jiang Ying, Head, Talent Development.

She was addressing attendees who gathered on 1 April for the signing of an MoU between IMRE and National Junior College (NJC) for a student-development programme.

IMRE and NJC have been collaborating since 2012 for scientifically inclined students to take part in research attachments with IMRE. This MoU extends the IMRE-NJC partnership until 2018.



Under our scientists' mentorship, NJC students won various accolades. Ms Shannon Lee, an NJC student attached to IMRE, developed an efficient electrocatalyst from eggplants, that may be used for batteries of the future. Guided by Dr Li Bing and Dr Geng Dongsheng, she received 3 top prizes at The Intel International Science and Engineering Fair (Intel ISEF) 2014. Two other IMRE-mentored NJC students won Gold and Silver (Team) for their work at this year's Singapore Science and Engineering Fair (SSEF).

"While students are attached to IMRE, they learn to take initiative and ownership. They develop skills and even find meaning in what they do – be it inventing something that helps the environment, a family member, or addressing universal human needs. It's about making discoveries," added Dr Jiang Ying.

### **Taiwan** (Source: IANTP)

#### ◆ *Innovation and Application of Nanoscience Thematic Program (IANTP)*

After the first phase (2003 ~ 2008) of embryonic growth and the second phase (2009 ~ 2014) of industrial layout, the promotion and implementation of Taiwan's National Nanotechnology Program has established the advantageous basis for further development of this twenty-first century technology and enhancement of the industrial competitiveness of Taiwan. In order to fully use this advantage after the end of the National Nanotechnology Program in 2014, IANTP was approved in April 2014 by the Ministry of Science and Technology (MOST). IANTP is aimed at increasing research impact of Taiwan's National Nanotechnology Program by encouraging scholars to engage in translational research based on scientific discoveries. The Program supports research to proceed from a basic Technology Readiness Level (TRL) of "Concept Development" to a more advanced "Prototype Validation". The supported projects should produce original nanomaterials, components/devices and technology. IANTP focuses on 4 areas, including "Biotechnology & Medicine", "Energy & Environment", "Electronics & Optoelectronics", and "Characterization & Synthesis", with particular emphasis that the research outcome will help Taiwan to meet with the challenges arisen from industrial development, as well as societal and environmental needs in the near future.

### **Thailand** (Source: NANOTEC)

#### ◆ *NANOTEC Senior Researcher awarded two Fellowship Programs*

Dr. Varol Intasanta, senior researcher at NANOTEC, Nano Functional Textile Lab had received the research grant from Grand Challenges Canada Stars in Global Health program for his proposal entitled "Ultrathin, Light-Weight and Disposable Nanofibrous Filters for Tuberculosis Prevention" Dr. Varol had also received the award on Leaders in Innovation program sponsored by the Royal Academy of Engineering in the UK. He attended the training course on technology commercialization in United Kingdom Between March 2 – 11, 2015.

Grand Challenges Canada, which is funded by the Government of Canada, has developed the Stars in Global Health program to support Bold Ideas with Big Impact from the best and brightest talent, both in low- and middle-income countries and in Canada, to use scientific/technical, social and business innovation to address some of the most pressing global health challenges.

The Leaders in Innovation Fellowship (LiF) program is being run by the Academy and funded by the UK Government Department of Business, Innovation and Skills' Newton Fund program. The fellowship brings the leading technology entrepreneurs from Newton Fund partner countries to the UK for an intensive training course on innovation whilst also building Business-to-Business networks with similar entrepreneurs in the UK.



### **Vietnam** (Source: VAST)

#### ◆ *National Technology Innovation Foundation*

Earlier this year, Vietnam government established the National Technology Innovation Foundation (NATIF) with a registered capital of VND1 trillion (US\$47 million). The fund aims to foster innovation among Vietnamese businesses and promote the commercialization of innovative ideas that can create new products and services.

In the era of international economic integration, especially with the imminent arrival of ASEAN Free Trade and Trans-Pacific Partnership (TPP) agreements, the pressure of all-round competition in products and human resources is going to be huge.

As Viet Nam lags behind in industry and it has an inadequate contingent of scientists, both in quantity and quality, especially in applied sciences and development of new technology, it is imperative that the Government provides incentives and acts as a babysitter in this pre-development period.

The Government has announced a roadmap for investment in science and technology. For example, one of the targets that have been set is for funding for science and technology to account for 1.5 per cent of GDP, but this goal has not been achieved. We also have other national-level science programmes like KC-xx, but this one, now being phased out, has not yielded expected results.

### ✧ General News

#### Australia (Source: ANN)

##### ◆ *APVMA Nanotechnology Regulation Symposium 2014*

The Australian Pesticides and Veterinary Medicines Authority (APVMA) hosted a symposium on nanotechnology regulation in Canberra, Australia, on 28 October 2014.

The symposium sought input from industry, scientists, regulators and the broader community on developing a regulatory framework for nanotechnologies in Australian agriculture and animal husbandry.

More than 120 people attended and contributed to discussion on the properties of nanomaterials, manufacturing, human health and environmental considerations.

The program was based on the APVMA draft report Regulatory considerations for nanopesticides and veterinary medicines, released in early October.

The report is the first of its kind to be released in draft for public exposure and discussion. National and international comment has already been received, much of it supporting the release and discussion of the working document.

During the symposium, the APVMA's Dr Phil Reeves, who produced the report, emphasised the importance of consultation and engagement when dealing with emerging technologies and encouraged further constructive feedback from participants.

He said that the process had already revealed some gaps that would be considered in the final report.

The APVMA is expecting to release the final document by the end of January 2015.

More information is available at: <http://apvma.gov.au/node/11191>

The report is available at: [Link](#)

##### ◆ *Report on Engineered Nanomaterials: and Update on the Toxicology and Work Health Hazards by Safe Work Australia*

Safe Work Australia published in January 2015 a report on, "Engineered Nanomaterials: and Update on the Toxicology and Work Health Hazards,"

The report provides suggestions for workplace exposure standards for carbon nanotubes and nanoscale silver and titanium dioxide. It also finds that conventional risk assessment approaches for chemicals can be used in managing risks of working with engineered nanomaterials.

This report should be read by nanomaterial manufacturers and importers, work health and safety practitioners, researchers and other interested persons who need to understand the hazards of engineered nanomaterials and require guidance on managing risks associated with those hazards.

This report can be downloaded at [link](#).

◆ *International Conference on Nanoscience and Nanotechnology (ICONN2016)*

The 2016 International Conference on Nanoscience and Nanotechnology (ICONN 2016) to be held in Canberra, 7-11 February 2016, aims to bring together Australian and International communities working in the field of nanoscale science and technology to discuss new and exciting advances in the field. ICONN will cover nanostructure growth, synthesis, fabrication, characterization, device design, theory, modeling, testing, applications, commercialisation, and health and safety aspects of nanotechnology.

The conference will feature plenary talks followed by technical symposia (parallel sessions) consisting of invited talks, oral and poster presentations on the following topics: Nanomaterials, Nanobiotechnology, Nanoelectronics, Nanophotonics, Computational Nanotechnology, Nanocharacterisation, Nanotechnology for Energy and Environment & Commercialisation, Safety and Societal Issues of Nanotechnology.

◆ *Report: [Nanotechnologies for pesticides and veterinary medicines: regulatory considerations](#)*

The Australian Pesticides and Veterinary Medicines Authority report: [Nanotechnologies for pesticides and veterinary medicines: regulatory considerations—final report](#) has been released.

The report looks at the benefits and challenges of regulating nanotechnology for use in agriculture and animal husbandry and highlights the key regulatory considerations for agvet chemical nanomaterials, based on the current state of knowledge.

**Indonesia** (Source: MNI)

◆ *Nanonesia.com : Nanotechnology Online Forum*

Rapid growth of information technology, particularly social media and mobile applications, opens opportunity to spread issues and information more massively. In the spirit to raise greater awareness about nanotechnology,



Indonesian Society for Nano started Nanonesia.com. It is designed to be a nanotechnology portal of information in Indonesia. Moreover, it will be online center for all nanotechnology practitioners, researchers, and students to discuss and share information. Nanonesia.com can also be downloaded from Google Play Store. This feature will give quick access for busy people to stay updated on recent technology information.

**Iran** (Source: INIC)

◆ *3rd Iran-Proposed Nano Standard Approved by International Standard Organization*

TEHRAN (INIC, 2014-11-22)- The standard proposed by Iran under the title of 'Definitions for the evaluation of science, technology and innovation indicators' was approved in the 17th Meeting of the International Nanotechnology Standardization Committee held in New Delhi, India, on November 3-5, 2014.

Representatives of Iran, the United States, Germany, South Africa, Australia, Britain, Brazil, China, Switzerland, Singapore, Russia, Japan, France, Canada, the Republic of Korea, Poland, Malaysia, Mexico, India, and the Netherlands participated in the 17th Meeting of the International Nanotechnology Standardization Committee. They discussed and exchanged ideas on the compilation of international standards in the field of nanotechnology. Also the representatives of the Asian Nano Forum (ANF), European Committee for Standardization (CEN) and Joint Research Center (JRC), as well as some members from other technical committees of ISO participated in the forum.

A standard entitled "Definitions for the evaluation of science, technology and innovation indicators" had been proposed to ISO by Iran about three years ago, and it had been approved in the primary voting by the member countries of ISO/TC229. The standard was developed by Iran's leadership in the past three years, and other countries proposed revisions on the standard in forms of technical, general and editorial comments.

The standard provides definitions on expressions, including nano products, nano companies, nanotechnology market, nano devices, and so on, which are vital for the evaluation of nanotechnology. The standard focuses on nanotechnology evaluation indicators at the international level. In fact, the standard enables the evaluation of the effects of economics,

volume of nanotechnology market and the number of companies and products. That is why this standard was very important to the countries and the leading countries in nanotechnology paid special attention to it.

During the meeting, the standard was discussed and it was approved by the member countries, and it will be published in the beginning of 2015 after the administration of the comments.

Meetings of the International Nanotechnology Standardization Committee are held every nine months in one of the member states.

◆ *Int'l Nano School Held in Tehran, Isfahan, Kashan, Shiraz*

The three-day International Nanotechnology School was held by the Center for Pharmaceutical Research of Shahid Beheshti University of Medical Sciences and Iran Nanotechnology Initiative Council at the Center for Pharmaceutical Research of Tehran University of Medical Sciences on 2-4 March 2015.

The aim of the course was to establish a school to gather high school students and university professors once a year to organize a three or four-day-long course with the participation of the best nanotechnology professors from across the world. In this course, basic concepts of nanotechnology and various laboratorial, scientific and theoretical methods were discussed in the fields of production of goods, commercialization and intellectual properties.

Three courses were held in this school for three days at the three levels of school students, university students and university professors with the participation of 200 participants from various cities of the country. Lecturers from five countries the United States, Canada, Australia, South Korea and Britain in association with six Iranian lecturers organized the courses as teachers. The invited lecturers have registered patents and nano products in the market.

This course was also held in form of one-day course in the three cities of Kashan, Isfahan and Tehran with the participation of the same lecturers. The Center for Pharmaceutical Research of Shahid Beheshti University of Medical Sciences seeks to organize the course in association with Iran Nanotechnology Initiative Council in different parts of the world next years.

This course is among the programs of ANFC2015, which is being held on Kish Island on 8-11 March 2015.

◆ *1st Asia Nano Forum Conference was Held in Iran*

The First Asia Nano Forum Conference organized by Asian Nano Forum (ANF) started on Kish Island, Iran, on March 8.

Asian Nano Forum is consisted of 15 members, including Iran. ANF tends to organize Asian Nano Forum Conference annually in one of the member countries in order to strengthen regional coordination, to exchange scientific information and increase cooperation among the researchers of the member countries.

There are the following four specialized sections in the conference:

1. Water and environment
2. Standard and safety
3. Energy
4. Health and Hygiene

During the four days of the conference, 18 specialized panels are being held, among which six panels are related to energy section, four to health and hygiene, five to water and environment and three to standard and safety.

Also workshops have been organized in AFNC2015, in which lecturers from different countries, including Iran, Australia, Canada, Singapore, Hong Kong, India, Italy, the United States, Japan, Spain, South Korea, China, Malaysia, and Britain deliver lectures on the scopes of the conference.

◆ *University of Tehran to Host 5th Ultrafine Grained, Nanostructured Materials Conference*

TEHRAN (INIC)- The Department of Metallurgy and Materials Engineering of University of Tehran in association with University of Trento, [Italy](#), will organize the Fifth Ultrafine Grained and Nanostructured Materials Conference (UFGNSM 2015) on 11-12 November 2015.



This conference will study the novel methods for the production of ultrafine grained and nanostructured materials and their properties, production of nanoparticles, controlling the structure of nano, nanocomposite materials, nanocoatings and thin films, characterization of ultrafine grained and nanostructured materials, simulation and modeling and education of nanotechnology.

Guest professors from credible universities will deliver lectures in the conference. Educational workshops and exhibition are also due to be held parallel to the conference with the participation of universities, companies and institutes active in the field of nanotechnology.

The Fourth Ultrafine Grained and Nanostructured Materials Conference was held on November 2014, and the selected articles were published in AMR international journal.

For more information about registration and paper submission, please visit the conference's website at <http://ufgnsml5.ut.ac.ir>.



### ◆ *Iranian Female Professor Awarded UNESCO Medal in Nanoscience*

Dr. Soudabeh Davaran, a professor of medicinal chemistry at Tabriz University, is one of the eight scientists who received the UNESCO medal in the field of nanotechnology.

The medal is awarded to the researchers who have helped the development of nanotechnology and nanoscience. UNESCO Director-General Irina Bokova presented the UNESCO Medal to the eight laureates for the 'Development of Nanoscience and Nanotechnologies' at UNESCO Headquarters on 10 April 2015. One of the laureates was Dr. Soudabeh Davaran who received a medal from the UNESCO director-general.

Valentine Bukhtuyarov, Vladimir Fortov, Mikhail Kovalchuk and Mikhail Selyanin from [Russia](#), Constance Chang-Hasnain from the United States of America, Tebello Nyokong from [South Africa](#), Shem Wandiga from [Kenya](#), and Soudabeh Davaran from [Iran](#) are the eight persons who received the medal.

Dr. Davaran is the head of Medicinal Nanotechnology Department of Pharmaceutics College of Tabriz University of Medical Sciences and the professor of medicinal biomaterials and medicinal nanotechnology of the university. She was graduated from Tabriz University of Medical Sciences in organic chemistry and polymer at MSc and PhD levels, respectively.

The UNESCO Medal “for contribution to the development of nanoscience and nanotechnologies” was established in 2010 at the initiative of the thematic group on “Nanoscience and Nanotechnologies” of the International Commission on the Development of the Encyclopedia of Life Support Systems (EOLSS). The medal is presented to the researchers who have significantly helped the development of nanotechnology and nanoscience.



### **Malaysia** (Source: NanoMalaysia)

#### ◆ *Innovating Malaysia Conference 2014*

August 2014 - Agensi Inovasi Malaysia (AIM) hosted the Innovating Malaysia Conference 2014 (IMC 2014) Prelude themed “Nanotechnology Industrial Adoption Through the National Graphene Action Plan (NGAP2020)” in partnership with NanoMalaysia Berhad. This forum was the networking channel for sharing and forming strategic partnerships amongst innovation, thought leaders, entrepreneurs as well as public and private enterprise.

#### ◆ *the Lux Research-NanoMalaysia Forum 2014*

October 2014 – NanoMalaysia and Lux Research co-organised the Lux Research-NanoMalaysia Forum 2014 themed “Innovation for Sustainable Economic Growth through Advanced Materials” on the 27th October which gave participants an ideal opportunity to learn about the latest innovation trends in Advanced Materials. The event was officiated by Datuk Dr. Abu Bakar Mohd Diah, Deputy Minister of Science, Technology and Innovation (MOSTI). Two document exchange ceremonies were held between FGV Cambridge Nanosystems with its partners.

More than 100 top level participants from various industries attended the forum which was by invitation only. Major sponsors for the event are MIDA, FGV, SIRIM Berhad and the Malaysian Industry-Government Group for High Technology (MIGHT). More than 20 companies had participated in the one-on-one 30 minute consultation with Lux Research's and NanoMalaysia's technology experts on site.

- ◆ *The National Workshop on NanoSafety and Regulatory Aspects of Nanotechnology*

October 2014 – The National Workshop on NanoSafety and Regulatory Aspects of Nanotechnology co-organised by National Nanotechnology Directorate-Ministry of Science, Technology and Innovation (NND-MOSTI) and NanoMalaysia in partnership with SIRIM Berhad. This workshop is aimed to enhance knowledge on the development and advancement of nanotechnology; to understand the concerns and issues that nanotechnology raises with the community; and to get expert suggestions and inputs on developing a NanoSafety Roadmap with relevant tasks required for developing and setting up the regulatory framework in nanotechnology activities.

- ◆ *Regional Open Innovation Forum on Promoting Nanotechnology and Agriculture for Sustainable Development*

October 2014 – NanoMalaysia co-organised the Regional Open Innovation Forum on Promoting Nanotechnology and Agriculture for Sustainable Development by ESCAP-APCTT in partnership with NND-MOSTI, Malaysia. This forum envisages discussing and brainstorming coordinated actions that would contribute to bringing the gap between research, innovation and industrial applications in nanotechnology; lowering the innovation barriers and spreading the best innovation practices for rapid innovation, commercialisation and investment in nanotechnology-based value added products and sustainable agricultural technologies and systems.

- ◆ *Research Seminar & Exhibition in Nanotechnology*

October 2014 - NanoMalaysia had also co-organised the Research Seminar & Exhibition in Nanotechnology with the National Nanotechnology Directorate which in line with the MOSTI Commercialisation Year 2014. This seminar involves presentations to know the status of implementation of nanotechnology projects. The exposition covering the entire cycle of R&D to commercialisation and in nano science and technology.

- ◆ *NanoMalaysia at the 14<sup>th</sup> International Nanotechnology Exhibition and Conference 2015 – nanotech 2015*

In an effort to promote the national nanotechnology industry and identify business opportunities that could be developed in Malaysia, NanoMalaysia participated in nano tech 2015 themed “Technology Innovation for Tomorrow”, which was held from the 28th – 30th January 2015 at Tokyo Big Sight, Japan. An estimated 1,000 visitors visited the NanoMalaysia booth during the exhibition and more than 150 visitors showed interest in making Malaysia as a strategic partner in nanotechnology-related ventures.



A number of honoured guests visited the NanoMalaysia booth such as Leftenan Kolonel YAM Tunku Ali Redhaudin ibni Tunku Muhriz, Tunku Besar Sri Menanti, YBhg. Dato' Sri Dr. Noorul Ainur Mohd. Nur, Secretary General Ministry of Science, Technology and Innovation Malaysia, and Dr. Pichet Durongkaveroj, Minister of Science and Technology Thailand.

Apart from these VIPs, the NanoMalaysia booth was visited by government agencies and multinational companies from other countries such as Japan, South Korea, Thailand, the United States, Europe and others who showed interest and were impressed with the nanotechnology program conducted in Malaysia.

- ◆ *NanoMalaysia at the Techconnect World Innovation Conference and Expo 2015*

The TechConnect World Innovation Conference is an annual event uniquely designed to accelerate the commercialization of innovations out of the lab and into industry. NanoMalaysia will be an exhibitor during the Techconnect World Innovation Conference and Expo 2015.

Date : 14-17 June 2015; Venue : Gaylord National Hotel & Convention Center, Washington D.C.

## New Zealand (Source: Univ. of Canterbury)

### ♦ Award

- Dr. Michelle Dickinson, Associated investigator of the MacDiarmid Institute has won the Prime Ministers Science Media Communication Prize and the New Zealand Association of Scientists Science Communicators Award for 2014. Michelle's work to make the serious subject of science fun and accessible, which she does through regular radio and television appearances, tweets, blogs and her 'Nanogirl' cartoon persona ([www.medickinson.com](http://www.medickinson.com) and @medickinson).
- The Deputy Director of the MacDiarmid institute Professor Alison Downard, University of Canterbury who was named a Fellow of the Royal Society of New Zealand this week
- Dr Grant Williams, Principal Investigator, MacDiarmid institute made Member of the New Zealand Order of Merit. The honour is bestowed on those "who in any field of endeavour, have rendered meritorious service to the Crown and the nation or who have become distinguished by their eminence, talents, contributions, or other merits".

## Singapore (Source: IMRE)

### ♦ Dr Ramam recognised for his contributions to the National Standardisation Programme

IMRE's senior scientist and Head of Industry Alliance, Dr Ramam Akkipeddi, was awarded the SPRING Singapore Merit Award (SSMA) at the Standards Partner Awards Ceremony 2014. Dr Akkipeddi was recognised for his contributions to the standardisation programme, specifically in the development of international standards for nanotechnology, where he served as the Leader of the Singapore Delegation for the nanotechnology standards working group. The SPRING Singapore Merit Award is given to individuals who have made significant contributions to the National Standardisation Programme through their commitment and resourcefulness in the development, promotion and implementation of standards.



### ♦ The Next Generation Carbon Fibre and Future Demand for Composites and Carbon Fibres Seminar, Global Innovation Imperatives (Gii) Event in Singapore: WITS Forum 2014

IMRE hosted the inaugural Global Innovation Imperatives (Gii) event, which was organised by the Singapore National Institute of Chemistry (SNIC) and the American Chemical Society (ACS). This year, Gii focused on Water Treatment, through the Water Innovation Treatment & Solutions (WITS) forum. The forum included talks on global water resources development and management that were presented by key leaders of industry, universities and agencies. It was concluded by a roundtable meeting on the draft of the whitepaper on "Global Challenges, Local Solutions". Prof Ellene Tratras Contis, the co-chair of the forum, addressing issues of water treatment and innovation at the forum.



### ♦ A\*STAR Southampton Symposium 2015

IMRE hosted the A\*STAR-Southampton Symposium over two days. This event served to strengthen existing collaborations and initialise new collaborations, between A\*STAR and the University of Southampton.

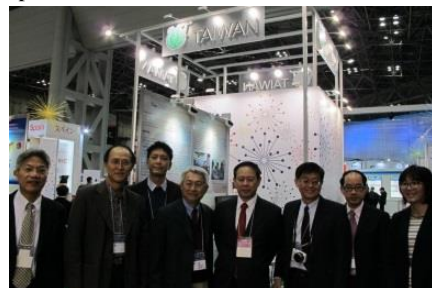
The two partners have been collaborating through research projects and mentorship of rising talents. This bilateral symposium was also a platform for identifying the capabilities of both organisations to advance work on the processing and characterisation of materials. One-to-one sessions were also held for researchers from IMRE to discuss their research projects with delegates from the University of Southampton. The delegates also toured various facilities at IMRE and A\*STAR.



## Taiwan (Source: IANTP)

### ◆ 2014 Taiwan Nano Exhibition

Taiwan Nano Exhibition and its serial demonstration of program achievements organized by NPNT was presented between 2<sup>nd</sup> ~4<sup>th</sup> October, 2014 at Hall 1 of Taipei World Trade Center. The largest Nano exhibition in the country has been moving into its 12<sup>th</sup> year, and this year attracted over 19,000 people to visit. The 2014 exhibition included government pavilions, domestic and foreign industry forum, and technology showcases, which display influential inventions and products. Not only the potential and advancement of Taiwanese nanotechnologies but also an international platform for further collaboration and business opportunities was revealed and provided to all of attendees.



### ◆ Taiwan Pavilion in nano tech 2015, Japan

This year (2015) is the 11th consecutive year for Taiwan to attend “nano tech International Nanotechnology Exhibition & Conference” in Tokyo, Japan. Project of International Cooperation on Nanotechnology, MOST, Taiwan selected 34 technology and research achievements from 24 industry, academia, and research units to demonstrate Taiwan’s latest nanotechnology status. There are 5 areas at Taiwan Pavilion: Electronics and Optoelectronics, Biomedicine, Instrumental Development, Materials and Traditional Industries, and Government Agencies & Non-profit association. Deputy Representative of Taipei Economic and Cultural Representative Office in Japan, Jui-Hu Hsu, and staff visited Taiwan Pavilion during the exhibition.

### ◆ The 13th Int’l Nano Exposition

The 13<sup>th</sup> International Nano Exposition was held in Taipei, Taiwan on June 16-18, 2015. The exhibits include Fundamental Researches of Nanotechnology, Biomedical & Agricultural Applications, Nano Electronics and Optoelectrics, Energy and Environmental Technology, Nano Materials and Traditional Industries, Instrumental Development, Ministry Policies for Education, and Nano Application Products. There are 39 domestic and overseas exhibitors from various industry, academia, and research units to demonstrate the latest nanotechnology developments and products. A workshop on Nanotechnology Innovation that aims to promote the business matching was also held during the Exposition and attracted many researchers and potential customers to join the presentations.

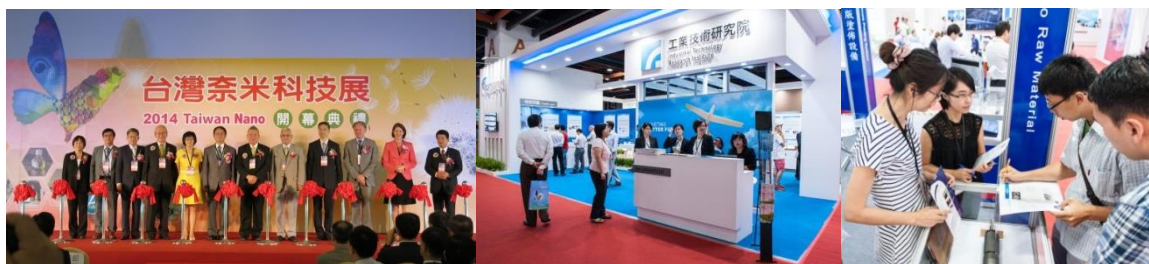


Photo source: National Program on NanoTechnology

## Thailand (Source: NANOTEC)

### ◆ The 4th Thailand International Nanotechnology Conference 2014

Thailand International Nanotechnology Conference in Thailand is an international conference both scientific and exhibition which are organized every 2 years by the Nanotechnology Association of Thailand. The 4th Thailand International Nanotechnology Thailand 2014 was being held from November 25-28 at Convention Center, Thailand Science Park. A total of 30 speakers and over 500 participants were attending consecutively 3 days event. Participants and visitors are from various institutions such as academia, private sector groups, research agencies, and S&T policy officials both Thai and overseas.



◆ *NANOTEC and KLEAN won Silver Prize Award in Korea*

Dr. Kittiwut Kasemwong a NANOTEC researcher from Nano Delivery System Laboratory at NANOTEC and Dr. Kitt Supchukun, Managing Director of KLEAN Greentech Co.,Ltd [whose joint research on “Zeta-Technology” a mycotoxin binding for animal feed pork, poultry, and fish] received the Silver Prize Award at the recent Seoul International Invention Fair (SIIF) 2014 in Korea. Zeta-Technology is a joint research on nanotechnology in selecting various types of nanoclay particles and transform their structure into nanocomposite. The processes helps promote reinforce action, enabling the products to effectively absorb all types of mycotoxin that pose problems in livestock production. In addition, the innovation also received a Special Award from the Association of Polish Inventors and Rationalizers a concurrent event under the name of International Warsaw Invention Show (IWIS).

◆ *Nano Smart Soil Mobile Unit joins Chulalongkorn Watergate 118th Anniversary Celebration*

The Nano Smart Soil Mobile Unit from NANOTEC joins the Pathumthani Governor in celebrating the 118 Years of the operation of Chulalongkorn Watergate on November 18, 2014. The theme of the celebration is traditional, that means that everyone attending the celebration party must wear traditional dress and join in activities depicting the era of 1889.

The Nano Smart Soil Mobile Unit also performed the first field test with water hyacinth at this Watergate on October 1, 2014.

As part of the Nano Smart Soil Mobile Unit promotion activity, members of the NANOTEC team distributed sample smart soil as well as the mobile unit was also on a standby for visit.



◆ *NANOTEC Researcher won Australia -Thailand Young University Researchers Exchange Program Award*

H.E Mr. James Wise, Australian Ambassador to Thailand recently held a congratulation party at his residence for 10 Thai researchers who were selected to participate in the Australia -Thailand Young University Researchers Exchange Program.

Dr. Pisist Kumnorkaew is a researcher from NANOTEC Integrated Nanosystem Laboratory (INS) who one of 10 Thai researchers being invited to participate in the Australia -Thailand Young University Researchers Exchange Program. He will undertake a short research exchange program to work collaboratively with Flinders University in South Australia on the topic of organic photovoltaic.



NANOTEC and Flinders University have developed a mutual friendship collaboration based on science, technology and innovation development of advanced nanotechnology applications.

The program is jointly supported by the Australian Government Department of Education, the Innovative Research University Group, and the Office of the Higher Education Commission with a goal to facilitate science and research collaborations between the two countries, and bring together future research leaders in the hope that they will foster long term relationships.

It also aims to develop early and mid-career Australian and Thai researchers by increasing their understanding of culture, in terms of science and research practices and systems, while developing their leadership skills as future science ambassadors for Australia and Thailand.

◆ *NANOTEC Researcher awarded ASEAN-US Prize for Women in Science*

Dr. Nuttaporn Pimpha is a senior researcher at NANOTEC Hybrid Nanostructure and Nanocomposites Laboratory who is the recipient of the 2014 ASEAN-US Prize for Women in Science Award (in the field of water quality research) for her dedication to research on water quality during the Thailand mega-flood of 2011. The award ceremony took place on August 25, 2014 at the ASEAN Science and Technology Week 2014 in Bogor, Indonesia.

The award supports water quality research aimed at improving the availability of clean and safe drinking water in the ASEAN region and encourages intra-ASEAN and ASEAN-U.S. collaboration on water quality research. This is the first year that the U.S. Department of State and UL (Underwriters Laboratories) has decided to join the ASEAN Committee of Science and Technology to strengthen ASEAN science and technical capacity through an ASEAN-U.S. Science Prize for Women.



◆ *NANOTEC exhibits at nanotech 2015, Japan*

The 14<sup>th</sup> International Nanotechnology Exhibition and Conference (nano tech 2015) considered the world's largest nanotechnology networking venue opened at Tokyo Big Sight, Japan. Thailand exhibition is one of the exhibitors from various countries. The theme of Thailand exhibition is "Nanotechnology in Thailand: Convergent Technologies for Sustainable Development". H.E. Dr. Pichet Durongkaveroj, Minister of Science and Technology together with Prof. Pairash Thajchayapong, Chairman of NANOTEC Executive Board and Prof. Sirirung Songsivilai, NANOTEC Executive Director led the Thailand Team which consisted of research agencies and private sector groups.

One of the highlight of Thailand's exhibition was the electronic sensory machine called E-SenSS which can measure the quantity of various taste-giving compounds such as acidity, sweetness, salinity, spiciness and other variables. E-SenSS can also measure smells and pick out the chemical compounds used to increase the appetite. The machines have electronic sensors that work like the sensory organs of a human being and process the information through a computer system with artificial intelligence and neural networks. E-SenSS will be able to help standardize Thai cuisine which is well known and one of the most popular choices by consumers' worldwide.



◆ *NANOTEC researcher awarded Willey-CST Awards contribute to Green Chemistry 2014*

Dr. Watanyuth Sajomsang, NANOTEC researcher who received Willey-CST Awards contribute to Green Chemistry 2014 for his research paper entitled

"Green Fabrication of Chitosan and Its Derivatives Nanoparticles for Theranostic Applications". The award was presented during Pure and Applied Chemistry International Conference 2015 which was held in Bangkok from January 21 – 23, 2015. Dr. Watanyuth presented a lecture on this research paper at the award ceremony.

Pure and Applied Chemistry International Conference (PACCON) 2015 is organized by the Chemical Society of Thailand under the Patronage of Her Royal Highness Princess Chulabhorn Mahidol and Department of Chemistry, Faculty of Science, King Mongkut's University of Technology Thonburi, under the theme "Innovative Chemistry for Sustainability of the AEC and beyond".



◆ *NANOTEC Research Project Awarded TRF Outstanding Research Award 2014*

NANOTEC research project entitled "Toxicological Evaluation of Silver Nanoparticles-Containing Fabrics" remarkably obtained the Thailand Research Fund (TRF) Outstanding Research Award 2014 on 21 May 2015. The research



project was classified into the category of public research for the safe use of nanomaterials. A NANOTEC Team also revealed that silver nanoparticles were utilized in countless commercial products including textiles in order to prevent the growth of bacterial. It was essential to have scientific data on nanosilver concerning the safety of users and the environment.

◆ *NANOTEC Researchers Awarded at the 43rd International Exhibition of Inventions of Geneva*

Dr. Kittiwut Kasemwong and Dr. Issara Sramala, NANOTEC researcher at Nano Agro and Food Innovation Laboratory and KLEAN Greentech Do.,Ltd, remarkably received a Bronze medal and a special award from Qatar for their joint research on “Zeta-Technology”, which concentrated on a mycotoxin binding for animal feed (pork, poultry and fish), at the 43<sup>rd</sup> International Exhibition of Inventions of Geneva.

The exhibition was organized in Geneva, Switzerland between 15 and 19 April of 2015 with the support of the Swiss Federal Government of the State, the City of Geneva and the World Intellectual Property Organization (WIPO).



◆ *NANOTEC Researchers Awarded an Outstanding Oral Presentation Award*

Dr. Teerapong Yata, NANOTEC researcher at Nano Delivery System Laboratory, received the Outstanding Oral Presentation Award for the research entitled “Engineered M13 Bacteriophage Nanocarriers for Targeted Oral Delivery of DNA Vaccine”, which was classified into the research area of Diseases and R&D for Sustainable Health, at the 23<sup>rd</sup> Annual Medical Science Conference 2015. The conference was held between 25 and 27 March of 2015 with the theme “National Laboratory System for Global Health Security” at Impact Muangthong Thani, Nonthaburi province.



◆ *NANOTEC Participated in HRH Princess Maha Chakri Sirindhorn 60th Anniversary*

To celebrate HRH Princess Maha Chakri Sirindhorn 60th Anniversary, the NSTDA Annual Conference (NAC 2015) was organized under the theme “Science, Technology and Innovation: Princess Sirindhorn's Initiative for the Benefit of Thai Society” during 31 March to 2 April 2015 at Thailand Science Park. The HRH Princess presided at the Royal Opening Ceremony of NAC 2015 on 30 March 2015.

NANOTEC researchers from Mosquito Prevention and Nano-Textile Flagship program including Nanotechnology for Environment Mitigation participated in the scientific conferences at NAC 2015 which received great interest from academia, private sectors and researchers. It provided opportunities for discussion on the research projects and one-on-one discussion between the representatives of private sectors and individuals from business development units in the field of research collaboration and technology licensing.

In addition to intriguing conferences, NANOTEC also welcomed the visit of young students from elementary and high school levels to participate in various basic scientific activities such as synthesis of silver nanoparticles and producing soap from natural herbs. Valuable experiences were provided for students on an actual research laboratory setting. It led to the implementation of positive mindset for them as future scientists

## RESEARCH BREAKTHROUGHS

Iran (Source: INIC)

### ♦ *Production of Nanosorbent in Iran to Remove Aromatic Pollutants*

Iranian researchers from Shahid Bahonar University of Kerman succeeded in the production of a sorbent with comparable advantages over the commercial sorbents in the extraction and removal of pollutants.

The sorbent is produced through a simple and cost-effective method and no disturbing bi-product is produced during the process.

In this study, a polymeric nanocomposite layer was synthesized and used for the extraction and measurement of a type of multi-cyclic aromatic hydrocarbons taken from samples of polluted water.

The nanocomposite can be produced easily and in addition to having a long lifetime, it has also appropriate stability at high temperatures, to the extent that the tests showed that it can be used about 80 times at 280 °C without any changes in sorption properties.

Multi-walled carbon nanotube/poly ortho aminophenol nanocomposite was used in the production of the sorbent. The coating has been deposited on the surface of a wire made of stainless steel as the electrode to measure and adsorb cancerous pollutions in various environments. Real samples have been used in this research to study the validity of the method and its application in the separation and measurement of pollutants, including multi-cyclic aromatic hydrocarbons. Wastewater of coal washing unit, agricultural water near the factory, river water and drinking water of the city were also tested.

Results showed that the produced nanocomposite is able to effectively separate and remove the pollutants.

Results of the research have been published in *Analytical Methods*, vol. 6, issue 23, 2014, pp. 9234-9241.

### ♦ *Enzyme Biosensor Used for Rapid Measurement of Drug*

Iranian researchers produced a new type of enzyme biosensor to increase the speed of clinical diagnosis. The produced biosensor has high selectivity and repeatability while it has low production cost.

Biosensors have been recently used in medical, biological and industrial aspects to increase the speed of diagnosis. According to Bahareh Salehi, the executor of the plan, an enzyme biosensor has been used in this research to selectively diagnose penicillin by using silver nanoparticles. In fact, the role of silver nanoparticles was the facilitation of electron transfer between the elements of biosensor, and as a result, increasing its accuracy and respond speed.

The main application of the results is in pharmaceuticals industries in the production of antibiotics. The biosensor can also be used in medical and biochemical sciences for the production of laboratorial and diagnosis kits. The proposed biosensor is considered as an appropriate replacement for the commonly-used liquid chromatography method. The advantage of the new tool is the simplicity of the production method and application, quick respond, selectivity, repeatability and reasonable production cost.

The penicillinase enzyme has been used in the production of the sensor. This enzyme easily absorbs penicillin even in the presence of disrupting species and provides accurate and desirable responds.

The results showed that the average diameter size of the nanoparticles has been about 90 nm in this research. The effects of temperature changes on the respond speed of the biosensor were studied at the range of 15-85 °C after the production of the sensor and its modification with the synthetic nanoparticles. Observations showed gradual increase in the sensor respond as temperature increased. The maximum value was observed at about 50 °C.



Results of the research have been published in International Journal of Electrochemical Science, vol. 9, issue 11, 2014, pp. 6201-6212.

### ◆ *Production of Special Nanocomposite in Iran with Application in Railways*

Iranian researchers from Sharif University of Technology succeeded in the production of a nanocomposite with appropriate mechanical properties and resistance against various environmental conditions.

The results of the research can be used in the production of insulators which have applications in railways.

The main objective of the research was to replace the commonly-used pieces in railways transportation, specially railways insulator with phenolic/fiberglass nanocomposite. The insulator should have high environmental resistance because it is imposed to various climate conditions during the year.

According to the researchers, the proposed pieces can be used in the body and top of spaceships and spacecraft, which require high strength at harsh environmental conditions, as well as in railways as a composite insulator. The reason is high resistance of phenolic resin against temperature and pressure.

Observations of the researchers showed that the use of clay nanoparticle in the structure of phenolic resin significantly increases the mechanical properties even at low compositions, to the extent that using only 2.5% of the weight of both types of clays in the composite structure results in 45% increase in the value of elasticity module and also an increase in tensile and shear strengths and impact resistance. On the other hand, the replacement of linen fibers that are widely used in railways with fiberglass results in an increase in the strength and environmental resistance.

Results of the research have been published in Composites Part A: Applied Science and Manufacturing, vol. 63, issue 1, 2014, pp. 149-158.

### ◆ *Silver Nanoparticles Produced in Iran from Forest Plants Extract*

Iranian researchers from the Islamic Azad University in [Iran](#) succeeded in the production of silver nanoparticles from the extract of a type of forest plant.

Among the most important advantages of the proposed method, is its simplicity, high speed, independency on expensive devices and biocompatibility.

Silver nanoparticles have special physical and chemical properties and biological activity. After many researches, the application of silver nanoparticles has widely increased, specially in health and hygiene fields. For instance, covering of the wounds, surgery devices and bone prostheses are coated with silver nanoparticles. Therefore, numerous methods have been invented for the production of the nanoparticles, such as chemical and physical deposition, reverse missile, hydrothermal and chemical vapor deposition. Among the present methods, nanophyto synthesis is a green method that has many advantages over other normal methods.

In this research, silver nanoparticles were synthesized through nanophyto synthesis method from the extract of viburnum lantana leaves. The proposed method is fast, simple and biocompatible and does not create any environmental pollution or hazard. The production of these nanoparticles through the proposed method is also cost-effective.

According to the researchers, the produced silver nanoparticles are cubic with average dimension of 48 nm. Studies showed that the antibacterial activity of silver nanoparticles with the cubic shape has a greater effect on microorganisms and cells than those with spherical shape.

Results of the research have been published in Synthesis and Reactivity in Inorganic Metal-Organic and Nano-Metal Chemistry, vol. 45, issue 3, 2015, pp. 381-387.

### ◆ *Graphene Applied in Production of Recyclable Electrodes*

Iranian researchers produced electrodes that increase sensitivity and detection limit of sensors and biosensors using graphene.



The ability to be used a few times by polishing the surface of the electrodes is the most important advantage of the product. Medical and diagnosis clinics and electronics industries can employ the results of the research.

One of the problems in normal modified electrodes is their need to be modified all the time. Therefore, electrodes that are modified in volume manner should be used to solve this problem. Carbon ceramic electrode is one of these electrodes. In this research, graphene was used in the structure of sol-gel instead of graphite to modify chemical and physical properties and increase the performance of carbon ceramic electrode.

The recyclable modified electrode can be used in the production of electrochemical sensors and biosensors. The sensitivity of sensors increases due to the use of graphene instead of graphite.

In this research, graphene was used for the first time in the structure of sol-gel-based electrodes. Graphene has many advantages over graphite and carbon nanotubes. It is a semi-conductor with zero band gap, and therefore, it has extraordinary high electrical conductivity. In addition, it has very desirable mechanical strength (about 200 times of steel) although it is very light.

Based on the results, the produced electrochemical sensor has high sensitivity, low detection limit and appropriate repeatability. It also has lower potential for the electrocatalytic oxidation of ascorbic acid in comparison with carbon ceramic electrode.

Results of the research have been published in *Microchimica Acta*, vol. 181, issue 15-16, 2014, pp. 1879-1885.

## ◆ *Iranian Scientists Take Step towards Production of Edible Insulin*

TEHRAN (INIC)- Iranian researchers from Endocrinology and Metabolism Research Institute of Tehran University of Medical Sciences studied and produced a drug nanosystem at laboratorial scale to achieve edible insulin.

The nanodrug increases the diffusivity of insulin to intestinal wall and decreases degradation against enzymes. Biocompatible and non-toxic nanoparticles have been used in the production of the nanodrug.

The main objective of the research was to open an edible path for peptide drugs, including insulin, increase the simplicity of insulin consumption for diabetic patients and take a step towards the treatment of diabetes.

Dr. Kobra Omidfar, one of the researchers, explained about the importance of the research, and said, "The most important challenges in the use of insulin as an edible drug are the degradation of insulin by numerous enzymes of digestive system, non-diffusivity of insulin macromolecule through intestinal wall, numerous blocks on the way of insulin to reach blood and its sudden release in inappropriate place. In order to overcome those problems in this research, niosome nanoparticle coated with trimethyl chitosan was synthesized and its ability to carry insulin in an edible manner was studied at laboratorial environment."

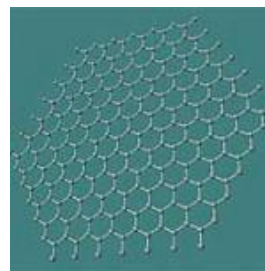
According to the results, the produced nanodrug prevents the degradation of insulin by trypsin and it significantly increases the diffusivity of insulin macromolecule through intestinal single-layer wall. Moreover, a test was carried out in the simulated environment of intestine, and it was observed that the nanodrug leads to delay release of insulin.

According to the researcher, the results lead to an increase in diffusivity of insulin through intestinal wall, decrease in enzyme degradation of insulin and increase in insulin release time. Achieving these objectives results in reduction of frequency of insulin consumption and elimination of pain due to insulin injection in diabetic patients.

Results of the research have been published in *Materials Science and Engineering: C*, vol. 46, issue 1, 2015, pp. 333-340.

## ◆ *Iranian Scientists Refine Wastewater of Nuclear Power Plants Using Nanoparticles*

Iranian researchers from Zabol University designed and produced a type of sorbent nanoparticles to extract small amounts of uranium from wastewater.



The nano-sorbent is able to detect low concentrations of uranium in the outlet stream of nuclear power plants, and it can extract more than 94.5% of uranium from different media.

Uranium is found at low concentrations in aqueous and non-aqueous outlet streams of nuclear reactors. However, low concentrations of this material can be harmful too. Therefore, the outlet streams should be refined so the least possible amount of uranium is released to the environment.

The researchers used zinc oxide/chitosan nano-sorbents to extract low concentrations of uranium from aqueous media. They also carried out the modeling process by using artificial neural network.

Zinc oxide nanoparticles can be used as an effective nano-sorbent due to their semi-conductive properties. These nanoparticles can be used with chitosan in form of hybrid to increase their desirable properties.

This research studies and compares detection limit and concentration factor with some other methods, including liquid-liquid distributing micro-extraction, solid phase of silica-gel and the polymer used for uranium extraction. Results showed that this method has a concentration factor much higher than that of other methods, and it also has appropriate detection limit.

According to the researchers, results also showed that the concentration factor is 125 for this method, while it has been reported 11, 50, and 108 for liquid-liquid distribution micro-extraction, solid phase of silica-gel and polymeric solid phase, respectively.

Results of the research have been published in *Chemometrics and Intelligent Laboratory Systems*, vol. 135, 2014, pp. 70-75.



### ♦ *Iranian Scientists Evaluate Dynamic Interaction between 2 Carbon Nanotubes*

Iranian researchers from Khajeh Nasir Toosi University of Technology in a theoretical study investigated the dynamic interaction between two perpendicular carbon nanotubes.

Results of the research have applications in the designing of nanosensors, medical nano-tools and electromechanical devices.

Carbon nanotubes have attracted the attention of many researchers in recent decades due to their desirable physical, chemical and mechanical properties. Although some studies have been carried out on the synthesis of nanotubes through the both horizontal and vertical shapes, no attention has been paid to the growth or the modeling of a complex containing both vertical and horizontal structures. Forest and membrane structures of carbon nanotubes have numerous applications.

Understanding the mechanical behavior of a system containing two single-walled carbon nanotubes beside each other is an introduction to understand the mechanical behavior of forest and membrane structures. Therefore, this research tries to present appropriate mechanical models to apply van der Waals force between two single-walled carbon nanotubes, and to evaluate the dynamic interaction between them.

Results of the research have applications in designing and analyzing nanomembranes and electromechanical nano-devices based on single and multi-walled carbon nanotube structures. According to the researchers, the change in van der Waals force was calculated due to the relative transverse movement of the two nanotubes in the presented model, and its effect on the movement of nanostructures containing perpendicular nanotubes was investigated.

Among the other new achievements of the research, mention can be made of the effect of shear deformation on the main frequency of the system and the ability of nonlocal Timoshenko Theory in the prediction of results obtained from high degree shear nonlocal theory.

Results of the research have been published in *Composite Structures*, vol. 125, issue 1, 2015, pp. 144-158.

### ♦ *Newly-Developed Nanocatalysts Increase Performance of Fuel Cells*

Iranian researchers used nanotechnology and produced a type of nanocatalyst which modifies the performance of fuel cells.

Natural materials with large and rich sources in the country have been used in the production of the catalyst. Therefore, the production of the catalyst is cost-effective. The application of fuel cells provides the opportunity to produce energy without creating any environmental pollution.

In this research, efforts have been made to produce appropriate catalysts to be used in methanol fuel cells by using carbon paste cheap electrodes and their modification with desirable intermediates. Electrical energy is produced in methanol fuel cells through the chemical oxidization of methanol.



The efficiency of the fuel cell increases when methanol oxidizes easily. However and due to some problems such as the slow oxidation of methanol and the pollution on the surface of normal electrodes, it is very important to produce new catalysts to overcome the limitations. Therefore, carbon paste electrode modified with clinoptilolite natural zeolite nanoparticles ion exchanged with nickel (II) cation were used in this research as the catalyst to oxidize methanol.

Reducing the potential required for the oxidation of methanol on the electrode surface and creating larger current are equal to the better efficiency of the fuel cell, which are very important from economical point of view. The catalyst produced in this research decreases the voltage required for methanol oxidation up to 500 mV in comparison with platinum electrode, and it significantly increases the produced current. In other words, methanol oxidizes very easily in the presence of this catalyst.

Results of the research have been published in *ELECTROCHIMICA ACTA*, vol. 147, issue 1, 2014, pp. 572-581.

### ◆ *Nanocomposites Play Effective Role in Production of Smart Fibers*

An Iranian researcher from Yazd University studied the effect of the presence of nanocomposites on the structure and final properties of propylene fibers.

The application of the proposed nanocomposite increases the tonality and improves humidity permeability and abrasive strength of the fibers. The results have applications in textile, medical, foodstuff and automobile-manufacturing industries.



This research studied some of the final properties of polypropylene fibers after the addition of silver/zinc antibacterial nanocomposite during the production process. Weakness in tonality, permeability and abrasion strength are among the important problems of polypropylene fibers. Therefore, this research studies the effect of inorganic and metallic nanostructures on the properties of antibacterial nanocomposite yarns.

In more specific words, humidity permeability changes versus temperature were observed in these nanocomposites, to the extent that the permeability of the optimum nanocomposite sample is 11.2% lower than the pure sample at 22 °C, which helps the conservation of the body temperature at cold climates, and increases the comfort of the clothes. However, the permeability increases in all samples when the temperature increases to 35 °C.

The permeability increase is about 21% in the pure sample while an increase of 122% is observed in the nanocomposite sample. Therefore, permeability significantly increases in the nanocomposite sample in comparison with the pure sample as temperature increases. Increase in permeability at high temperature eases heat transfer from the body through sweating, and it helps the comfort of the clothes. In addition, an increase of 133% was observed in the tear point in the optimum nanocomposite samples.

Results of the research have been published in *Journal of Engineered Fibers and Fabrics*, vol. 9, issue 4, 2014, pp. 39-44.

### ◆ *Scientists Find New Method to Determine Anti-Depression Drug in Biological Samples*

Iranian researchers from Bu-Ali Sina University of Hamedan succeeded in the production of a sensor which can be used in a sensitive tool to measure an anti-depression drug.

The sensor can be considered as a good replacement for complicated and costly methods due to its high sensitivity and accuracy, and its low production cost.

The project was carried out to measure fluvoxamine maleate drug by using a modified electrode with high sensitivity in biological samples. Many methods have so far been reported for the measurement of this drug, including liquid chromatography (HPLC), gas chromatography, capillary electrophoresis and polarography. Despite their advantages, all these methods have problems and limitations, including the use of organic and toxic solvents or the use of toxic mercury in polarography method. Moreover, some of the methods are very expensive. The aim of the research was to present a quick, sensitive and cheap method with low environmental pollution.

Comparison between the results obtained from this method and those obtained from HPLC shows that the proposed sensor has a better performance. Therefore, this method can be used as a cheap method to replace the costly HPLC method. Another advantage of this method is that it does not require organic solvents at large volume in comparison with HPLC, which results in less environmental pollution.

Mercury nanoparticles have been used in the production of the sensor. Therefore, the application of this method is much easier and results in less pollution than polarography method that uses enormous amount of the toxic metal of mercury.

Results of the research have been published in *Sensors and Actuators B: Chemical*, vol. 210, issue 1, 2015, pp. 259-266.

## ◆ *Production of Gas Nanosensor with Industrial, Home Applications*

Academic researchers used nanotechnology to produce a sensor with high sensitivity and detection range, which enables the on-time detection of gas emission.

The sensor has been made of cheap materials through a simple and controllable method.

Today, tin dioxide is known as a precursor in ceramic, catalytic, and electronic industries. Production of gas sensors is one of the applications. Tin dioxide is not practically used alone, and it should be used with an additive, mostly one of the noble metals. The researchers studied the effect of the presence of silver as a noble metal on a sensor made of tin dioxide.

According to the researchers, other materials, including palladium and platinum had been used as sensitive materials in order to produce gas sensors. However, the application of silver in this research results in the production of a gas sensor with much better properties than palladium and platinum in gas detection.

It seems that the production of this sensor saves the life of many people from death caused by carbon monoxide when the sensor is used in refinery plants and even in houses. In addition to the abovementioned application, tin dioxide/silver nanocomposite has other applications in solar cells, photocatalysts, catalysts, and in general terms, in electrical sensors and places where the material sensitivity becomes important for conductivity purposes.

Results of the research have been published in *Synthesis and Reactivity in Inorganic Metal-Organic and Nano-Metal Chemistry*, vol. 44, issue 5, 2014, pp. 759-764.

## ◆ *Application of Graphene Oxide in Body Implants*

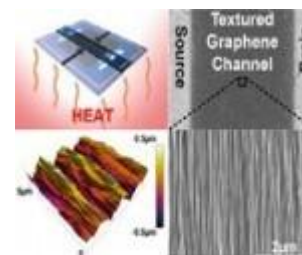
Iranian researchers from Kashan University synthesized a nanocomposite which can be used in tissue engineering.

The biocompatible nanocomposite is highly strong and no toxic or harmful solvent has been used in its production.

Hydroxyapatite is one of the most valuable biocompatible compounds in the production of bone implants. However, hydroxyapatite cannot be used solely due to its low strength and fragility. Composites of hydroxyapatite are made and used to increase its mechanical properties.

In this research, a nanocomposite was made of graphene oxide/hydroxyapatite/chitosan that can be an appropriate bed for the growth of bones. This nanocomposite has better biocompatibility properties than the pure hydroxyapatite nanoparticles.

Since no toxic or expensive materials were used in the production of this nanocomposite, it can be expressed that the reduction in costs and environmental pollutions are among the most important advantages of the research. The



nanocomposite has been produced through the novel method of freeze drying. This method conserves the porous structure of chitosan in the final product contrary to thermal methods.

In this research, colloid solution containing hydroxyapatite nanoparticles, chitosan and graphene oxide converts into ice in freeze drier device. In this stage, chitosan chains are entrapped in ice crystals. In fact, a consistent network of ice crystals is formed, which is surrounded by chitosan. In the end, the melting of ice crystals in the drying process and their elimination from the networked formed by chitosan creates a very porous scaffold.

Improving mechanical properties and bioactivity of graphene oxide/hydroxyapatite/chitosan nanocomposite in comparison with pure hydroxyapatite nanoparticles is among the important achievements of the research.

Results of the research have been published in RSC Advances, vol. 4, 2014, pp. 25993-25601.

### ◆ *Perfect Optical Properties in Production of Aluminum Oxide Colloid Nanoparticles*

TEHRAN (INIC)- Iranian researchers produced nanoparticles in forms of colloids which have very good optical properties and conserve their stability for a long time.

Aluminum oxide colloid nanoparticles have applications in various fields and industries, including laser, solar cells, production of transistors and nanomedicine. The colloid form of these particles have very interesting properties and characteristics, and their size, shape and properties at nanometric scale can be controlled very well.

According to the researchers, the stability of nanomaterials in long period is one of the most important challenges in the production of nanomaterials. The large difference between surface and volume energy of nanoparticles is the cause of this problem. This energy gap, in addition to other parameters such as density difference in electrical charges and type and density of surface atoms, which are affected by the morphology of the particles, prevent the easily formation of a stable colloid. These parameters in addition to other obstacles such as the creation of stable chemical complexes in an uncontrolled situation prevents the formation of alumina nanoparticles in form of colloid, and therefore it is very important to select a certain method to obtain the desirable results.

The produced nanoparticles have very high stability and appropriate optical properties, and they can be used in the production of optical devices. Taking into account the desirable optical properties of the produced nanoparticles, it is expected that an important step is taken in the development of nanotechnology in the field of medicine, electronics and photonics after passing the required tests and obtaining mass-production of these nanoparticles.

### ◆ *Best Conditions for Synthesis of Gold Nanolayers*

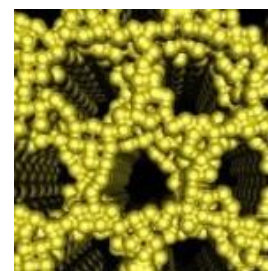
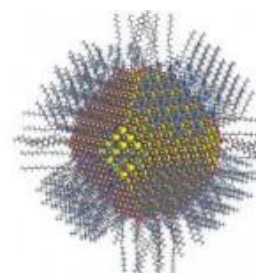
Researchers from Bu-Ali Sina (Avicenna) University in association with an Iranian enterprise tried to detect effective parameters in the synthesis of gold nanocoatings.

The optimum conditions can be used in the devices to produce nanometric layers by applying the results of the research and the costs can be reduced.

Thin layers have applications in electronic, microelectronic and optical industries. Gold thin films have wide applications in microelectromechanical systems, sensors, electronic fabrics, bioengineering systems and so on. These applications are the result of desirable properties of gold, including high chemical stability, oxidation resistance and good biocompatibility.

The aim of the research was to get to know thin layers and specific properties of gold at nanometric scale. To this end, the researchers studied the creation of gold nanoparticles through physical vapor deposition method, the distribution of nano-micro gold particles at various thicknesses and the effect of temperature on the particles before and after the annealing process.

There will be no need for trial and error method in the creation of gold nanoparticles by using the results of the research. In addition, the increase in the rate of the production of these nanostructures and reducing the production cost will be



possible due to the high accuracy and sensitivity of the method in the creation of gold nanoparticles and the prevention of formation of gold oxide during and after the process.

### ◆ *Nanosorbents Reduce Amount of Heavy Metals in Petrochemical Wastewater*

Iranian researchers used zero capacity iron nanoparticles to decrease the amount of heavy metals in wastewater produced by refineries.

This structure has high adsorption capacity and can be easily recovered and reused.

Heavy metals, including lead, copper, cadmium, chrome, zinc and nickel are the most common metal pollutants that are found in industrial wastewater. These metals are toxic to humans and other living creatures even at low concentrations, and it is necessary to eliminate them from the wastewater before being released in the environment.

Adsorption is one of the simplest and most economic separation methods, which can be used in the elimination of pollutants such as chrome from the wastewater. Although active carbon is the most common used sorbent to adsorb chrome, researchers try to find other sorbents with high sorption capacity and ease of recovery due to the difficult and expensive recovery of active carbon. Iron is one of the most available elements on earth, which can be used as an ideal option for the elimination of pollutants.

The present research studied the elimination of chrome and reduction of oxygen required for the oxidation of the wastewater of an Iranian petrochemical unit by using zero capacity iron and iron oxide nanoparticles, and it compared the results.

The results showed that zero capacity iron nanoparticles can be used as an effective agent in the elimination of chrome existing in petroleum wastewater. The efficiency of the purification increases as the amount of zero capacity iron nanoparticles and the time of the application of ultrasonic waves increase.

### ◆ *Self-Cleaning Woolen Fabrics Produced in Iran*

Iranian researchers produced woolen fabrics at laboratorial scale, which have antibacterial and antifungal properties.

The produced samples show self-cleaning properties too under the radiation of sunlight.

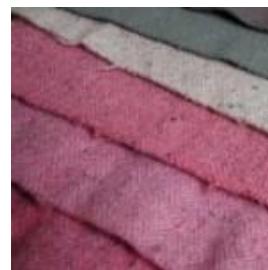
Woolen products are very good sources for the growth of bacteria and microorganisms due to their protein structure, and they are sensitive to alkaline and sunlight, and they have strength limitations.

According to Amir Behzadnia, one of the researchers, this study was carried out aiming to improve the properties of woolen products through special finishing process, including increasing the self-cleaning, antibacterial, antifungal, acidic and alkaline resistance. This objective was achieved by creating a homogenous coating made of a nanocomposite of zinc oxide/nitrogen – silver (N-Ag/ZnO) on the fabrics.

Based on the results, the processing of the woolen fabric samples by using optimum amount of honeycomb nanocomposite such as N-Ag/ZnO improves the biological, mechanical and hydrophilicity of the fabrics. Among the other advantages of the use of this nanocomposite in the production of fabrics, mention can be made of creating a delay in flammability, increasing the whiteness degree and decreasing the alkaline and acidic solubility without creating the cellular toxicity.

Results of the research have applications in textile, polymer, and ceramic industries and in other applicable surfaces. They can also be used in medical and military industries.

Ultrasonic bath has been used in the finishing process of the fabrics. By using the bath, the process is carried out in one stage at low temperature at shorter time. Ultrasonic waves are also the cause of the homogenous distribution of simultaneous charges of silver and nitrogen on the surfaces of zinc oxide nanoparticles. Finally, the abovementioned properties are created in the final product by processing of the woolen fabrics with the nanocomposite.



**Japan** (source: NIMS)

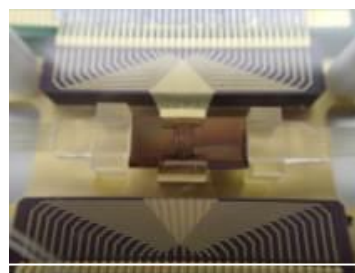
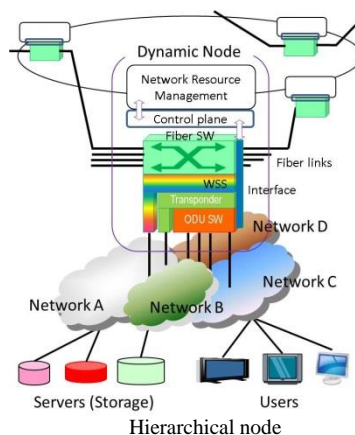
◆ *Ultra-low-energy “path on demand” optical network for video related applications*

Growing video traffic that dominates the Internet traffic will soon cause a serious energy crunch at electronic routers. As an effective solution, AIST, Ibaraki, Japan, has proposed Dynamic Optical Path Networks (DOPN)<sup>1,2</sup> that offloads the video traffic from IP networks to fast circuit-switched optical networks, and launched a research project, called “VICTORIES,” in collaboration with NTT Corporation, FUJITSU LABORATORIES LTD., Furukawa Electric Co., Ltd., Trimatiz Limited, NEC Corporation, Fujitsu Limited, Fujikura Ltd., Alnair Labs Corporation, Sumitomo Electric Industries, Ltd., and KITANIHON ELECTRIC CABLES CO., LTD.. “VICTORIES” stands for the Vertically Integrated Center for Technologies of Optical Routing toward Ideal Energy Savings, which is partly supported by

Project for Developing Innovation Systems of MEXT, Japan.

Recently, the VICTORIES project succeeded in building an eight-node DOPN testbed<sup>3</sup> by developing ODU cross-connects, CDC-ROADMs, and fiber cross-connects in a hierarchical manner, and enabled multi-granular traffic control. In common with Software Defined Networking, DOPN is equipped with a separate control plane and a Network resource Management System (NMS) in compliance with OGF Network Services, v. 2.0 (NSI-CS) protocol, which manages and controls the hierarchical network. As specific applications, AIST developed 4K-Video on Demand (VOD) and Video Conferencing (VC) services. NSI-CS is the only international standard protocol that supports advance reservation, which is essential for VOD and VC. DOPN successfully offers “path on demand” for 4K-VOD and VC services. The testbed is capable of controlling 90 Tbps traffic, with a measured power consumption of only 6 kW, orders of magnitude lower than the IP network with an equivalent capacity.

Commercialization of DOPN requires a cost-effective option of the fiber switch. The fiber switch, therefore, is preferred to be of integrated device. AIST has been developing integrated fiber switches utilizing silicon photonics technology and succeeded in fabricating an 8×8 switch thus far<sup>4</sup>. One of the testbed nodes actually employs a polarization-insensitive dual 4×4 fiber switch based on silicon photonics, fabricated in a CMOS facility of AIST that features immersion ArF lithography. To prototype such switches in the CMOS facility gives a good opportunity to clarify potential issues toward volume production. AIST is planning the fabrication of an integrated 32×32 switch in the near future, while the testbed will be utilized to evaluate not only technologies enabling DOPN but also applications enabled by DOPN.



4×4 Si-Photonics SW

◆ *Nanoarchitectonics of Photocatalytic Materials for Efficient Solar Fuel Production & Environment Remediation*

Semiconductor photocatalysis offers a potential solution for the worldwide energy shortage and environmental pollution issues by solar fuel production as well as environment remediation utilizing solar energy. In NIMS, we have been challenging possibilities of nano-photocatalytic materials, by exploring new materials via energy band engineering for more efficient harvesting of solar light, controlling of surface/interface nano-structures for achieving higher reactivity, and unveiling reaction mechanism from both experimental and theoretical approaches. In this News Letter, we introduce three recent research



Fig. 1. Schematic illustration and comparison of the structure and key processes in (Upper panel) natural photosynthetic system and (Lower panel) artificial photosynthetic system

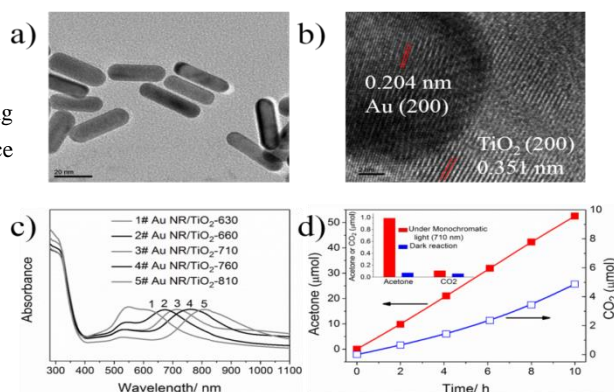
topics:

## 1) Learn from Nature:

As a nano-life science-inspired nanoarchitectonics, here we demonstrate an unique strategy for constructing a promising 3D artificial photosynthetic system. By using leaves of cherry tree as the template, we have successfully fabricated perovskite titanates with the 3D hierarchical architectures that mimic the structure of natural photosynthetic system in multi-scaled levels (Fig. 1). As a result of efficient mass flow/light harvesting network in such a special structure, the conversion efficiency of CO<sub>2</sub> into hydrocarbon fuels (CH<sub>4</sub>) has been significantly improved (ref. 1).

## 2) Nano Metal-Photosensitized Titanium Dioxide with Wide-Range Visible-Light Harvesting:

In order to fully utilize solar energy, it's highly desirable to develop photocatalytic materials that harvest photons in a wide range of visible or even infrared light. Recently, we have succeeded in applying the phenomenon of localized surface plasmon resonance (LSPR) of nano metal to expand the active region of TiO<sub>2</sub> from UV to visible and even near-infrared light by sophisticatedly tuning the aspect ratio of Au nanorod (NR) via a seed-mediated synthetic route (ref. 2). Figure 2 shows the morphology as well as the photocatalytic performance of Au NRs sensitized TiO<sub>2</sub>. It's found that not only transversal plasma which is similar to sphere Au particles (~520 nm), but also longitudinal plasma of Au NRs in visible-infrared light region could be observed, corresponding to the oscillation of the free electrons along and perpendicular

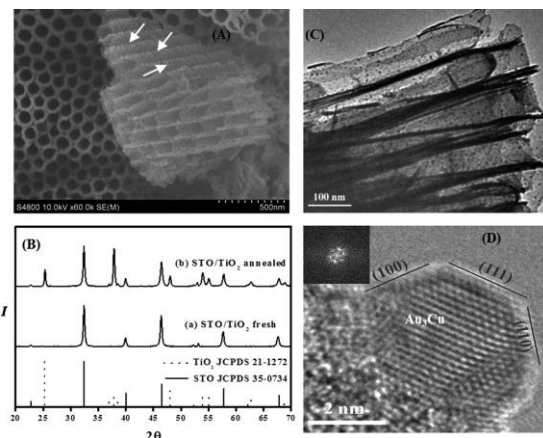


**Figure 2** TEM images of a) Au NR, and b) Au NR/TiO<sub>2</sub>-660 photocatalyst. c) UV-vis diffuse reflectance spectra of Au NR/TiO<sub>2</sub> photocatalysts with different Au NR aspect ratio, and d) photocatalytic oxidation of IPA over Au NR/TiO<sub>2</sub>-710 under visible light irradiation (400<λ<820nm) as a function of reaction time. Inset: reaction carried out under monochromatic light (710nm).

to the long axis of the rods. Figure 2d) shows the photocatalytic oxidation of volatile organic compounds IPA under a wide range of visible light 400<λ<820 over sample 3, Au NR/TiO<sub>2</sub>-710. IPA was found to be decomposed to acetone firstly and then to CO<sub>2</sub> finally, not only under visible light irradiation, but also under monochromatic light as long as 710 nm, demonstrating clearly the contribution of longitudinal plasma of gold NRs in the photocatalytic reaction.

## 3) Highly efficient conversion of CO<sub>2</sub> to CH<sub>4</sub> on SrTiO<sub>3</sub>/TiO<sub>2</sub> Coaxial Nanotube Arrays

More recently, we have introduced four approaches to realize efficient solar-energy-driven conversion of CO<sub>2</sub> into hydrocarbon fuels (ref. 3). First, we combined two known semiconductor photocatalysts strontium titanate (STO) and titania (TiO<sub>2</sub>) – which led to the separation of the charges generated by light and hence a more effective photocatalysis. Second, the high surface area of the nanotubes was made greater by holes in the tube surfaces (Fig. 3), which enhances catalysis by increasing the contact between the gases and catalysts. Third, the tubes were decorated with gold-copper (Au<sub>3</sub>Cu) nanoparticle



**Fig. 3** A) Scanning electron microscope image and B) X-ray diffraction pattern of strontium titanate (STO)-titania (TiO<sub>2</sub>) coaxial nanotube arrays; C) transmission electron microscope image of Au<sub>3</sub>Cu@STO/TiO<sub>2</sub> nanotube arrays; D) High-resolution transmission electron microscope image and fast Fourier transform pattern of Au<sub>3</sub>Cu nanoparticles

co-catalysts to further enhance the catalysis, and fourth, hydrous hydrazine (N<sub>2</sub>H<sub>4</sub>•H<sub>2</sub>O) was used as the source of hydrogen. A combination of these approaches enables an increase of hydrocarbon generation from CO<sub>2</sub> by a factor of ten. This work is believed to offer a new approach to lead to a breakthrough in efficiency of oxide-based solar chemical conversion.

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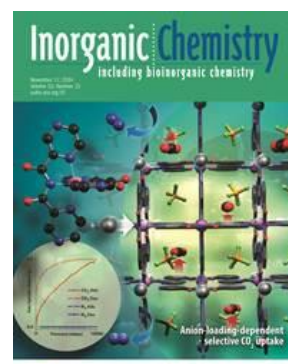
- 1) Han Zhou, Jianjun Guo, Peng Li, Tongxiang Fan, Di Zhang, Jinhua Ye\*, "Leaf-architected 3D Hierarchical Artificial Photosynthetic System of Perovskite Titanates Towards CO<sub>2</sub> Photoreduction Into Hydrocarbon Fuels", *Scientific Reports* 3 (2013) 1667.
- 2) Lequan Liu, Shuxin Ouyang, Jinhua Ye\*, "Gold-Nanorod-Photosensitized Titanium Dioxide with Wide-Range Visible-Light Harvesting Based on Localized Surface Plasmon Resonance", *Angew. Chem. Int. Ed.*, 52, 6689-6693, 2013.
- 3) Qing Kang, Tao Wang, Peng Li, Lequan Liu, Mu Li, Kun Chang, and Jinhua Ye\*, "Photocatalytic Reduction of Carbon Dioxide by hydrous hydrazine over Au-Cu Alloy Nanoparticles Supported on SrTiO<sub>3</sub>/TiO<sub>2</sub> Coaxial Nanotube Arrays", *Angew. Chem. Int. Ed.*, 54, 841–845, 2015.

### New Zealand (Source: Univ. of Canterbury)

#### ♦ *Front Cover of Inorganic Chemistry*

Doubling the anion occupancy in the channels of the metal organic framework (NiII-based MOF → Co<sup>III</sup>-based MOF) increases the observed adsorption selectivity for CO<sub>2</sub> over N<sub>2</sub>. These robust isostructural MOFs were assembled using AgBF<sub>4</sub> to activate the secondary coordination instructions present in the carefully designed monometallic pyrazine imide complexes of nickel(II) and cobalt(II or III).

Cover created by Michael Crawford (Dunedin) from a concept provided by Sally Brooker." See 2014 paper in *Inorganic Chemistry*: M. G. Cowan, R. G. Miller, P. D. Southon, J. R. Price, O. Yazaydin, J. R. Lane, C. J. Kepert, and S. Brooker, *Inorg. Chem.* 2014, 53, 12076-12083



#### ♦ *the effect of Post Deposition Heat Treatment (PDHT) on the structural, compositional and surface characteristics of HA films deposited on Ti-6Al-4V*

Publication: Abdul Azis, S.A., Kennedy, J., Murmu, P.P., Fang, F., Cao, P. , Structural and compositional characterization of ion beam sputtered hydroxyapatite thin films on Ti-6Al-4v, *Asian Journal of Applied Sciences* Volume 7, Issue 8, 2014, Pages 745-752

Ion Beam Sputtering (IBS) technique has been used to prepare a series of hydroxyapatite (HA) thin films on Ti and Ti alloy substrates for biomedical application. We report the effect of Post Deposition Heat Treatment (PDHT) on the structural, compositional and surface characteristics of HA films deposited on Ti-6Al-4V. The films underwent PDHT for 2 h at 300, 400, 500 and 600 °C under air environment. After PDHT, the structure and the chemical composition of the films were characterized using Rutherford Backscattering Spectrometry (RBS), X-ray Diffraction (XRD), Fourier transform infrared absorption spectrometry (FTIR) and Scanning Electron Microscopy (SEM). The results showed that the crystallinity of HA increased with temperature. However, SEM results revealed that some cracks were observed if the temperature of PDHT was higher than 600 °C. FTIR measurements showed that the existence of hydroxyl and phosphate bands in all films increased with temperature. RBS analysis indicated that the as-deposited films had a low Ca/P ratio which increased to stoichiometric value with increasing PDHT temperature. From this study we suggest that 600 °C is probably the best PDHT temperature to obtain a better characterization and surface properties of HA film produced by IBS. It can also be concluded that IBS can be used as an alternative method for deposit HA film on titanium alloy substrate.

#### ♦ *Electrochemical detection of intracellular and cell membrane redox systems in *Saccharomyces cerevisiae**

Scientific Reports: Rawson, F.J., Downard, A.J., Baronian, K.H., Volume 4, 9 June 2014, Article number 5216

ISSN: 20452322 DOI: 10.1038/srep05216

Redox mediators can interact with eukaryote cells at a number of different cell locations. While cell membrane redox centres are easily accessible, the redox centres of catabolism are situated within the cytoplasm and mitochondria and can

be difficult to access. We have systematically investigated the interaction of thirteen commonly used lipophilic and hydrophilic mediators with the yeast *Saccharomyces cerevisiae*. A double mediator system is used in which ferricyanide is the final electron acceptor (the reporter mediator). After incubation of cells with mediators, steady state voltammetry of the ferri/ferrocyanide redox couple allows quantitation of the amount of mediator reduced by the cells. The plateau current at 425 mV vs Ag/AgCl gives the analytical signal. The results show that five of the mediators interact with at least three different trans Plasma Membrane Electron Transport systems (tPMETs), and that four mediators cross the plasma membrane to interact with cytoplasmic and mitochondrial redox molecules. Four of the mediators inhibit electron transfer from *S. cerevisiae*. Catabolic inhibitors were used to locate the cellular source of electrons for three of the mediators.

### Singapore (Source: IMRE)

#### ♦ Full-colour photorealistic printing at the nanoscale

A team of researchers from IMRE, NUS and SUTD have created the first plasmonic palette utilising colour generation strategies for photorealistic printing with aluminium nanostructures. This work expands the visible colour space through spatially mixing and adjusting the nanoscale spacing of discrete nanostructures. Using aluminium as the plasmonic material instead of commonly-used plasmonic materials such as gold and silver, the research team achieved a full colour range for super-resolution colour printing with enhanced durability and dramatically-reduced materials costs, while operating in size regimes that are scalable to higher-throughput approaches such as photolithography and nanoimprint lithography. The researchers highlighted the versatility and quality of aluminium plasmonic pixels by reproducing a Monet masterpiece in the form of a plasmonic “micropainting” which measured a mere 200 by 250-micrometres.

The team fabricated isolated plasmonic aluminium nanodisks that are able to scatter light of different wavelengths which manifests as colour in the visible regime. The colours generated can be tuned by controlling the size of each nanodisk, and new colors can be generated by “mixing” nanodisks of different sizes or adjusting the relative position of nanodisks within a defined pixel. This builds upon their previously-published technique of printing plasmonic colours, which eliminates the use of conventional colour dyes and enables super-resolution colour printing up to 100,000 dpi.

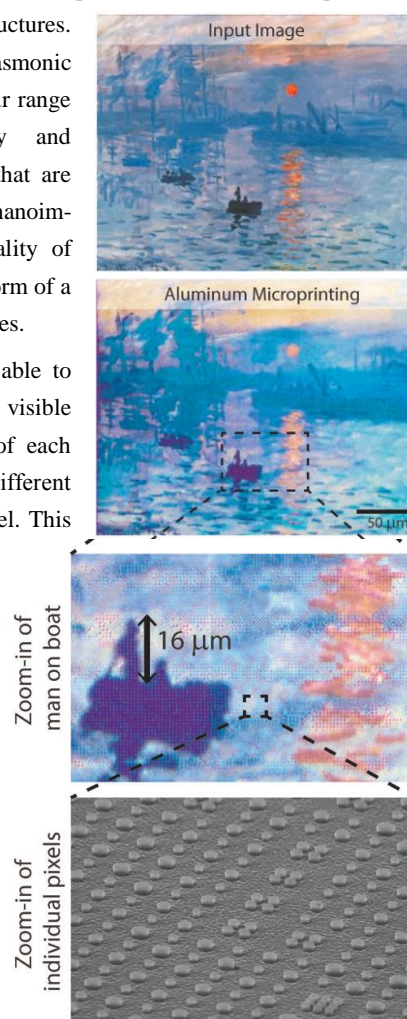
The advances in the plasmonic colour printing technology could pave the way toward a new generation of low-cost, high-resolution colour printing with direct applications in anti-counterfeiting, security tagging, cryptography, and information storage.

For more information about the publication, please contact Dr Shawn Tan [shawn-tan@imre.a-star.edu.sg](mailto:shawn-tan@imre.a-star.edu.sg).

Publication: Zhongyu Cai, Yan Jun Liu, Xianmao Lu, and Jinghua Teng; “Fabrication of Well-Ordered Binary Colloidal Crystals with Extended Size Ratios for Broadband Reflectance”; ACS Appl. Mater. Interfaces, 2014, 6 (13), pp 10265–10273.

#### ♦ New, improved binary colloidal crystals for a variety of applications

IMRE researchers, together with an IMRE-attached PhD student, developed a new method to fabricate non-close packed Binary Colloidal Crystals (BCCs) with extended size ratios and well-ordered crystalline structures as compared to previously reported BCCs fabricated by the conventional convective self-assembly method. The extended size ratios give the BCCs more freedom in terms of the tuning of the bandgap and optical properties. The well-ordered crystalline structure gives better crystal quality, and thus better optical performance.



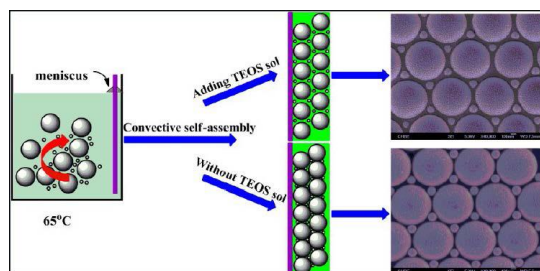
BCCs have excellent potential in tuning material properties via the control of the size ratio of small to large colloidal spheres ( $\gamma$ S/L). IMRE's BCCs are fabricated by co-assembling hydrolysed TEOS with PS spheres. The researchers found that  $\gamma$ S/L can be extended to 0.376 by adding TEOS sol into the colloidal suspension. The resulting polystyrene/silica (PS/SiO<sub>2</sub>) BCCs show

distinctive reflections, indicating their well-ordered structure. The extended size ratios render more flexibility in engineering the photonic bandgap structures of BCCs and hence provide a better platform for developing a range of applications such as photonics, spintronics, sensing and bioseparation.

BCCs can be used for sensing, protein patterning, photovoltaics, and in bioseparation. The team used the newly developed BCCs for solvent sensing because of the refractive index changes of different stimuli. The features of the new BCC gives researchers the freedom to tune the bandgap of the 3D photonic crystal structures, which can result in property changes such as getting a broader reflectance than those of conventionally fabricated BCCs.

For more information about the publication, please contact: Dr Teng Jinghua, [jh-teng@imre.a-star.edu.sg](mailto:jh-teng@imre.a-star.edu.sg)

**Publication:** Zhongyu Cai, Yan Jun Liu, Xianmao Lu, and Jinghua Teng; "Fabrication of Well-Ordered Binary Colloidal Crystals with Extended Size Ratios for Broadband Reflectance"; ACS Appl. Mater. Interfaces, 2014, 6 (13), pp 10265–10273.



Comparison of BCC fabrication using conventional and improved convective self-assembly methods.

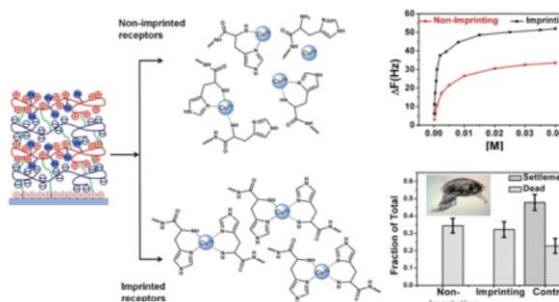
## ◆ New active film for effective marine antifouling

Researchers from IMRE have developed an imidazole containing peptide, such as L-histidine methyl ester, bound to metal ions that can be used in an active antifouling film. The active film is grafted on polyallyl amine to create an efficient antifouling surface and to improve the performance of antifouling paints.

Antifouling paints reduce hull fouling because they contain copper, among other metals such as zinc and nickel. Copper is a heavy metal that is toxic to marine invertebrates affecting their reproduction, growth, and abundance. It is also a pollutant in the marine environment, especially close to docks and harbours, because it leaches from the hulls of boats into the surrounding water. The research team used the very efficient imidazole containing peptides, such as L-histidine methyl ester grafted on polyallyl amine to construct thin layer by layer (LbL) architectures with high affinity to bind Cu<sup>2+</sup> ions. Enhanced

binding ability is achieved through a metal imprinting process involving covalent immobilisation of receptors within the film structure in presence of metal ions. Highly cross-linking density groups of methyl esters in the polyanion, can overcome the stability issues of the thin films generally encounters. This is a feature of particular interest in attempts to develop an efficient antifouling surface and improved stability of the films and are highly stable in sea salts environments for prolonged periods, and the copper leaching rate is very slow, for about 90 days, suggesting opportunities to use this covalent cross-linking approach to design functional imprinted films for antifouling and many other applications.

Designing and fabricating new, effective and environmentally friendly coating systems as alternatives to tributyltin (TBT) based antifouling paints is important. The imidazole containing biocide peptide, grafted on polycation to bind metals, shows promise as an alternative antifouling agent that effectively protects against fouling of barnacles and other



LbL films with the concept of imprinting and non - imprinting approaches and their saturation isotherms of copper loading and antifouling performance against cyprids.

marine organisms and is also less damaging to the environment than existing formulations. The technology can also benefit metal extraction processes, for example, in the water purification or natural resources recovery industries.

For more information about the publication, please contact: Dr Sreenivasa Reddy Puniredd [puniredds@imre.a-star.edu.sg](mailto:puniredds@imre.a-star.edu.sg)

Publication: Sreenivasa Reddy Puniredd, Dominik Jańczewski, Dewi Pitrasari Go, Xiaoying Zhu, Shifeng Guo, Serena Lay Ming Teo, Serina Siew Chen Lee and G. Julius Vancso; "Imprinting of metal receptors into multilayer polyelectrolyte films: Fabrication and applications in marine antifouling"; Chem. Sci., 2015, 6, 372-383

### ◆ *Nanoscale in 3D*

Researchers from IMRE, NUS, and SUTD in Singapore have developed a new approach to printing microscopic stereograms in full colour. The team has created possibly the smallest ever stereogram that does not require the viewer to don special glasses, but creates the 3D effect when viewed through an optical microscope.

Using 'biaxial' nanostructures, the team engineered polarisation-sensitive 'plasmonic pixels' that change colour depending on the polarisation of light illuminating it, allowing the first demonstration of a three-dimensional (3D) plasmonic stereoscopic colour microprint.

To print these 3D images, a layer of hydrogen silsesquioxane was spun on a silicon wafer surface and patterned with a series of holes defined by electron beam lithography. After post-processing, the remaining nano-pillars are capped with aluminium, forming an array of plasmonic pixels. Central to the colour creation are 'plasmon resonances', produced when light hits the thin aluminium layer to interact with the pixels. Each pixel produces a colour, determined by the nanostructure size or shape and the spacing between adjacent nanostructures. By employing ellipses or closely-spaced squares, a different interaction occurs when the pixel is illuminated, where each pixel produces a different colour under each polarisation. A full-colour 'dual image' can then be created by arranging the pixels in a desired pattern; each image only revealed to the observer under the design polarisation.

Stereograms typically comprise two side-by-side images viewed separately by the left and right eye to create the illusion of depth. Examples include red and green prints that reconstruct 3D objects when viewed with a pair of red and green glasses. Here, stereograms were formed using a fade-free colour printing method, which also enables multiple colour microprints to be printed and viewed within the same area without using red and green filters. Moreover, compared to laser printers which print images using droplets of ink spaced about 20 micrometers apart, this approach shrinks the separation to 400 nanometers - roughly 50 times smaller than its commercial counterparts to produce an ultra-high resolution print of 62,500 dpi.

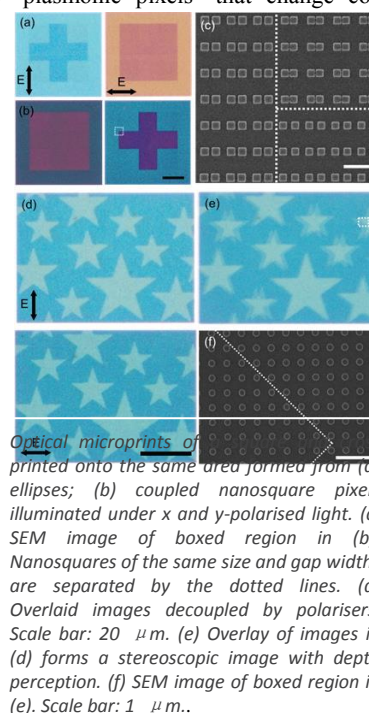
The research was published in the journal Nature Communications.

For more information about the research, please contact: Dr Goh Xiao Ming, [gohxm@imre.a-star.edu.sg](mailto:gohxm@imre.a-star.edu.sg)

### ◆ *Steering light along tiny golden bead strings*

A multidisciplinary team of IMRE and CEMES scientists have demonstrated that long chains and networks of gold nanoparticles can be used to confine light energy and guide it over long distances. In an article published in the journal, Nature Materials, the team of researchers applied a recently developed technique called 'monochromated STEM EELS', which can observe optical phenomena with unprecedented detail.

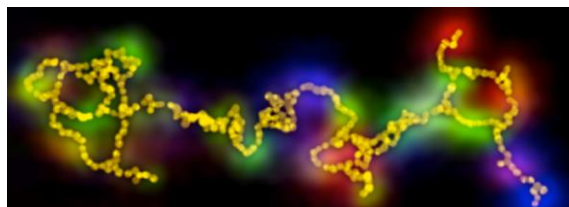
The behaviour of light at nanometer length scales is impossible to observe with light microscopes, which is why the researchers used monochromated electron microscopy. Large networks of gold particles with diameters of only ~10 nm were made using the chemical expertise at CEMES (see image). These long bead strings were then carefully fused



together and measured in Singapore. It was shown that these networks form pathways along which the light energy can travel in the form of 'surface plasmons'.

The sizes of the networks can vary from very small (containing only a few dozen beads) to lengths of several micrometers. The colours on the chain indicate locations where light of different colours are concentrated. The distance from left to right is about 750 nm, which itself is only one hundredth the width of a human hair.

The work opens up the possibility to control light energy and its travel distance by tuning the shape and size of the bead string networks. The findings in this work show that different colours of light are concentrated at specific points in the networks. In a larger effort to further miniaturise and speed-up functional circuits, these networks should prove very useful, since it has now been demonstrated that light energy can be addressed and accessed at specific nodes in these miniaturised optical networks.



A network of gold beads, each 10 nm in diameter. From left to right, this network is 750 nm long. The colours around the network show where different light energies are localised. Blue represents 0.38 eV, red 0.70 eV and green 0.89 eV of energy. The energy map and network image were obtained using electron microscopy.

**Publication:** A. Teulle, M. Bosman, C. Girard, K. L.

Gurunatha, M. Li, S. Mann, E. Dujardin; "Multimodal Plasmonics in Fused Colloidal Networks"; Nature Materials, 2014, DOI: 10.1038/NMAT4114

◆ *Reference table for quick estimation of concentration and size of nanosilver*

One of the limitations to the use of silver nanoparticles is an easy method to calculate concentrations, to allow non-destructive analysis. Current methods could for example, require the use of expensive and time consuming equipment such as ICP-MS. With the creation of the table, it is possible to obtain a good concentration estimate using just a UV-vis spectrometer, and the research community could conduct easier and more productive research with silver nanoparticles. The developed methods are also applicable to other types of nanoparticles or structures.

IMRE scientists have created a standardised table of extinction coefficient data for silver nanoparticles, which allows for easy and quick estimation of the concentration and size of modified and mono-dispersed silver nanoparticles from their optical spectra. The data was obtained by determining the silver content of citrate - stabilised silver nanoparticles, using sodium cyanide-mediated etching. Quantification of silver ion concentration enabled the calculation of extinction coefficients. In this case, experimentally calculated extinction coefficients are in good agreement with collated literature values. The results are also in good agreement with the theoretical calculations using Mie theory.

Silver nanoparticles, much like gold, have become popular for applications such as in vitro diagnosis, and have great potential for vivo applications. Silver nanoparticles also have antimicrobial properties, and as such the use of 'nanosilver' has in recent years been popularised in consumer products. Current and future applications include, their use in clothing, fabrics, personal care/health products, and antimicrobial surfaces.

For more information about the publication, please contact : Dr Paul Francis Free, [freepf@imre.a-star.edu.sg](mailto:freepf@imre.a-star.edu.sg).

**Publication:** D. Paramelle, A. Sadovoy, S. Gorelik, P. Free, J. Hobley and D. G. Fernig; "A rapid method to estimate the concentration of citrate capped silver nanoparticles from UV-visible light spectra"; Analyst, 2014, 139, 4855-4861

◆ *Enhancing urban life with noise-reducing materials*

The research team in Sensors & Transducers Programme recently started a collaboration with the Institute of High Performance Computing, Housing Development Board and National Environment Agency. This project is also supported by the National Research Foundation through L2NIC (Land and Liveability National Innovation Challenge), led by the Ministry of National Development.



With the intensification of land use in Singapore, it is inevitable that buildings will

be exposed to higher noise levels due to sources such as vehicles and economic activities. To address the issue of high noise levels while maintaining natural ventilation is a challenge.

In a high-rise high density living, windows are often the primary path for external noise to travel into the living environment. IMRE is working with its partner agencies to develop solutions enabled with green and intelligent sound absorbing materials. We will develop piezoelectric materials and electromechanical transducers to improve aural comfort in the living environment.

The project also aims to study the effectiveness of new window designs with new materials and structures to substantially reduce noise transmission while maintaining good ventilation. The intelligent sound absorbing materials and noise mitigation technologies developed in this project can also be adopted for other commercial and industrial buildings.

## ♦ Changing the future of batteries

**What:** Researchers at IMRE have developed a new carbon nanofiber composite that enables high performance rechargeable zinc-air batteries (ZnABs) with higher energy efficiency and longer cycle life.

**How:** The composite material,  $\text{Co}_3\text{O}_4$

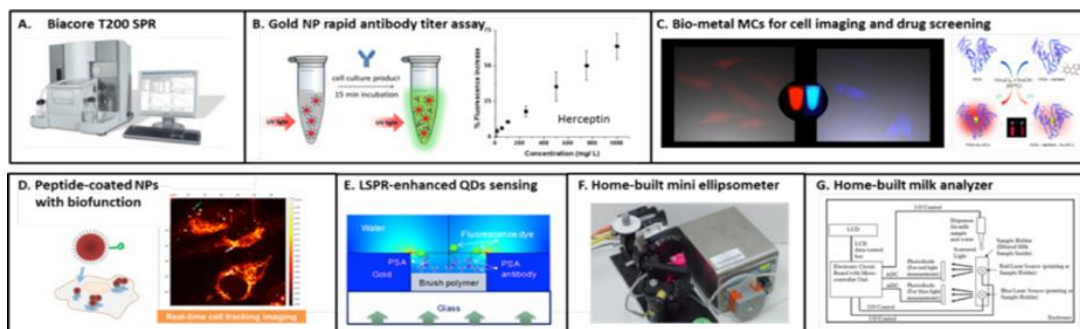
nanoparticles-decorated nitrogen-doped carbon nanofibers (CNF), was synthesised via a combination of electrospinning technique and subsequent thermal treatments. The resultant materials take a particle-on-fiber morphology, with parts of the  $\text{Co}_3\text{O}_4$  nanoparticles embedded inside the nitrogen-doped carbon fibers. This material is found to effectively catalyse oxygen reduction reaction in battery discharge process. It outperforms commercial Pt/C in catalysing oxygen evolution reaction which is essential for battery charging process.

**Why:** This new CNF composite is efficient, durable and low cost, thus, it holds great promise for future high power and high energy density metal-air batteries (Zn-air, Li-air, Mg-air, Al-air, etc.)

The technology was featured in a paper titled “ $\text{Co}_3\text{O}_4$  nanoparticles decorated carbon nanofiber mat as binder-free air-cathode for high performance rechargeable zinc-air batteries” in the Jan 2015 issue of Nanoscale. The authors were Li Bing, Ge Xiaoming, Thomas Goh, Andy Hor, Geng Dongsheng, Du Guojun, Liu Zhaolin, Zhang Jie, Liu Xiaogang and Zong Yun.

## ♦ Developing advanced bio-analytical technologies for bettering lives

One of IMRE's research areas is in developing advanced analytical techniques for applications in areas such as medical diagnosis, food analysis and environmental monitoring. We have core capabilities and a strong patent portfolio in the following areas:



(1)

Studying complex biomolecular interactions through surface sensitive analytical techniques: to gain comprehensive understanding of biomolecular interactions.

- (2) Metal nanoparticles-based rapid assays to explore metal-nanoparticle aggregation and fluorescent quenching and enhancement principles: for one-step “mix-and-measure” quantification of antibody drugs, detecting protein, DNA and small molecular drugs.
- (3) Synthesis of protein, DNA and peptide-templated multifunctional fluorescent metal nanoclusters: used for drug screening, sensing antioxidant and free radicals, site-specific cellular imaging and photodynamic therapy.
- (4) Nanoparticles surface passivation and functionalisation for cellular imaging and in vivo medical imaging: This can be used for photothermal imaging with live cells.
- (5) Localised surface plasmon resonance (LSPR) POC device for detecting cancer biomarkers: We can fabricate low-cost and large scale LSPR chips, design simulation of gold nanostructures and create compatible bio-assays.
- (6) Mini-ellipsometer integrating optical and fluidic systems for quantitative real-time measurement of molecular binding with sub-nanometer sensitivity.
- (7) Light scattering and electric bioimpedance analysers: for food analysis, such as measuring amount of fats in milk , sugar in beverages, etc.

These technologies are highly accessible and portable. Our team works with cross-disciplinary collaborators from A\*STAR research institutions, universities and healthcare institutions. Moving forward, we aim to translate the above platform technologies into robust, easy-to-use, smart and wearable formats.

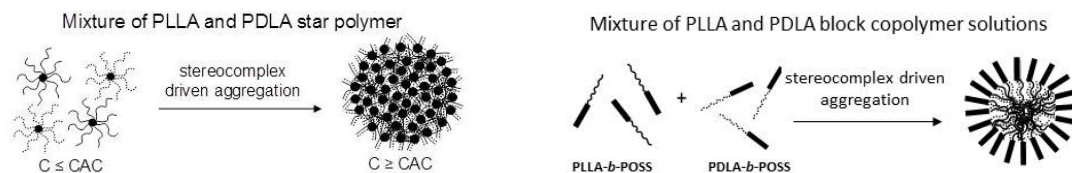
### ◆ Hybrid Polymers

An IMRE-ICES (Institute of Chemical Engineering and Sciences) collaboration research team has developed polymers comprising a polyester and at least one polyhedral oligomeric silsesquioxane, where the polyester is capable of forming a stereocomplex with a polymer comprising of complimentary polyester and composites.

Hybrid block copolymers such as PDLA-b-P(MA-POSS) or PLLA-b-P(MA-POSS) are typically used to improve compatibility between the rigid filler, polyhedral oligomeric silsesquioxane (POSS) and the polymeric resin poly-L-lactide (PLLA). POSS has a 3-dimensional cage structure that contains functional groups that could provide compatibility via the principle of “like dissolves like”. The length of these POSS cages can also be controlled by polymerising unto themselves via atomic transfer radical polymerisation (ATRP). Therefore, the hybrid block copolymer in this invention allows for precise control of the lengths of the organic (PLLA) and inorganic (POSS) segments in order to alter the morphological and mechanical properties of the nanocomposite.

One application of this hybrid block copolymer is to enhance the toughness of PLLA by incorporating PDLA-b-POSS as a filler. This will significantly enhance the interfacial adhesion between the POSS hybrid and the PLA matrix.

IMRE’s team which is made up of Dr Leong Yew Wei, Dr Maureen Tan Beng Hoon, Dr Lin Ting Ting, Dr Chua Yang Choo, Dr Tjiu Weng Weei and Dr He Chao Bin, collaborated with Dr Wong Pui Kwan from ICES for this project.



### ◆ Keep cool with IMRE window design

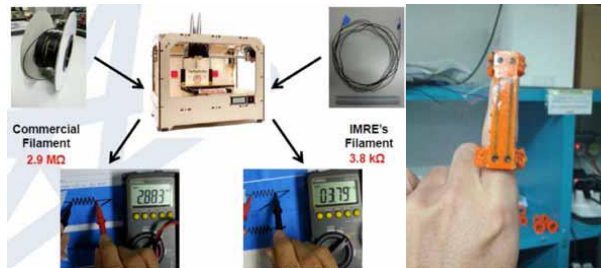
Windows are the largest contributors of heat gain in buildings. Thus, modern buildings typically use double glazed windows (DGU) together with solar control low emissivity (low-E) coatings to reduce the effect of heating. IMRE Senior Scientist, Dr Gregory Goh, noted that heat gained through windows in the tropics is mainly due to solar radiation rather than the temperature gradient between the air-conditioned building interior and the surrounding ambient. He then designed a laminated single pane window incorporating a near infrared absorbing layer coupled with a low emissivity coated glass, as part of a \$1.24 million project jointly funded by A\*STAR and the Ministry of National Development (MND). The project started in 2012 and concluded in February, this year.

Using commercially available hard low-E coated glass, the newly proposed IMRE single-pane design leads to savings of 47% in electricity usage for air-conditioning. By adding a multilayer dielectric to this single-pane design, electricity savings can increase to 55%. In addition, this multilayer dielectric would make the windows self-cleaning and have anti-bacterial properties.

### ◆ 3D-print circuits with new conductive thermoplastic

Scientists at A\*STAR's Institute of Materials Research and Engineering (IMRE) have invented a new type of thermoplastic thread that can be used in 3D printers to create functional circuits for use in electrical gadgets.

The resistivity of IMRE's thermoplastic material is in the range of 0.5-1.0  $\Omega$  cm, up to 1,000 times more conductive than most commercially available plastic filaments for 3D printing. The filament is strong enough to stay intact throughout the 3D printing process in a conventional thermoplastic 3D printer.



"I believe this will revolutionise desk-top manufacturing for electronic gadgets," said Dr Johnson Goh, IMRE scientist and Head of the Science and Engineering Research Council's (SERC) Nanofabrication, Processing and Characterisation Group and Principal Investigator of this project.

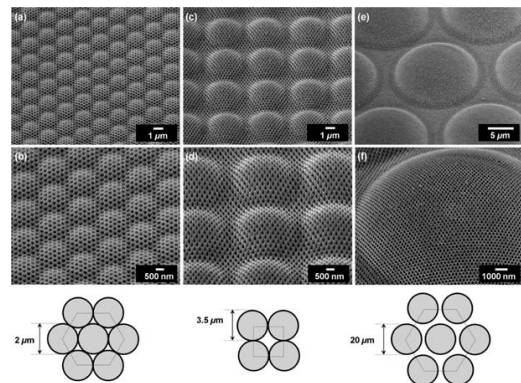
The team has found that using IMRE material to 3D-print circuits rather than creating circuits through the conventional etching-and-soldering method is much safer, faster and cheaper. In addition, such circuits have highly uniform conductivity, with less than a 5 percent variation, compared to more than a hundred percent in many commercially available conductive filaments.

Dr Goh and his team have successfully used this new material to print prototypes such as a USB connector that can light up a LED bulb, complex three-dimensional circuits, and a wearable flexible sensor.

### ◆ Anti-reflective technology inspired by moths' eyes

Nature offers many inspirations for scientific breakthroughs and the Foundry team from IMRE have found it in moths' eyes. Compound eyes of moths are made up of hexagonally packed microlenses patterned with nano-scaled dome-shaped bumps. This patterning helps to greatly reduce the reflection of light at a wide range of wavelengths.

Replicating these nano-scaled patterns of the moths' eyes could offer multifunctional properties such as antireflectivity and high transmission suitable for optoelectronic devices, but it is challenging to produce these arrays on large-area scale substrates.



IMRE scientists, Dr Loke Yee Chong and Dr MSM Saifullah and their team, have developed a method to create nano-patterns over the surfaces of various materials, to reproduce the antireflective effects of the moths' eyes.

Called sacrificial layer mediated nanoimprinting (SLAN), this new method enables fabrication of nano-scale patterns like those in moths' eyes on large-area substrates. The SLAN technique could also be employed in roll-to-roll and roll-to-plate nanoimprinting.

Such a treatment can be applied to solar cells to make them more effective, to ensure that they capture as much light as possible, rather than reflecting it.

This treatment can also make the materials super-hydrophobic (water-repelling) and produces antifogging characteristics.

This technology was featured in a paper titled “Multiscale Ommatidial Arrays with Broadband and Omnidirectional Antireflection and Antifogging Properties by Sacrificial Layer Mediated Nanoimprinting” in the Jan 2015 issue of ACS Nano.

### ◆ *High-quality atom-thin 2D materials for electronic devices*

Typical examples of a single glazed window (left) and a double glazed window (right)

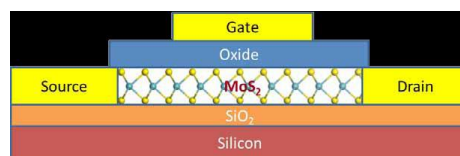
IMRE scientist, Dr Wang Shijie, and his team have developed a new technique for creating large areas of atom-thin two-dimensional (2D) semiconductor molybdenum disulfide (MoS<sub>2</sub>) for use in electronic devices .

MoS<sub>2</sub> belongs to a family of materials called transition-metal dichalcogenides. These materials and their wide range of electrical properties provide an excellent platform material system for versatile electronics. However, creating high-quality material over areas large enough for industrial-scale production has not achieved satisfactory results until this discovery.

“Our technique is a one-step process that can grow good-quality monolayer films, or few layers of molybdenum disulfide films, at wafer scale on various substrates using magnetron sputtering”, says Dr Wang. Dr Wang’s team has demonstrated excellent conductivity of the MoS<sub>2</sub> film produced by this new method.

The team will be focusing next on the application of this technique to synthesise other 2D materials and integrating them with different materials for various device applications.

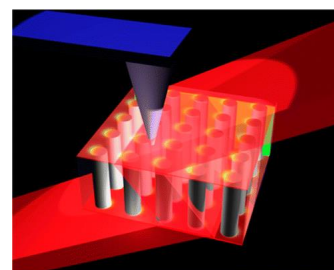
This technology was featured in a paper titled “Method for creating high-quality two-dimensional materials could enable industrial-scale production” in the Apr 2015 issue of Nanowerk News.



### Taiwan (Source: IANTP)

### ◆ *Looking into Meta-Atoms of Plasmonic Nanowire Metamaterial*

Nanowire-based plasmonic metamaterials exhibit many intriguing properties related to the hyperbolic dispersion, negative refraction, epsilon-near-zero behavior, strong Purcell effect, and nonlinearities. We have experimentally and numerically studied the electromagnetic modes of individual nanowires (meta-atoms) forming the metamaterial. High-resolution, scattering-type near-field optical microscopy has been used to visualize the intensity and phase of the modes. Numerical and analytical modeling of the mode structure is in agreement with the experimental observations and indicates the presence of the nonlocal response associated with cylindrical surface plasmons of nanowires.



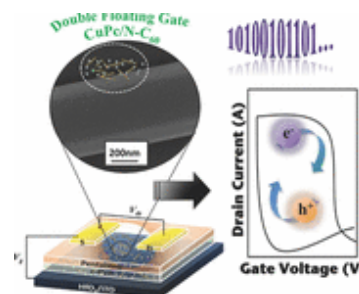
Publication: Kun-Tong Tsai, Gregory A. Wurtz, Jen-You Chu, Tian-You Cheng, Huai-Hsien Wang, Alexey V. Krasavin, Jr-Hau He, Brian M. Wells, Viktor A. Podolskiy, Juen-Kai Wang, Yuh-Lin Wang, and Anatoly V. Zayats

Nano Letters, 2014, 14 (9), pp 4971–4976

### ◆ *Single-Crystal C<sub>60</sub> Needle/CuPc Nanoparticle Double Floating-Gate for Low-Voltage Organic Transistors Based Non-Volatile Memory Devices*

Low-voltage organic field-effect transistor memory devices exhibiting a wide memory window, low power consumption, acceptable retention, endurance properties, and tunable memory performance are fabricated. The performance is achieved by employing single-crystal C<sub>60</sub> needles and copper phthalocyanine nanoparticles to produce an ambipolar (hole/electron) trapping effect in a double floating-gate architecture.

Paper: H. C. Chang, C. Lu, C. L. Liu, and W. C. Chen, *Advanced Materials* **27**, 27-33 (2015)



◆ *Enhancing performance of inverted polymer solar cells using two-growth ZnO nanorods*

In ordinary polymer solar cells, the short exciton diffusion length causes increasing probability of electron-hole recombination as the active layer thickness exceeds the diffusion length. Hence, the diffusion sets a thickness limitation of the active layer. ZnO nanorods have been used to provide an advantage of electronic path, making it possible to increase the effective thickness of the active layer. However general hydrothermal treatment has a

limitation of the ZnO nanorod length because the nanorods accelerate their growth speed horizontally after growing over a period of time, leading to the reduction of space to be filled with the organic light absorber. Thus, in this work, two-growth ZnO nanorods are employed to overcome the above limitation. The first growth process is for defining nanorod density, while the second process is to increase the length without much expansion of the rod size. This allows for elastically tuning the morphology between the active layer and the ZnO electron transport layer to achieve deeper and superior infiltration of organic light absorber. Consequently, this improves the performance of the device. The power conversion efficiencies of devices in PBDTTT-C-T/PC71BM and PTB7/PC71BM are then enhanced from 5.40% to 7.80% and 7.24% to 8.01%, respectively. (Yu-Che Ho, Ping-Yi Ho, Hsin-Che Lee, Sheng-Kai Chang, Yun-Ru Hong, Ching-Fuh Lin, *Solar Energy Materials and Solar Cells* **132**, 570-577 (2015))

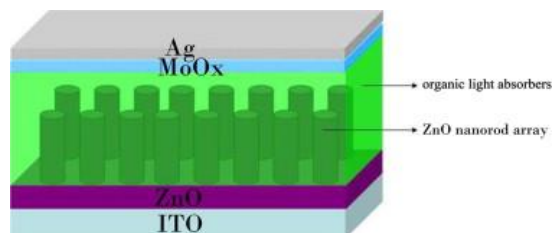


Fig. Schematic diagram of the device structure with ZnO nanorod array.

## EVENTS

Date	Avenue	Events
Jan.28-30	Tokyo, <b>Japan</b>	<b>Nanotech Japan 2015 (The 14th International Nanotechnology Exhibition &amp; Conference)</b> <a href="http://www.nanotechexpo.jp/">www.nanotechexpo.jp/</a>
Feb. 8-12	Nelson, <b>New Zealand</b>	<b>Advanced Materials and Nanotechnology 7 (AMN7)</b> <a href="http://www.macdiarmid.ac.nz">www.macdiarmid.ac.nz</a>
Mar. 8-11	Kish Island, <b>Iran</b>	<b>Asia Nano Forum Conference 2015 (ANFC2015)</b> <a href="http://www.anfc2015.net/">www.anfc2015.net/</a>
Mar.11-14	Delhi, <b>India</b>	<b>4th International Conference on Current Developments in Atomic, Molecular, Optical and Nano Physics with Applications (CDAMOP 2015)</b> <a href="http://www.cdamop.com/">http://www.cdamop.com/</a>
May 11-13	Fukuoka, <b>Japan</b>	<b>The 11<sup>th</sup> International Nanotechnology Conference on Communication and Cooperation(INC11)</b> <a href="http://inc11.org">http://inc11.org</a>
June 14-17	Washington DC, <b>USA</b>	<b>Nanotech 2015 - Advanced Materials &amp; Applications</b> <a href="http://www.techconnectworld.com/World2015/">website: www.techconnectworld.com/World2015/</a>
Jun. 16-18	Taipei, <b>Taiwan</b>	<b><u>The 13th Int'l Nano Exposition</u></b> Contact: <a href="mailto:jason.cheng@mail.pida.org.tw">jason.cheng@mail.pida.org.tw</a> <a href="http://www.optotaiwan.com/Nano/?lang=eng">http://www.optotaiwan.com/Nano/?lang=eng</a>
Jun.29-Jul.3	Nagoya, <b>Japan</b>	<b>The 16th International Conference on the Science and Application of Nanotubes (NT15)</b> <a href="http://www.nt15.jp/">www.nt15.jp/</a>
Jul.1-3	Seoul, <b>Korea</b>	<b>NANO KOREA 2015 “Nanotechnology, the Engine of Creative Economy”</b> <a href="http://sympo.nanokorea.or.kr/2015/eng/main/">http://sympo.nanokorea.or.kr/2015/eng/main/</a>
Jul.6-8	Sydney, <b>Australia</b>	<b>6th International Nanomedicine Conference, at Coogee</b> <a href="http://www.oznanomed.org/welcome-from-the-conference-chairs">http://www.oznanomed.org/welcome-from-the-conference-chairs</a>
Jul.19-23	Sydney, <b>Australia</b>	<b>2nd Asia Oceania Conference on Neutron Scattering (AOCNS 2015)</b> <a href="http://aocns-2015.com">http://aocns-2015.com</a>
Aug. 3-5	<b>Singapore</b>	<b>5th Molecular Materials Meeting (M3)</b> <a href="#">website</a>
Aug. 2-5,	<b>Singapore</b>	<b>Asia Nano Forum Summit 2015</b>
Aug. 2-7,	<b>Singapore</b>	<b>Asia Nanotech Camp 2015</b>
Aug. 22-23	New Taipei, <b>Taiwan</b>	<b>2015 International Conference on Biomedical Signal and Image Processing</b> <a href="http://www.icbip.org/index.html">http://www.icbip.org/index.html</a> Contact: <a href="mailto:icbip@asr.org">icbip@asr.org</a> (Ms. Wendy Lee)

Sep.27 – Oct.2	NSW, <b>Australia</b>	<b>NanoS-E3 2015 - International School and Workshop on Nanotechnology</b> <a href="http://www.ausnano.net/index.php?page=events&amp;event=226">http://www.ausnano.net/index.php?page=events&amp;event=226</a>
Oct. 18-22	Limpopo Province, <b>South Africa</b>	<b>7th International Symposium on Nanotechnology: Occupational and Environmental Health</b> <a href="http://www.nanoeh2015.co.za/">http://www.nanoeh2015.co.za/</a>
Oct.22	Daejeon, <b>Korea</b>	<b>2015 Asian Science &amp; Technology Innovation Forum</b> <a href="http://www.asianstiforum.org">http://www.asianstiforum.org</a> <a href="mailto:arn.korea@gmail.com">Contact: arn.korea@gmail.com</a>
Oct.25-29	Lorne, <b>Australia</b>	<b>Recent Progress in Graphene and Two-dimentional Materials Research (RPGR2015)</b> <a href="http://rpgr.physics.monash.edu.au">http://rpgr.physics.monash.edu.au</a>
Nov.11-13	Changwon, <b>Korea</b>	<b>The 2nd International Conference &amp; Exhibition for Nanopia</b> <a href="http://nanopia.org/">Website: http://nanopia.org/</a> <a href="mailto:office@nanopia.org">Contact: office@nanopia.org</a>
Dec.7-9	Jeju, <b>Korea</b>	<b>The 9th International Conference on Advanced Materials and Devices</b> <a href="http://www.icamd.or.kr/">Website: http://www.icamd.or.kr/</a> <a href="mailto:secretariat@icamd.or.kr">Contact: secretariat@icamd.or.kr</a>
Jan.27-29 2016	Tokyo, <b>Japan</b>	<b>nano tech 2016 International Nanotechnology Exhibition&amp;Conference</b> <a href="http://www.nanotechexpo.jp/">www.nanotechexpo.jp/</a>
Feb.7-11 2016	Canberra, <b>Australia</b>	<b>ICONN 2016 - International Conference on Nanoscience and Nanotechnology</b> <a href="http://www.ausnano.net/iconn2016/index.php">http://www.ausnano.net/iconn2016/index.php</a>