

# SingNano – Singapore Nanotechnology Network NEWSLETTER

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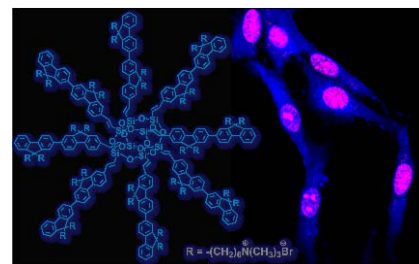
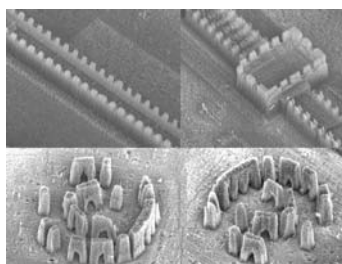
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## EVENT HIGHLIGHTS (Contributed by NANO GLOBE Team)

### Nanotechnology Initiatives/Programs in Iran, Pakistan, Philippines, Sri Lanka and Other Developing Countries in the Asia Pacific Region (Dr. Lerwen LIU, NanoGlobe)

-Highlights of the United Nation APCTT-ESCAP Consultative Workshop on Promoting Innovation in Nanotechnology and Fostering Its Industrial Application: An Asia – Pacific Perspective

I have been writing about Asia nanotechnology since 1999 and covered most of the Asia Pacific countries. The Asia Nano Forum (ANF, [www.asia-anf.org](http://www.asia-anf.org)) (which I co-founded and am serving as the Secretary) is now a network of 15 economies, however, it has not covered some of the regional economies especially some of the United Nation members including Bangladesh, Nepal, Pakistan, Philippines, and Sri Lanka.

During Dec. 2-3th, 2009, I was fortunate to have the opportunity to participate at the United Nation (UN) first nanotechnology conference and was invited by the UN Asia and Pacific Center for Transfer of Technology (APCTT-ESCAP) which allowed me to learn about the UN Economic and Social Commission for Asia and the Pacific (ESCAP) nanotechnology initiative and its member economies nanotech policy, programs and activities.

Sri Lanka, a country of about 20M people primarily still an agricultural based developing economy with over 70% of its population living in the rural area. Its GDP per capita is about 2000USD (lower than Vietnam whose GDP per capita is 3340USD). Despite of its recent political instability, its Ministry of Science and Technology and National Science Foundation recognizes the importance of nanotechnology and started to establish its S&T policy to ensure Sri Lanka will not missed the upcoming revolution. I find Colombo a very clean and comfortable city, where I don't see chaos in traffic, hotels ban smoking indoor, people follow the traffic rules, very friendly towards each other and to visitors.

Initiated and supported by the Sri Lanka Ministry of Science and Technology (MOST) led by its Minister Prof. Tissa Vitharana, the first "Consultative Workshop on Promoting Innovation in Nanotechnology and Fostering its Industrial Application: An Asia-Pacific Perspective" was organized by the APCTT-ESCAP, Sri Lanka Ministry of Science and Technology, National Engineering Research and Development Center (NERD Center) and the National Science Foundation (NSF) on Dec 2-3, 2009 in Sri Lanka capital Colombo. The event was inaugurated by Sri Lanka traditional lighting the candles ceremony symbolizing the lighting the darkness of ignorance followed by the opening address given by the Minister Tissa Vitharana who shared his vision of nanotechnology for improving quality of life for Sri Lankans (see photo attached).

The event is an invitation only event with about 50 invited participants from UN Asia and Pacific member countries and one representative from each major R&D institution in Sri Lanka. Sri Lanka NSF launched its Nanotechnology Initiative in 2007 and set up the Sri Lanka Institute of Nanotechnology (SLINTEC) as a private company with LKR 420 million (about USD3.7M) in 2008 with a unique public-private-partnership (PPP) structure where 50% of institute funding comes from 5 private companies including Hayleys, MAS Holdings, Brandix, Loadstar and Dialog. Within a year, the center has now nicely set up with necessary facilities needed for nanomaterials synthesis, characterization and prototyping. It recruited overseas Sri Lankan scientists and executives with passion, vision and network as well as technical and business capabilities to accelerate the nanotech incubation process in the institute. It also recruited experienced faculty members from local universities to be R&D program managers. It is aggressively seeking for industry collaboration to ensure its R&D efforts stayed focused. It has an impressive advisory board including distinguished scientists such as Prof. Ravi. P. Silva (UK), Prof. A.P. de Silva (UK), Prof. Gehan Amaratunga (UK) and Prof. Kumar Wichremasinghe (USA). The institute is also very active in seeking international cooperation to ensure its international competitiveness. It signed recently a research agreement with Ritsumeikan University (Japan), research group of Prof. Susumu Sugiyama, a well-known MEMS expert in Japan. "We are very fortunate to have a team of passionate and talented scientists and management focusing on application development of nanotechnology and we follow our milestones very seriously. We exploit Sri Lanka rich natural resources such as titanium, graphite and other activated carbon towards nanomaterials application. We aim to deliver sustainable nanotechnology for global competitiveness of Sri Lankan industry and the world will see the label 'Made in Sri Lanka' in future high-tech products enabled by nanotechnology", CEO Mr. Ravi Fernando shared with us during the conference delegation visit at SLINTEC(see photo attached). The research areas of the institute include Textile & apparel, Solid tires, Fertilizer, Rubber gloves, Activated carbon, Nano materials, and Biosensors. Details of the institute can be found at its website [www.susnanotec.lk](http://www.susnanotec.lk).

I am most impressed by the Sri Lanka nanotechnology policy is its emphasis on private, public partnership (PPP) and incorporating responsible development and regulatory framework.

Among other countries which are not in our ANF network, Pakistan stands out well in setting up a nanotechnology center by the Pakistan Council of Scientific and Industrial Research (PCSIR), where facilities are for industry to use as well as for conducting R&D that meets industry needs. Its nanotechnology lab facilities are utilized for the development,



Minister of Science and Technology of Sri Lanka gave the opening speech

synthesis and characterization of 12 different nanocomposite coatings used in industries including Orthopedic implants & Surgical, Cutting Tool, Tool & Die and Textiles. Nanotechnology policy in Pakistan is made by its National Commission on Nanoscience and Technology (NCNST). “We place our priority in industry development and support. We have now a fully functional nanotechnology center that focuses on nanocoating, nanomaterials and nanopowder R&D and industry development”, Dr Shehzad Alam, Director General of the PCSIR of the Ministry of Science and Technology, emphasized during his presentation.

Nanotechnology is one of the 8 priority areas (Biotech, Electronics, ICT, Materials Science, Photonics, Space and Nanotech) of the Philippines Council for Advanced Science & Technology Research & Development (PCASTRD). PCASTRD has developed the roadmap of development of nanotechnology which places 8 priority areas: 1) Nanomaterials and Nanocomposites, 2) Solar Energy Devices, 3) Nano-designed sensors and actuators, 4) Nano-based delivery systems, 5) Nanocomposite films and membranes, 6) Nanosensors, 7) Nanoporous Filters and 8) Nano-based environmental remediation systems. The PCASTRD established various scholarships and fellowships to accelerate the science and technology human resources development in Philippine. The Balik Scientist Program to encourage overseas Filipino scientists and technologists to return to the Philippines and share expertise in order to accelerate the scientific agro-industrial and economic development of the country.

The most rapid rising member country which has the most comprehensive national nanotechnology program is Iran. Iran set up its National Nanotechnology Initiative in 2005 and has spent USD135M during 2004-2008, half of which is funded by the private sector. Its NNI is entering phase II with a 10 year program. Iranian scientists and industries are active engaging international cooperation activities. It has an established education program to train MSc and PhD students, educating the public and policy makers as well as industry and business community. Iran has been actively engaging ISO nanotech standardization activities and was elected as a member of ISO/TC229 to become a representative of the Middle East and North Africa. Its R&D priorities are Energy, Health, Water & Environment, Nanomaterials and Construction. Iran is heading the ANF Energy and Water Working Group. Details about Iran nanotechnology can be found at its portal site [www.nano.ir](http://www.nano.ir). Iran Nano Business Network (INBN) was set up in 2007 connecting 110 nanotech companies. Infrastructure network was set up in 2004 covering 42 advanced laboratories national wide. In terms of number of ISI publication, Iran has jumped from rank 42 in 2004 to rank 19 in 2008. The embargo on Iran has motivated Iran industry to develop its own technology and products including STM, Water Purification System, Air Filters, Industry Scale Quantity CNT and others.

Neither Bangladesh nor Nepal have established nanotechnology programs or initiatives due to limited infrastructure for R&D, lack of trained human resources and limited international collaboration. However there are research efforts ongoing in the areas of nanoparticles (Ag, Oxidies) synthesis, functionalisation in polymers and composite materials. Both countries expect to have nanotechnology incorporated in its existing S&T policy in the near future.

Nanotechnology development update in the rest of the Asia Pacific countries is included in my recent book *Emerging Nanotechnology Power: Nanotechnology R&D and Business Trends in the Asia Pacific Rim* (<http://www.worldscibooks.com/nanosci/7224.html>).

The UN APCTT-ESCAP Nanotech workshop, held in Colombo, in collaboration with the Sri Lanka NSF and NERD Center was participated by UN Asia Pacific regional member countries including Bangladesh, China, Korea, India, Indonesia, Iran, Malaysia, Nepal, Pakistan, Philippines, Sri Lanka and Thailand. Dr Peter Mogyorosi (Director of Laser Consult KFT, Consultant to APCTT) and myself are two invited experts to provide overviews on Nanotechnology global R&D and commercialization. I also represent the Asia Nano Forum to invite the non ANF member economies to join our network and invite the opportunity to work with APCTT-ESCAP. There was not concrete conclusion at the end of the workshop, however Dr Jeong Hyop Lee summarized different nanotech commercialization models presented by the member countries which include 1) Indonesia's green and international cooperation and global value chain strategy, 2) Pakistan's industry outreach and extension strategy and Sri Lanka's private public partnership strategy. Iran representatives suggested to conduct nanotechnology regional road-mapping and will seek funding from Iranian government to execute this initiative. Suggestion was also raised on conducting joint R&D project which will require expert and funding support.

“We shouldn't duplicate what's been done and will work in partnership with existing network such as the Asia Nano Forum and focus on facilitating the developing world to develop innovative nanotechnology which will contribute to the advancement of local industries and improve quality of life of their citizens”, head of APCTT-ESCAP Dr K. Ramanathan concluded the event.



Delegation visit to SLINTEC, the Nanotech institute in Sri Lanka, received by its CEO and his team of management and scientists

## Nanotechnology Update in Vietnam - From a visit in Vietnam in Nov. 2009 (Dr Lerwen LIU, NanoGlobe)

I continued our world nano tour in Vietnam in November 2009 month when I participated two nanotech conferences as an invited speaker.

The first one was the Solid State Physics and Materials Science 2009 (SPM2009) held in Da Nang during Nov. 9-10th, an annual domestic conference where physicists and materials scientists gather. Da Nang is the 3rd largest city in Vietnam and it is attractive to foreign tourists for its beautiful beaches and the old capital Hue nearby. This is a city of Scooters, unlike most big cities in China where cars are dominating the road and causing severe pollution and traffic jam. Normal people's life is simple and yet they look happy and self-contained.

The conference was mostly in Vietnamese and there was neither English program nor website. I was one of a few foreign speakers who gave our presentations in English in the morning to about 200 participants. We observed this conference and found a number of research areas the Vietnamese scientists are pursuing and some of the research activities are quite competitive and has interesting commercial applications. These areas including Carbon Nanotube composite materials, III-V semiconductor materials for LED application, Nanowires or CNT hybrid with semiconductor metal oxides materials application for high sensitivity gas sensors and FET, metallic nanoparticles application in agriculture as pesticides and anti-microbial, TiO<sub>2</sub> for water treatment, biodiesel/biofuel, Magnetic nano- particle for biomedical application including imaging, separation of molecules, and treatment (DDS, hyperthermia) and many other interesting areas. The most impressive talk was given by Prof. Phan Hong Khoi who is the Project Manager of the Vietnam Energy Efficient Public Lighting Project funded by United Nation and Vietnamese Academy of Science and Technology. Prof. Khoi presented overview on Vietnam status in commercializing LED technologies. "We are getting support from the World Bank, Asia Development Bank to fund manufacturing of energy efficient lighting products. Our project provides for capacity building, training, technology, standardization and policy implementation", Prof. Khoi revealed during our interview.

A clear focus on the application R&D is in the area of energy, environment, sensors and smart materials. All overseas speakers have already or in the process of established nanotech R&D collaborations with Vietnamese universities and industries. Dr. Cattien Nguyen, who is a senior research scientist working at NASA Ames Research Center based in Silicon Valley, has established quite a few collaborative projects especially in the areas of CNT and LED with scientists and industries in Vietnam. "Vietnam, and in particular Ho Chi Minh City and Hanoi are like Shanghai a few years ago, full of excitement and opportunities. The young scientists here are highly motivated and with international exposures, they can easily become international competitive", Dr Cattien Nguyen shared with us during our interview. Similar to other Asian countries, the overseas trained Vietnamese scientists, who are now working in private companies or are professors at universities in Vietnam, have been the key driver for advancing Vietnam nanotechnology and accelerate its commercialization with the help of corporate and private investors.

The other conference was the International Workshop on Nanotechnology Application (IWNA2009), Nov. 12-14 held in Vung Tau city. A full conference program can be found at its website [www.hcmnt.edu.vn](http://www.hcmnt.edu.vn).

Vung Tau is one of Vietnamese beach resort cities, about 2 hrs (130km) by a slow local bus from Ho Chi Minh City. It is also the crude oil extraction center of Vietnam.



The crowd at the domestic annual Solid State Physics and Materials Conference (SPM2009) held during Nov. 9-10th, 2009 in DaNang City. Dr Phan Ngoc Minh is the Chairman of the conference (far left on the front row).



Lerwen with the Vietnamese nanotech elites at the SPM2009 from right to left: Prof. Phan Ngoc Minh, Prof. Nguyen Phuong Tung, Prof. Tran Kim Anh, Lerwen Liu, Prof. Phan Hong Khoi, and Prof. Le Quoc Minh.

The conference was a bi-annual international nanotech event started 2007 after the Laboratory of Nanotechnology in Vietnam National University – Ho Chi Minh City lab was established in 2006 which is one of the Vietnam nanotech infrastructure building initiatives launched in 2004. The conference chair is Prof. Dang Mau Chien who is the director of laboratory which is the main sponsor of this conference. Prof. Chien and his colleagues' collaborative relationship with Europe has brought speakers from France (especially Minatec), Netherland (Univeristy of Twente), Spain, Japan, Korea, Taiwan and Singapore. The opening plenary talks in the morning of the first day were all about MEMS given by Herve Fanet - Commissariat à l'Energie Atomique (CEA) - LETI - MINATEC, France; Cees J.M. van Rijn - Wageningen University / AQUAMARIJN Micro Filtration B.V, The Netherlands, and Susumu Sugiyama - Ritsumeikan University, Japan. The Laboratory of Nanotechnology has a strong collaboration with Minatec and it has the most comprehensive facilities for MEMS devices fabrication and characterization in Vietnam. The rest of the conference covered cutting edge R&D and application in nanotechnology including fundamental research, nanofabrication and synthesis, nanomaterials and nanostructures, MEMS and Nano Devices, and nanotechnology application. There was also a poster session. A special Forum on Business Opportunities in Micro and Nanotechnology Industry was held on the last day where industries and research scientists presented the latest nanotech application and industry activities in Vietnam, France and Japan.

There are about 200 participants in the conference and 35% are foreigners. The organizers offered fantastic hospitalities to speakers and participants from overseas offering free and delicious lunches and dinners plus local guided tour in Vung Tau city.

During this conference, I discovered the advancement and enthusiasm of Vietnamese industry moving into nanotechnology. The Forum on Business Opportunities of Micro-Nanotechnology Industry in Vietnam held on the last day of the conference attracted over 50 participants which was the most popular session together with 2 other technical parallel sessions. Prof. Nguyen Phuong Tung from the Institute of Applied Materials Science introduce the potential of nanotechnology application for oil and gas exploration and production and some of the ongoing the research activities in her research group in collaboration with Vietnam oil and gas industry in Vung Tau city. GP Technology CEO Albert Chan Tu presented its company unique high performance low cost technology for manufacturing thin film solar cell and equipment Its technology is based on amorphous silicon and APP-CVD method (atmosphere pressure thus low-cost, no vacuum required)

I was particularly impressed by the SHTP Labs, a carbon nanotubes producer located in the Saigon Hi Tech Park Research Laboratories which demonstrated their low cost solid phase production method for producing short CNT and its capability of application in making composite materials in collaboration with Good Year and Hitachi Hi-tech. This company is able to produce 1kg per hour CNT with 100nm long.

One of the most impressive talks in this conference was solution based low cost production of ZnO nanorod and its potential in replacing GaN in LED and ITO for conducting electrode application presented by two invited speakers from Singapore Prof. SUN Xiao Wei (NTU) and Prof. CHUA Soo Jin (NUS and IMRE).

As a result of this conference and our site visit, we discovered that major nanotech facilities have been established near Ho Chi Minh funded by the Ho Chi Minh City government (HCMC). They include

11.5M USD Saigon high-tech park a) Nano Lab, b) Microelectronics Lab, and c) Precision Mechanics Lab.

6M USD Nanotechnology Laboratory at Ho Chih Ming University, a complete microfabrication and characterization facility

Vietnam is moving towards establishing clean-tech industries especially in Solar and Lighting areas. Another presented at the business forum was Red Sun Energy which is a maker of module panels from 25Wp to 175Wp (mono and polycrystalline) with 15% solar efficiency, and other energy saving products including Solar water heater, Solar LED lighting, LED illuminated write board and etc.

I enjoyed enormously my Vietnam experience in Nov. 2009 and will go to Hanoi Nov.2010 for the big Hanoi 1000 Years Anniversary celebration together with a major nanotechnology conference. Vietnam will host the Asia Nano Forum 7th Summit during this period as well. Until then, Happy Holidays!

## Nanotech Malaysia 2009 Conference and Exhibition (Dr Lerwen LIU, NanoGlobe)

Themed as Energy, Health & Environment, Nanotech Malaysia 2009 was the third annual nanotechnology event organized by the Universiti Kebangsaan Malaysia and co-organized by the Academy of Sciences Malaysia and the Ministry of Science, Technology and Innovation (MOSTI). It was held in Kuala Lumpur Convention Centre from 27-29 October 2009, attracted over 200 participants from government, research institutions, industry and public.

Nanotech Malaysia 2009 was officially opened by YB Minister of Science, Technology and Innovation Datuk Dr. Maximus Johnity Ongkili. In his keynote address, Datuk Dr. Ongkili mentioned that MOSTI will be launching National Nanotechnology Statement that will highlight the initial planning of the government to further pursue intensive development



Lerwen visited the Laboratory of Nanotechnology at Vietnam National University- Ho Chi Minh City. From left to right: Prof. Dang Mau Chien (director), Lerwen Liu, Prof. Phan Ngoc Minh (IMS, VAST) and Prof. Takahito Ono (Tohoku Univ. Japan)

in the nanotechnology industry in Malaysia. The statement will take into account all perspectives from the industrialists, academia, researchers, and related government agencies.

Through MOSTI and MOHE (Ministry of Higher Education), the government has funded up to RM 124.3M in nanotechnology area under the 9th Malaysia Plan. In addition, the government will set up a National Innovation Centre and a network of Centres of Innovation Excellence for allowing faster commercialization and for the industry to provide fast feedback to the research work. Nanotechnology has now been included as one of the growth engines for the new economic policy, as announced also by the Prime Minister of Malaysia, Datuk Seri Najib Tun Razak, on a separate occasion. (<http://www.bernama.com/bernama/v5/newsgeneral.php?id=450784>)

This year's conference also marked the inauguration of Malaysia Nanotechnology Association (MNA). It was proposed in 2007 with 15 members and finally officially registered in September 2009. It is a platform for communication among scientists, researchers, and industry players and facilitating networking with the local community and international counterparts. One of its main activities is organizing the annual Nanotech Malaysia Conference and Exhibition, which has been started since 2007 as the highlight of Malaysia's National Nanotechnology Initiative (NNI) launched in 2006.

There were over 150 technical papers were presented, divided into 4 symposiums namely Nanomaterials and Nanostructured Devices, MEMS/NEMS & Nanoelectronic Devices, Nanobiotechnology & Healthcare, and Nanotechnology in Agriculture, Energy & Environment. It is interesting to note that the overseas participation for the technical paper presentation was mostly from Austria and Iran. The Austrians mostly took part in Nanobiotechnology & Healthcare, highlighting their research in nanobiotechnology as well as nanotechnology risk and safety.

One highlight of the Iranian participation in both the conference and exhibition was the participation of NanoPac Persia Company. Founded in 2005, it is one of the most successful nanotechnology companies in Iran, sold 250K units of nanofilter within the first two months of its product launch in 2007. An interesting application of its antibacterial and antifungal nanoparticles is NanoFarm for agricultural business, such as chicken farm. The use of NanoFarm reduces the pathogenic organisms in chicken farm environment and reduces pollutant gases such as ammonia and hydrogen sulfide. As a result, it reduces the number of periodic flock mortality and increases the yield.

Malaysia is also catching up in establishing her nanotechnology capabilities. Seen in the exhibition floor, Institute of Microengineering and Nanoelectronics (IMEN) showcased a few of its research activities such as zinc oxide nanowires, MEMS fingerprint sensor, lab-on-chip for DNA preparation, and piezoelectric micropump. IMEN was established in 2002 under the patronage of Universiti Kebangsaan Malaysia (UKM). Its research areas include MEMS & NEMS technology, photonics and nanophotonics technology, organic & printed electronics, semiconductor packaging, system design, and high frequency technology for telecommunications.

Universiti Teknologi Malaysia (UTM) is actively developing integrated device technology for terahertz and sensor applications. In addition, UTM has commercialized its breakthrough in synthesizing low cost silica aerogel from rice husks, called Maerogel. Besides being inert, non-toxic, and environmentally friendly, Maerogel can be synthesized at cost as low as 20% of today's aerogel production cost, making it affordable to be a commonplace material and used in widespread applications. Gelanggang Kencana Pte Ltd, who is taking the exclusive IP license for certain period from UTM will be in operation early 2010 with its first commercial plant to produce 5 tonnes of Maerogel annually.

SIRIM Berhad is a national research and technology development corporation with established infrastructure for its research activities namely National Centre for Machinery and Tooling Technology, Advanced Manufacturing Technology Centre, Advance Materials Research Centre (AMREC), Environment and Bioprocess Technology Centre, and Techno-Economy and Commercialization Centre. Nano



The organizing committee of Nanotech Malaysia 2009 including Datuk Dr. Maximus Johnity Ongkili, Prof. Burhanuddin Yeop Majlis, Prof. Halimaton Hamdan and Prof. Ilie C. Gebeshuber.



Rice husk R&D achievements of Universiti Teknologi Malaysia



Dr. Liu with NanoPac Persia Co's Directors Dr. Farshid Soheili (second from right) and Mr. Mehran Hajirasouliha (most right)

Materials Program at AMREC was presented in the exhibition, with some examples of research projects such as study on silver nanoparticles, sonochemistry synthesis of nanometal and nanometal oxides, and synthesis of vanadium doped nano-TiO<sub>2</sub>.

Microelectronics & Nanotechnology Shamsuddin Research Centre (MiNT-SRC) is one of the Centre of Excellence in Universiti Tun Hussein Onn Malaysia (UTHM) established in 2006. Its research scopes include microelectronics and semiconductor devices, thin film technology and applications, MEMS, VLSI design, medical electronics, and biomaterials. A few of research projects on-going in UTHM include study of nano-TiO<sub>2</sub> for wastewater treatment, UV biosensor system using periodic nanoparticle arrays, and nanoscale in-situ monitoring system for nano-devices fabrication and analysis.

Nanotech Malaysia 2009 was an impressive effort to show Malaysia's commitment to nanotechnology development. It highlighted the government recognition to nanotechnology as one of the growth engines of the new economic policy. The event also showed the enthusiasms of the Malaysian community in nanotechnology R&D and their active engagement of international collaboration.

## Promoting Nanotechnology Awareness in Singapore's Business Community and Funding Agencies (Ms. Yesie L. BRAMA, NanoGlobe)

In effort of raising public awareness and continual learning on Nanotechnology, the American Chamber of Commerce in Singapore and International Enterprise (IE) Singapore organized nanotechnology-related events separately on the same day, 24th November 2009. Speaking on both events was Dr Lerwen Liu, the Managing Director of NanoGlobe Pte Ltd, a consulting company specializing on nanotechnology.

A breakfast talk to start the day was organized by the American Chamber of Commerce (AmCham) in Singapore, featuring Dr Lerwen Liu who provided an overview of nanotechnology applications to improve human's quality of life as well as an overview of nanotechnology activities in Asia Pacific. A surprising turn out of about 30 people early morning at 8am, mostly were the AmCham members, filled up the seminar room rather quickly. The topics that caught much of attention from the audience were nanotechnology in health and environment. Curiosity and interest were expressed for nanobubbles technology for water treatment especially on its potential opportunity as membrane replacement and the cleaning capability (i.e. amount of water it can treat within certain period).

Curiosity and concerns were also expressed for safety aspect of nanoparticles. Mr Lloyd Soong in the audience, the CEO of Pasture Pharma, addressed this concern by citing his company's product, nanoparticles-based FDA approved mask recommended for H1N1. This mask incorporates many nanoelements including silver to effectively neutralize micro-organisms on both outside and inside of the mask surface. The qualification test of the mask showed that no allergy, drug resistance and microbes' resistance were evident. It is known that currently there are not yet established universal standards and regulations on nanotoxicity, however Dr Liu highlighted that Asia-Nano Forum (ANF), a network organization promoting excellence in research, development and the economic uptake of nanotechnology within the Asian region, is in the process of coordinating the EHS (Environment, Health, and Safety) database and regional cooperation.

Moving on to the second part of the day, IE Singapore organized the very first Singapore Nanotechnology Round Table 2009 to gather local nanotech companies in discussing how IE Singapore can support the growth and international business development of the companies. Dr Liu delivered an overview of nanotechnology applications however with more emphasis on commercialization efforts of companies worldwide. A few of cited companies applying nanotechnology in their manufacturing processes and products were Samsung, CIMA Nanotech, Zyvex Performance Materials, Tera Barrier Films, and NanoMaterials Technology. In addition, IE Singapore provided some details funding schemes that support Singapore based companies, especially in terms of tax incentives and global expansion activities, for example up to 70% funding support for staff training in offshore office.

We learned from these two events that the American business and industry community in Singapore are interested in finding out nanotechnology business opportunities for them. They are also apparently concerned about safety and standards. At the same time, the Singapore government has identified nanotechnology as one of their priorities and provided attractive funding schemes for international business development and expansion of the Singapore based companies.



Dr Liu speaking about nanotechnology development and activities at the breakfast talk in American Chamber of Commerce in Singapore



Dr Liu introduced worldwide industry development of nanotechnology at IE Singapore Nanotech Round Table 2009.

## **IMRE Industry Day – Nanotechnology Showcase for Industry Commercialization (Ms. Yesie L. BRAMA, NanoGlobe)**

Over 100 participants mostly from industry were invited to participate in half-day forum of IMRE Industry Day on 11 December 2009. IMRE scientists presented four different areas of development, namely Light and Energy, Medical Technology, Advanced Materials, and Advanced Fabrication Techniques. Towards the end of the event, Tera-Barrier Films Pte Ltd, a third spin-off from IMRE shared their experience on lab-to-market, transitioning from scientists to executives and business developers.

IMRE has been very much connected to industry in their research and development activities. Many projects have successfully been licensed out to the industry for example the Atomic Layer Deposition System by Azimuth Technologies. In addition, many industry collaboration projects have been initiated and executed for example with Siemens AG, BASF, Nitto Denko, P&G, Mitsui Chemicals, Sumitomo Chemicals, Boeing Company, Rolls Royce Fuel Cell Systems, and many others.

Impressive progress is made by IMRE's spin-off, Tera-Barrier Films Pte Ltd. Starting their barrier film research development in 1999 with target on flexible OLED display, Tera-Barrier received S\$1.5M in 2006 as part of ETPL (i.e. commercialization arm of A\*STAR, a government research agency of Singapore) Flagship Project for scaling up and commercialization. Now they are able to produce world leading performance of moisture & oxygen barrier, one millionth of a gram per square meter per day, a thousand times better than existing products, with roll-to-roll scale up process. ETPL Flagship Project accelerates the commercialization process by helping on new target markets identification, making contacts with potential customers as well as with investors. Tera-Barrier Films Pte Ltd was finally launched in August 2009 with series A investment from Applied Ventures, LLC. Their produced films will be able to significantly increase the life span of organic photovoltaics (OPV) and flexible display.

Besides presenting its track record on commercialization effort, IMRE also shared their technical projects. A few exciting topics caught our attention were new polymer nanocomposite material for many applications including UV curable hard coating, which involves collaboration with Mitsui Chemicals, as well as smart materials for sensors and actuators. IMRE has developed a prototype with the use of smart piezoelectric based materials for battery-less remote control and wireless communication devices. IMRE has also developed impressive capabilities in printed electronics ranging from low-temperature & higher-transmittance ITO technology, printable blue emitter, translucent OPV, and printable semiconductor with non-toxic solvents. The group is currently seeking for industrial partners.

Overall, the Industry Day provided good platform for introducing IMRE's applied technologies and capabilities from lab to market, as well as their track record in commercialization and working with industry. It was also a good venue to gather feedback from the industry on their specific needs of technologies.



Welcome address of IMRE Industry Day by Dr Lim Kiang Wee, Executive Director of IMRE.



Dr Mark Auch, CEO of Tera-Barrier Films Pte Ltd, sharing his experience from lab to market

## **ONSITE INTERVIEW (Contributed by NANOGLOBE Team)**

### **Nano-bubbles - Green Solution for Reviving Water Ecosystems (Ms Jing JIANG, NanoGlobe)**

BioNano's proprietary water treatment system is radically different from ozone-based water treatment technology. BioNano's water treatment system can produce 200,000 nano-bubbles with the diameters ranging from 50 to 15,000 nm at extremely high pressure and temperature through reaction of air and water producing clusters of radicals. These clusters of radicals produced by BioNano's proprietary water treatment system decompose organic substances, oxidise heavy metals, neutralise stubborn chemical substances in waste or polluted water, and in the process, the suspended substance is attached to the nano-bubbles and then floats to the water surface for removal. The suspended substance can subsequently be decomposed by micro-organisms in the water or be collected as fertilised soil for agriculture use. At the end of the treatment process, the water ecosystem is restored.

During the last three years, BioNano has implemented successful waste water treatment projects in the Greater China region, including Kaohsiung City in Taiwan, Xiamen City and Shenzhen City in Mainland China. The successful project of cleaning the Landscape Lake at Shenzhen Polytechnic in July 2009 is a key milestone in the development of BioNano's business in Mainland China. The project involves the cleaning of the 1.5 square kilometers of open water body within two weeks. The dead lake became alive as a paradise for fish and other water organisms after the BioNano treatment.

BioNano set up its office in Suzhou, China in March 2009 at the Suzhou Industry Park, a high technology industrial park 80 km East of Shanghai City. BioNano set up the office after being awarded RMB10 million (USD1.47million) Suzhou Industry Park Science and Technology Pioneer in October 2008.

BioNano's office in Suzhou, China is currently conducting a project at a river East-bound into Jinji Lake, which is located within the central business district, Sihui Fang, of Suzhou Industrial Park. BioNano's ambitious goal is to improve the water quality of Tai Hu or Lake Tai, the third largest lake in China, with an area of 2400 square kilometres and water source for three provinces and Shanghai City, by improving its water ecosystem. BioNano is confident that water quality of Tai Hu can be vastly improved through its innovative and environmental friendly water treatment system.

NanoGlobe interviewed the founder, and Chairman of BioNano, Professor Fwu-Shan SHEU, in the Suzhou office of BioNano in June 2009 after BioNano completed the project at the Landscape Lake in Shenzhen Polytechnic (see Fig.1).

NanoGlobe understood from Professor Sheu that BioNano International was founded in 2003 by Professor Sheu and other stakeholders. Professor Sheu received his MSc and PhD degrees in the field of molecular and cellular neuroscience from Northwestern University, USA. He spent 16 years in the US and Hong Kong actively conducting research in functional nano-materials and sensors for application in life sciences. He was invited to join a newly established premier University Scholars Programme offered by the National University of Singapore as Associate Professor in 2000. He is currently a Principle Investigator and Senior Research Scientist of the Nano-biotechnology Research Group in the NanoCore Laboratory of the National University of Singapore. The other key members of BioNano team are established scientists and engineers who are actively involved in the implementation and further development of BioNano's proprietary water treatment system.

BioNano's mission and strategic objective is to actively contribute to the improvement of the environment on this earth that we all live in by restoring water ecosystems using its proprietary and environmentally friendly water treatment system throughout the world.



Successful lake water treatment project for the polluted Landscape Lake in Shenzhen Polytechnic: the polluted lake water before treatment is shown on the left; the clear and biologically friendly lake water after BioNano's nano-bubble treatment is shown on the right.

## Low-Cost and Creative Tools for Learning Nanoscience and Creating Nanostructures at Schools (Ms. Yesie L. BRAMA, NanoGlobe)

Impressed by the plenary presentation given by Prof Sow Chorng-Haur at Nanotech Malaysia 2009 (held in end October 2009) on low-cost fabrication of nanoscale metal oxide, NanoGlobe team visited Prof Sow on 20 Nov 2009 to find out more about him and his research activities. Prof Sow hosted our visit with great hospitality. He is an Associate Professor in the department of Physics at the National University of Singapore (NUS) with a team between 15-20 researchers and students. He is also a Fellow in NUS Teaching Academy. He is also an Assistant Dean for Outreach in the Science Faculty, and a member of NUS Nanoscience & Nanotechnology Initiative (NUSNNI).

We are most impressed by his passion for education and outreach. Besides undergraduate and graduate students, Prof Sow engages about 25 – 30 high school students to introduce nanoscience at early age and most importantly provide hands-on experience, fun and excitement in research. His teaching aspirations are to fuel students' enthusiasm in the discovery of scientific truths and nurture students' creative and innovative spirit in tackling fascinating problems. This is proven from the presence of "Our wall of crazy ideas" in his laboratory to allow his



Fig. 1. Prof Sow and Dr Liu in front of "Our Wall of Crazy Ideas".

students expressing all ideas they have and subsequently discussing the possibility of those ideas. (Fig. 1)

We are fascinated by his approach to inspire young students through his simple and low-cost methods. One example is the use of only a hot plate at controlled environment to grow wide variety of nanoscale metal oxides with fascinating morphologies, such as nanowires, nanowalls, nanoflakes and nanorods. There is no other requirement than a polished surface of the substrate in this method.

Another example is optical tweezers, which was assembled in-house by only integrating a laser source and an optical microscope. Through a focused laser beam, they are able to grab nanoparticles, generate micro and nanostructure patterns, and be used as characterization tool. Although it currently has the resolution of  $\sim 600\text{nm}$ , optical tweezers is much more affordable than focused ion beam (FIB) system (2 orders of magnitude more expensive) typically used in semiconductor industry and sophisticated laboratories. Therefore it is very suitable for his education purpose to motivate the young students in schools.

The fun of focused laser beam application for most students is to create micro-arts. Creative 3D structures such as micro-Stonehenge and micro-Great Wall (Fig. 2) are fabricated by graduate students during their vacation period. In hybrid nanomaterial systems, he explained that he can use aligned carbon nanotube (CNT) templates as natural 3D scaffold (CNT forest) for controlled assembly of various semiconducting nanoparticles quantum dots. The CNT forest acts as nano-sieve to sort out the quantum dots with a size difference of  $\sim 0.5\text{nm}$ . The focused laser beam can then be used to pattern these arrays of CNT preferentially decorated with the quantum dots, creating CNT/quantum dots multi-colour & multi-component 3D micro-sculptures. Many microstructure patterns have been created, such as micro-NUS logo, micro-pattern of Tai Chi, and micro-Singapore Island. (Fig. 3)

In the area of biophysics and biomechanics disciplines, the optical tweezers can also be used to characterize the mechanical & physical properties of red blood cells. For example, working in a team led by Prof Lim Chwee Teck, Division of Bioengineering, NUS, the team had shown the difference between a healthy and malaria-infected red blood cell. The optical tweezers can be used to stretch the blood cell and they found that healthy cell is very stretchable while the malaria-infected cell is very stiff and difficult to stretch. This method is thus very useful for diagnosis application. (Fig. 4)

Currently, Dr. Sow is one of the collaborators of a newly awarded SGD 10M Competitive Research Programme project led by Prof Subodh Mhaisalkar from NTU entitled Nanonets: New Materials, Devices for Integrated Energy Harnessing & Storage, funded by the National Research Foundation (NRF) of Singapore.

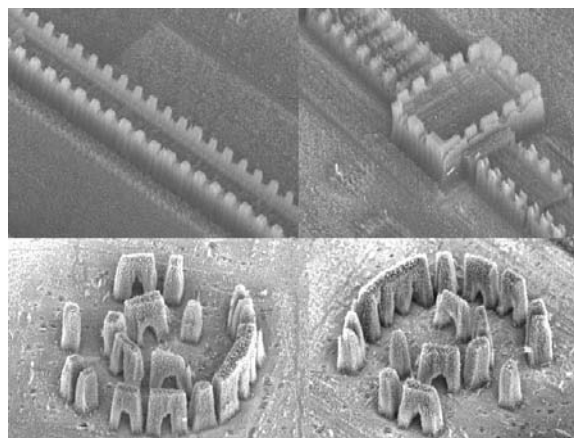


Fig. 2. pattern CNT into 3D micro-Great Wall and micro-Stonehenge (Source: Prof Sow CH, NUS)

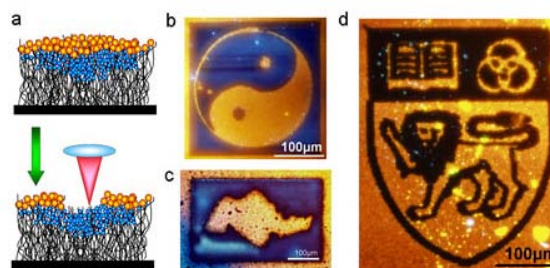


Fig. 3. (a) Schematic of the patterning process using optical tweezers for quantum dots decorated CNT. Fluorescent microscopy images of (b) Tai Chi pattern (c) Singapore Island (d) NUS logo (Source: Prof Sow CH, NUS)

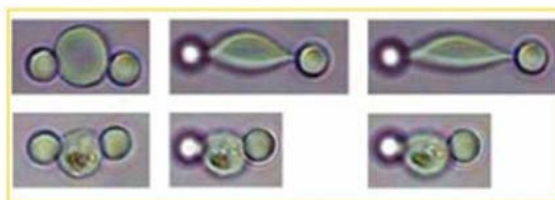


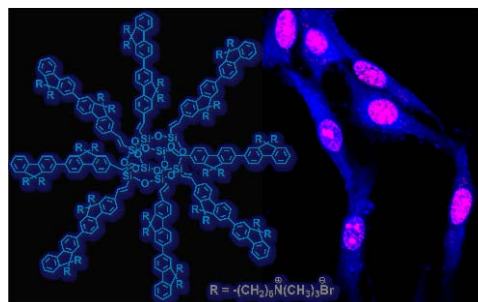
Fig. 4. Optical tweezers stretching of a healthy red cell (top row) and a stiffer red blood cell in a late stage of malarial infection (bottom row). (Source: Prof CT Lim, Div of Bioengineering, NUS)

## TECHNICAL ACHIEVEMENTS

### Hybrid Unimolecular Fluorescent Nanoparticle for Signal Amplification in Cellular Imaging (Assistant Prof Liu Bin's group, CME-NUS)

A team from the Department of Chemical and Biomolecular Engineering at the National University of Singapore has developed a bottom-up strategy to take advantage of polyhedral oligomeric silsesquioxanes (POSS) and conjugated oligoelectrolyte as building blocks to synthesize water-soluble hybrid fluorescent unimolecular nanoparticles with a diameter of  $\sim 3.6\text{ nm}$  for signal amplification in cellular imaging (chemical structure shown in the figure). This fluorescent nanomaterial possesses shape-persistent three-dimensionality, high PL quantum yield in buffer, good cytocompatibility, whole-cell permeability, and excellent fluorescent amplification ability to commercial dyes. With this nanomaterial as light-

harvesting energy donor, visualization of the entire cellular structure with weakly-emissive dyes becomes possible. This invention thus provides new opportunities to improve the performance and quality of fluorescence technologies for biological imaging through energy transfer approach using hybrid nanomaterials as the signal amplifiers. From the materials viewpoint, the emission wavelength, charge nature and diameter of POSS-based fluorescent nanoparticles can be easily adjusted through chemical modification of fluorescent arms so as to fulfill the different requirements of specific applications. In terms of materials applications, the high quantum yields and good signal amplification capability of POSS-based molecules can bring in high-quality biological images even with a small amount of indicator dyes, consequently avoiding the side effect of elevated dye concentrations.

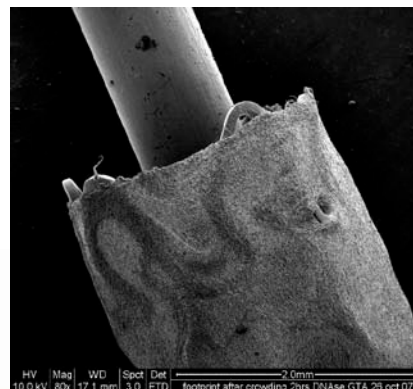


For more information, please refer to: K. Y. Pu, K. Li, B. Liu, *Adv. Mater.* 2009, on line, DOI: 10.1002/adma.200902409

### Stents coated with Electrospun Nanofibers (Prof. Seeram Ramakrishna's group, contributed by NUS Industry Liaison Office)

A team from NUS Nanoscience and Nanotechnology Initiative (NUSNNI) has produced an aligned nanofiber-covered stent. The electrospun aligned nanofibers are deposited longitudinally along the traditional bare metal stent. This allows the ease of stent expansion during deployment, while significantly reducing tears and other deformations in the nanofiber coating.

These nanofiber encased stents can be substituted for uncoated or drug-coated stents currently in use. Flexibility of the configuration permits this invention to be used merely as a physical support or to serve an additional function of delivering drug. Drugs may be easily incorporated into the nanofiber matrix and can be delivered if needed, in a slow-release, long lasting manner. These nanofiber covered stents have the inherent property of reducing vessel injury during and after implantation, due to reduced friction, physical resistance and turbulence-induction compared to conventional products. In addition to treatment of CHD, physicians can use these stents to treat abdominal aortic aneurysms, thoracic aortic aneurysms as well as aneurysms in other locations.

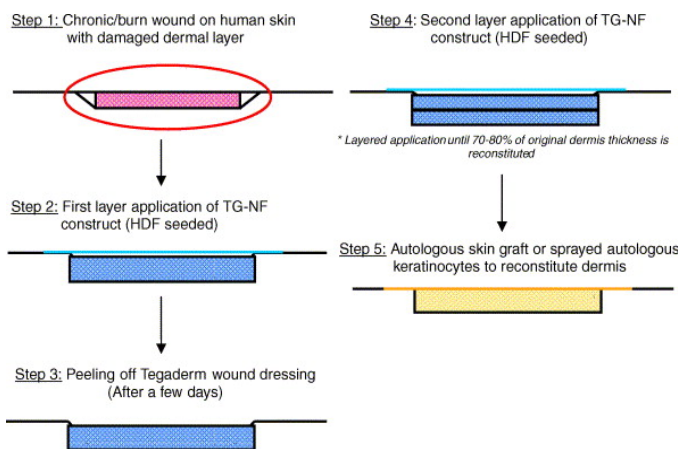


SEM image of a stent coated with aligned nanofibers in an expanded state.

### Nanofibrous Materials for Tissue Engineering, Wound Dressing & Dermal Reconstruction (Prof. Lim Chwee Teck's group, contributed by NUS Industry Liaison Office)

An invention developed by a team from Division of Bioengineering offers a cost-effective composite, to be used for dermal wound healing. This consists of a nanofibrous scaffold, made from a polymer blend of poly( $\epsilon$ -caprolactone) (PCL)/gelatin, directly electrospun onto a polyurethane dressing (Tegaderm™, 3M Medical) –the Tegaderm-nanofiber (TG-NF) construct. This invention can benefit patients by providing faster wound healing with no scarring at a lower cost.

PCL used in the PCL/gelatin nanofibrous scaffold is a soft-and-hard tissue-compatible bioresorbable material. It is also biodegradable. Thus, in vitro and in vivo biocompatible and efficacy studies on medical and drug delivery devices composed of PCL have received FDA approval. PCL/gelatin overcomes the shortcomings of natural and synthetic polymers, resulting in a new biomaterial with good biocompatibility and improved mechanical, physical and chemical properties. Culturing of cells on both sides of the nanofibrous scaffold construct resulted in a fibroblast-populated 3-dimensional dermal analogue with maximized cell loading, mimicking extracellular matrix.



## FUNDING/GRANT UPDATES

### **IE Singapore supports Singapore-based nanotechnology companies in accessing global markets (contributed by Mr Timothy Chua, International Enterprise Singapore)**

You have a great product or service. Now it's time to take it further. Singapore-based nanotechnology companies can tap on International Enterprise (IE) Singapore's range of services to export, develop business capabilities, find overseas partners and enter new markets.

To ease your overseas foray, IE Singapore has a suite of financing, grants and tax deduction schemes to provide financial assistance and support. Our financing schemes facilitate access to capital, while our grants and tax incentives cover cost of expenses in specific key areas.

IE Singapore also has a wide range of assistance programmes to help you build your internationalisation competencies. With our suite of capability development programmes, IE Singapore can help your company hone business capabilities in areas such as branding, design, manpower, intellectual property management and alliance formation.

With a global network in over 30 locations, IE Singapore can offer you the necessary connections to venture overseas. Whether you are looking for buyers or joint venture partners overseas, we can help you get connected. You can also join us on our business missions and trade fairs to explore overseas opportunities and build business networks. In addition, IE Singapore also holds regular market-based seminars for you to learn more about the opportunities in overseas markets.

For more information on how IE Singapore can support your internationalisation journey, please visit [www.iesingapore.com](http://www.iesingapore.com) or contact Timothy Chua, +65 6433 4443, [Timothy.Chua@iesingapore.gov.sg](mailto:Timothy.Chua@iesingapore.gov.sg)

### **16 Technology Commercialization Projects Receive S\$4 Million POC Grant from NRF (Source: NRF Press Release)**

On August 21, 2009, the National Research Foundation (NRF) announced the award of the Proof-of-Concept (POC) grant to 16 projects from the institutes of higher learning (IHLs). S\$75 million has been set aside for this purpose under the NRF's Proof-of-Concept Scheme 1. The 16 project teams will each receive up to S\$250,000 to develop their inventions into prototypes, bringing them closer to commercialization. This second POC grant call received 91 proposals submitted by Singapore-based researchers from the local universities and polytechnics, including UniSIM. Twenty seven proposals were shortlisted by the POC panel for presentation, out of which 16 were recommended for award. Apart from NUS and NTU, awarded projects this round also came for the first time, from the Duke-NUS Graduate Medical School, the Singapore Management University (SMU), Singapore Polytechnic and Republic Polytechnic.

NRF expects that the POC scheme will encourage many more researchers to take the step of developing their ideas beyond invention into useful applications for the market. Dr Lerwen Liu, a member of NRF's POC evaluation panel said: "It was very encouraging to see a number of very interesting proposals this round. The POC scheme provides a great incentive to encourage academics to pursue industry application of their research. As for the private sector, POC provides a valuable bridge and reduce risk for investors. I am particularly pleased to see some of the proposals prepared by young scientists." Besides POC, NRF has recently provided S\$22 million to the 3 universities to encourage academic entrepreneurship and another S\$25 million to fund translational research & development in the 5 polytechnics. The 4 nanotechnology related NRF POC awarding projects are:

- Low Cost High Performance Anti Reflective Coating based on Sinanocrystals Embedded in SiO<sub>2</sub> Film (Eunice Goh Shing Mei, PhD student in NTU)
- High Efficiency Electrogenerated Chemiluminescence with Colloidal Quantum Dot Emitters in Ultrathin Cells for Display Applications (Dr Sun Xiaowei, NTU)
- Photonic MEMS (Microelectromechanical Systems) Tunable Laser (Prof Liu Ai Qun, NTU)
- New Compact, Fast, Parallel-processing Fourier-transform Interferometer (FPP FTIR) Enabling Short-pulse Spectroscopy (Prof Herbert O. Moser, NUS)
- Development of a New and Precise Alignment System for Micromanipulation (Prof Tan Kok Kiong, NUS)
- Development of a Hand - held Solid Dispenser Using a Motor - Driven Auger (Dr Ken Lee, Singapore Polytechnic)

## NANOTECH NEWS

### **Elmarco and National University of Singapore have started Joint Projects (Contributed by Prof. Seeram Ramakrishna's group, NUSNNI)**

[Elmarco](#), industry's first supplier of industrial scale nanofiber production equipment, and [National University of Singapore](#) (NUS), a leading global university centered in Asia, today announced they have started a work on joint development projects.

Elmarco and NUS signed a Memorandum of Understanding (MOU) on March 2009 and agreed to explore novel nanoscale materials at industrial scale and contributing their respective expertise, know-how and access to relevant academic and industry networks. Successful outcomes of the agreement are anticipated to provide breakthrough in water treatment, health, energy and environment related applications.

One of the results of partnership between NUS, Elmarco and other partners will be a water filtration equipment that will use nanofiber membranes. This equipment should solve problems with drinking water in the regions, where people suffer from water contamination.

“Water is expected to be more and more valuable in the future. Therefore water pollution is becoming a global problem. New materials contribute to solving the global issue with safe drinking water“ said Mr. Ladislav Mares, Executive Director of ELMARCO. Other key research topics are the development of dyesensitized solar cells (DSSC) and Li-ion batteries for EV by introducing nanofibers. “The new joint development represents an important and exciting partnership” said Prof. Seeram Ramakrishna, who serves as the Vice President (Research Strategy) at the National University of Singapore. He is an acknowledged global leader for his pioneering work on engineering of nanofibers for regenerative medicine, harvesting solar energy, and water treatment. “We think it is important to pursue research that could accelerate the use of nanofibers since we believe they may play an important role in manufacturing high value added products in emerging markets” noted Ladislav Mares.



(From right side) Ladislav Mares, Executive Director of Elmarco s.r.o., Prof. Seeram Ramakrishna and Kaz Nomoto.

## Introducing NANO Magazine: The Magazine for Small Science (Contributed by Nano Magazine)



NANO Magazine is a dynamic magazine featuring the latest nanotechnology applications, views, news and reviews worldwide.

Each issue includes reviews written by leading experts and contributions from key figures in industry and academia. Features range from nanotechnologies for tackling cancer, fighting crime or uses in household products and food. Regular articles cover nanotechnologies for industry, medicine and the environment, alongside interviews with the leading lights of the nanotechnology world and profiles of countries investing in nanotech.

In Issue 14, NANO magazine examines the many applications of nanomaterials: from thin films and protective coatings, to controlled release materials and even applications in the fashion world. Other articles include a UK Country Profile, an interview with Peter Dobson, a review of nanotoxicology and a behind the scenes look at the activities of the Leibniz Institute for New Materials.

[Read Issue 14's Nanogold and nanosilver wool in high fashion apparel, textiles and carpets for free](#)

[Click here to read more or subscribe.](#)

## Baytubes® carbon nanotubes to be used in innovative safety technology to prevent explosions in fuel tanks (Source: Bayer MaterialScience News Release)

Baytubes® multi-wall carbon nanotubes (CNTs) from Bayer MaterialScience AG are to be used in an innovative safety technology that significantly reduces the risk of explosions in fuel tanks. Bayer MaterialScience AG and Hirtenberger PROSAFE Safety Technology GmbH (HPST), Hirtenberg, Austria, have completed an exclusive worldwide cooperation and supply contract for Baytubes CNTs. HPST is to use the Bayer MaterialScience AG product in the manufacture of newly developed spheres designed to prevent the formation of explosive gas mixtures in fuel tanks. The spheres are soon to be introduced onto the global market under the name SAFEBALL. They offer considerable advantages over the extruded metal mesh or plastic foams previously used for this purpose.

SAFEBALLS take the form of hollow spheres that are introduced into a tank and completely fill it. Despite this, the available volume of the tank is only reduced by approximately 8.5 percent. Two of the advantages of SAFEBALLS are that they not only prevent an explosive mixture of gas and air in a tank from exploding, but also allow the tank to “breathe,” so

that significantly smaller quantities of hydrocarbons are released into the environment. In this way, the spheres can also make a significant contribution to environmental protection in the future.

Their special shape allows fuel to flow freely but prevents any dangerous surging. Surging occurs when large volumes of liquid are displaced, for example while a road tanker is in operation, thus affecting the vehicle's stability. When a tank is to be cleaned, the SAFEBALL spheres can easily be removed and then replaced once the operation is complete. They are also treated with anti-fungal and anti-bacterial agents.

All these benefits are due to the exceptional properties of Baytubes CNTs from Bayer MaterialScience AG. Nanotubes exhibit a high level of electrical conductivity and mechanical strength and are extremely light in weight. "Without CNTs from Bayer MaterialScience AG, it would have been impossible to develop our technology so quickly," said HPST CEO Thomas Stelzl, the inventor of the SAFEBALL concept, at the signing of the agreement. "Bayer MaterialScience AG was our first choice supplier right from the start, because we knew we could rely absolutely on the specified purity and quality of the CNTs and, even more importantly, on Bayer MaterialScience AG's ability to deliver the raw materials we need to meet increasing order volumes."

Thanks to the development of an innovative, in-house production process, Bayer MaterialScience AG is one of the few companies in the world capable of producing CNTs of the required high purity on an industrial scale. As early as 2007, the company started operations at a pilot plant in Laufenburg, Germany, that can produce 60 metric tons per year. Another pilot facility with an annual capacity of 200 metric tons is currently under construction at CHEMPARK Leverkusen.

SAFEBALLS can be produced with a range of additional functions for special applications. These include fire-extinguishing – for which a special gel is incorporated into the spheres – and the integration of active and passive transponders that enable vehicle data to be electronically stored to prevent theft or provide information on maintenance.

## **Webinar Series of Application for Nanomedicine: New Strategies and Innovations to Understand, Treat, and Monitor Disease (contributed by UC San Diego)**

UC San Diego School of Medicine and UC San Diego Moores Cancer Center invite you to participate in the Webinar Series of Application for Nanomedicine: New Strategies and Innovations to Understand, Treat, and Monitor Disease. This unique webinar series brings expertise from many fields at UC San Diego and it is intended to demonstrate how nanotechnology can enhance the diagnosis, monitoring and cutting edge treatments of cancer. At UC San Diego they have built a program that incorporates nanotechnology in cancer care and they would like to educate you on this new discipline. This course will illustrate applications of nanotechnology in cancer treatment that are soon to be available in a clinic near you.

This series is divided into weekly modules which can be viewed separately or one can participate in the full series to get the complete picture on how incorporating nanotechnology is changing cancer treatment.

This year's course is especially pertinent to the practice of medicine and for practitioners who take care of cancer patients in 2010 and is intended for primary care, internal medicine, general practice, surgeons and all other interested healthcare professionals. Members from the research, academic and industry sectors will also benefit from this course. This course is a live and interactive course and we would love to get your feedback, questions and interest in new applications that may be pertinent to your practice of medicine. More details refer to <http://ntc-ccne.org/Seminars/nanomed/index.html>.

## **UPCOMING EVENTS (contributed by EDITOR)**

### **Singapore**

#### **IMRE Seminar on "Polymeric Nanostructures for Chemical and Biomedical Applications"**

06 January 2010 (10.00 am – 11.00 am), Seminar Room 1, Institute of Materials Research and Engineering (IMRE), Singapore

Website: <http://www.imre.a-star.edu.sg>

#### **Workshop on Printable Electronics Research**

08 January 2010 (9.00 am – 6.30pm), Seminar Room 1, Institute of Materials Research and Engineering (IMRE), Singapore

Online registration: <http://www.imre.a-star.edu.sg/events-register/per/>

#### **SIMTech-SPRING Singapore-NTU Joint Seminar: Green Products from Photocatalytic Technology: Applications and Standardisation**

08 January 2010 (1:00 – 5:00 pm), SIMTech Auditorium, Tower Block, Level 3, Singapore

Website: <http://www.simtech.a-star.edu.sg/simcorp/loadEventDetail.do?id=1.6&currId=1.6.1&cid=4718602&pid=24510465>

#### **2010 International Conference on Nanotechnology, Optoelectronics and Photonics Technologies (NOPT 2010)**

26-28 February 2010, Singapore

Website: <http://www.iacsit.org/nopt/confs.htm>

#### **The 2nd International Conference on Computer and Automation Engineering**

26-28 February 2010, NEC, Singapore

Website: <http://www.iccae.org>

#### **Science and Technology Fest 2010**

03-05 March 2010, BSF, Singapore

Website: [http://eastar.eventshub.sg/ems\\_wb\\_Details.aspx?CallID=28&EventID=111092](http://eastar.eventshub.sg/ems_wb_Details.aspx?CallID=28&EventID=111092)

#### **Semicon Singapore**

19-21 May 2010, Suntec Singapore, Singapore

Website: <http://www.semiconsingapore.org/index.htm>

#### **International Conference on Precision Engineering (ICoPE2010) and 13th ICPE**

28 – 30 July 2010, Grand Copthorne Waterfront Hotel, 392 Havelock Road, Singapore

Website: <http://www.simtech.a-star.edu.sg/simcorp/loadEventDetail.do?id=1.6&currId=1.6.1&cid=4718602&pid=18513921>

### **Worldwide**

#### **Photon's 5<sup>th</sup> Solar Terawatt-hours Conference Series**

02-04 February 2010, San Francisco, California, US

Website: [http://www.photon-expo.com/en/pts\\_2010\\_usa/sthc\\_2010.htm](http://www.photon-expo.com/en/pts_2010_usa/sthc_2010.htm)

#### **nano tech 2010 International Nanotechnology Exhibition & Conference**

17 - 19 February 2010, Tokyo, Japan

Website: <http://www.nanotechexpo.jp/en/index.html>

#### **2010 IEEE International Symposium on Biomedical Imaging: From Nano to Macro**

14 – 17 April 2010, Rotterdam, Netherlands

Website: <http://www.biomedicalimaging.org/>

#### **Hannover Messe**

19-23 April 2010, Exhibition Grounds, 30521 Hannover, Germany

Website: [http://www.hannovermesse.de/homepage\\_e](http://www.hannovermesse.de/homepage_e)

#### **2010 China International Micromachine/MEMS Exhibition & New Technology and Industrialization Forum**

27-29 May 2010, Shanghai, China

Website: [www.memschina.com](http://www.memschina.com)

#### **Nanomaterials 2010**

8-10 June 2010, Hotel Russel, London, UK

Website: <http://www.nanomaterials2010.com/>

#### **Nano conference & Expo 2010 (NSTI 2010)**

21-25 June 2010, Anaheim, CA, US

Website: <http://www.techconnectworld.com/Nanotech2010>