Asia Nano Forum

NEWSLETTER

Activities of January – June 2022

ISSUE NO.40 | SEPTEMBER | 2022

ANF Newsletter Topic:

- Overview by ANF President
- Activities in Member Countries
- Calendar of Events
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Asia Nanotechnology Leaders

Shaping the Future of Science & Technology for Socio-Economic Well-Being

Asia Nano Forum (ANF)
is a **network organization**, founded in May 2004 and now a registered society in Singapore, known as Asia Nano Forum Society, since Oct 2007.

ANF mission
To promote responsible development of nanotechnology that educationally, socially, environmentally, and economically benefits each economy by fostering international network collaboration.

ANF objectives

- Foster nanotechnology in the region by creating mechanisms to share information, human and physical resources, and expertise
- Support regional economic and environmental development through joint projects addressing major regional issues, with an emphasis on support of developing and emerging economies
- Coordinate joint investment in and mutual access to major infrastructure by member economies
- Promote and coordinate standardization and safety of nanotechnology concepts and measurements
- Act as an advocacy group for nanotechnology in the region and for adequate regional representation of nanotechnology at global forums
- Initiate, promote, and manage co-operative scientific and technology research projects within the member economies
- Enhance public awareness and education of nanotechnology and associated social, environmental, health and economic issues

❖ **Working Groups**

Standardization
Coordinator:
Dr. Ting-Tang SONG
(ITRI, Taiwan)

User-Facility Network
Coordinator:
Dr. Yasuo KOIDE
(NIMS, Japan)

Nano Safety and Risk Management
Coordinators:
Dr. Wannee CHINSIRIKUL
(NANOTEC, Thailand)
Dr. Paul WRIGHT
(RMIT, Australia)

Commercialization
Coordinators:
Dr. Rezal Khairi AHMAD
(NanoMalaysia, Malaysia)
Mr. Alexander POGANY
(BMK, Austria)
Dr. Jun'ichi SONE
(JST, Japan)

Contents

Overview

Over the past three years under the COVID-19 pandemic, we all remain continuing our relationships and collaboration related to nanotechnology activities. There are several successful events, such as the 1st ANF ExCo Meeting on 26 January 2022, ANF Working Group Workshop on User-Facility Network on 27 January 2022, and the 4th Virtual Meeting of International Network Initiative on Safe and Sustainable Nanotechnologies (INISS-nano) on 8 April 2022, etc.

In this September issue, we are pleased to present trends and activities on advanced nanotechnology from ANF member economies. We would like to thank all ANF members for their support in sharing update information for this newsletter. All organizations are welcome to join this nanotechnology networking to foster nanotechnology in the region by creating mechanisms to share information, human and physical resources, and expertise.

Finally, I would like to express my sincere gratitude to my colleagues, especially ANF Office Bearers, both Vice Presidents, Dr. Rezal Khairi Ahmad and Dr. Annabelle V. Briones, both Secretaries, Dr. Jason Chang and Dr. Pavadee Aungkavattana and their teams, and Treasurer, Dr. Shuhei Numazawa. They have been extremely working hard in keeping ANF on track during this difficult moment of the COVID-19 era. With kind support from every sector, I believe that we can work together to extend network collaborations for greatest outcome on nanotechnology development among us. Until we can meet again in the next ANF summit, I wish you all the best and stay safe.

Wannee Chinsirikul
President, Asia Nano Forum

Activities in Member Countries

INDIA

National Institute of Technology, Srinagar is one of the premier Educational Institutes in the Northern Regions of the country. It was established in 1960 and has been one of the eighteen Regional Engineering Colleges sponsored by the Government of India during the 2nd Plan. The Institute acquired the status of National Institute of Technology with deemed to be University status during August 2003 and attained full autonomy in its Academics.

1. The Environmental Symposium on "Our Relation with Nature"

All the UN's Sustainable Development Goals (SDGs) have some connection to the environment and the Goal 6 (Clean Water and Sanitation), Goal 7 (Affordable and Clean Energy), Goal 11 (Sustainable Cities and Communities), Goal 12 (Responsible Consumption and Production), Goal 13 (Climate Action), Goal 14 (Life Below Water), and Goal 15, (Life on Land) are issues to be discussed on 5 June 2022. We at NIT Srinagar are committed to address all major issues related to SDGs in collaborations with prestigious institutions of the government and organizations.

The Environmental Symposium, entitled, "Our Relation with Nature" in collaboration with Government of UT and in association with NLCO aims to become the leading annual symposium at NIT Srinagar, the first of which was celebrated in 2021. The goal is to encourage students to take leading role in protecting the environment (which is hugely complex system that includes the air *WE* breathe, the land *WE* live on, the water *WE* drink and the climate around us) through knowledge, awareness, and consciousness. With kind support of Prof. Sehgal, Director, Shri Manzoor Wangnoo, Chairman NLCO, Shri G N Var, Chairman, PSA and under the Chairmanship of Dr. M A Shah, Professor and Head, PG Department of Physics, a marvelous one-day summit was organized for the School and College Children on 5 June 2022 with few themes as.

(A) Unplanned urbanization: it leads to myriad problems - encroachment of land, poor runoff systems, water logging, unscientific waste dumping, minimum accessibility through roads, vulnerability of people and properly during natural calamities like floods and earthquakes.
(B) Biodiversity loss: deforestation has led to a sharp decrease of biodiversity in our beautiful valley, humans have encroached in the wild forests to make industries, commercial and residential buildings, such areas need protection.
(C) Untreated wastes dumped in water bodies: the hazardous bio-medical wastes from hospitals are dumped directly into the water bodies. This water is used by the local populations for various purposes, the intake of such water is carcinogenic and a health hazard.

Prof. M A Shah felicitating the Deans, Guests, Sponsors, Volunteers and Student winners for their excellent performance

2. Clean Soil and Sagar for peace & prosperity

Physics - Nature & Sustainability

Inculcate, Educate and Encourage students to take leading role in the protecting the environment, which is hugely complex system that includes the air *WE* breathe, the land *WE* live on, the water *WE* drink and the climate around us, through scientific knowledge, mass awareness and consciousness for sustainability. All most, all the United Nation's Sustainable Development Goals (SDGs) have connection to the environment and quality education. The issues related to the planet earth have been identified and the innovators need to come forward to find an amicable solution for the prosperity and peace.

To prevent soil pollution

1. Polythene suppliers/manufacturers should be given a deadline by the J&K Pollution Control Board and a complete ban on its manufacture, import and use should be forced and implemented. The suppliers should be encouraged for production of sustainable and eco-friendly alternatives such as cloth bags, Jute bags, paper bags.
2. Minimize the single use of plastics in homes and Government offices. An alternate approach like use of glass bottles/ jugs etc, can be used and reused.
3. Packing material for food items should be of non-plastic/food safe bags, which can be reused or recycled.
4. Limited use of pesticides and fertilizers should be permitted, in consultation with the Agriculture and Horticulture experts. Excessive use of agrichemicals by farmers should be banned and strictly monitored by the Agriculture/Horticulture Department. Organic farming and use of vermi-compost should be encouraged. Hon'ble LG (J&K) was first one to has launched, Nano-fertilizer, which will not only reduce pollution, but also will bring Green Revolution.
5. Effective e-waste management policy should be put in place and risks emerging from e-waste should be taken seriously.
6. Toxic metal and metalloid containing products should be banned. These persistent toxic chemical like Mercury (Hg), Arsenic (As), Cadmium (Cd), Lead (Pb) etc. contaminate air, soil and water and accumulate in different organism and entire ecosystems thereby causing severe toxicities to humans, plants and wildlife.
7. The forest acts need to be more stringent and uncompressing. The trees are natural oxygen banks and have ability to keep elevated global temperature in control, thus help in cope with climate change, which is of major concern.

Preventing air pollution:

1. Surface and Air Transport causes air pollution and is a significant contributor to global warming. Use of bicycles should be encouraged and promoted for shorter distances.
2. School transportation system should be minimized, by encouraging students to walk or use bicycles, for shorter distances within three kilometres. Government can consider providing free bicycles to children of poor families.
3. Electric vehicles, electric two wheelers should be promoted by Govt and subsidised. The necessary infrastructure for charging such vehicles should be put in place.

4. Outdated vehicles should be banned from plying on the roads and mechanism for buying back such vehicles should be explored both for commercial and private vehicles.
5. Industries such as Brick Kilns, Cement factories, Stone Crushers etc. which cause excessive air pollution, should be shifted to barren lands, in far-flung uninhabited areas and installed with pollution depressant devices to mitigate air pollution.
6. Green technologies should be promoted by the govt as it is cheap, environmentally benign and free from health hazards.
7. We need to install nano-sensors to guard the environment and our surroundings. Graphene sensors are revolutionizing construction, communication and air monitoring.

Preventing water pollution

1. A comprehensive policy for conservation of all water bodies including River Jhelum, Dal Lake, Wular Lake and other adjoining lakes should be enforced.
2. Rehabilitation Policy for inhabitants of Dal Lake, should be implemented on priority.
3. Rivers and channels be protected with strengthened embankments to avoid loss of water and prevent pollution.
4. The smaller channels in cities and villages should be restored, so that water is not polluted. The natural water supply should be used for multipurpose, including in construction.
5. Drinking water from PHE taps should not be allowed to be mis-used for construction purposes, washing of vehicles or gardening etc.
6. Municipal Corporations should make it mandatory to have bore well/ Hand pump before granting construction permission.
7. Rainwater recharge/ harvest should be implemented at Govt and house hold scale for irrigating lawns and gardens.

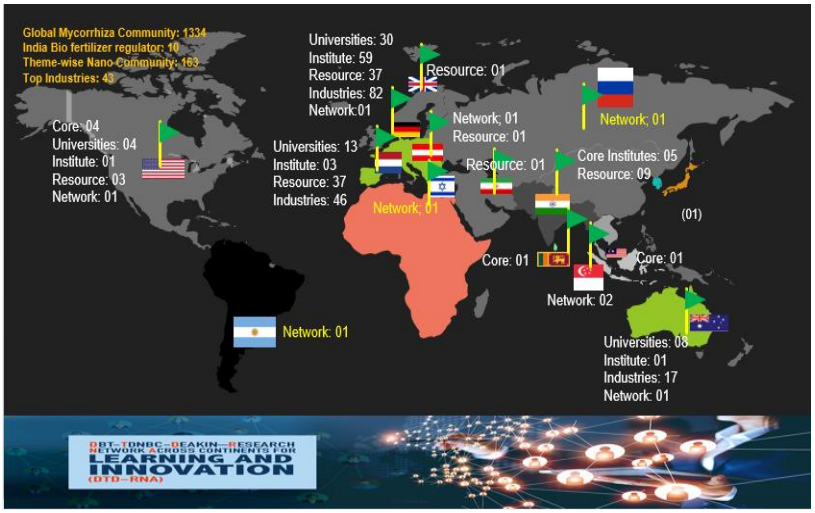
The bottom line is that:

- The Teachers need to teach the importance of water and soil conservation and assign projects of looking for alternate ways to save water in the home/ gardens. Teach them to grow plants and vegetables in schools, which will help to develop an interest in the environmental issues.
- Give projects to students how to run cars, cabs and motors on energies other than the fossil fuels. Teach the benefits of sustainable transport options such as cycling. Not only does cycling help the environment but it is also a great way to keep our population fit.
- Teach them how to generate electricity from solar power. There are many small items such as garden lights that are perfect for solar power and small in built panels will collect generate enough power to provide a light in a garden for many hours.
- Government departments / enforcement agencies/ NGOs should join hands with the public to save running water bodies, fresh forests and ban what is disastrous for environment.
- The Mother earth is going to get unkind if soon we don't go green. So green technologies should be promoted and adopted everywhere, including in our laboratories and lands.

Thus, we need to **hold hands to save the environment** and extend help to organizations/institutions/ Boards for such noble causes. We will be at forefront for such a noble cause. It plays an important role in healthy living and the existence of life on**," Only One Planet". NLCO Chairperson is doing exceptional work for wetlands and water bodies.**

The TERI-Deakin Nanobiotechnology Centre (TDNBC) is a major flagship program of Sustainable Agriculture, and it was established in 2010 by collaboration between India's research think-tank TERI and Australia's Deakin University. TDNBC, TERI, India and Deakin University, Australia are two destinations engaged in intensive research around agriculture, material science, food storage and safety. Innovation in the area of Nanoscience in Deakin University, Australia is also on forefront therefore in 2010, a strategic engagement was established between Deakin University in Australia and TERI, New Delhi India and the centre "TERI-Deakin Nanobiotechnology (TDNBC)" was created at TERI Gram, Gurugram, India. Considering the importance and relevance of joint research platform, TERI-Deakin Nanobiotechnology Centre (TDNBC), Gurugram, India and Deakin University, Australia, in association with Department of Biotechnology, Government of India has created "DBT -TDNBC - DEAKIN – Research Network Across continents for learning and innovation (DTD-RNA)".

This is the unique network and has the vision to contribute to a better world through nanotechnology. The Nanotechnology field is one of the fastest growing areas of research and technology. DTDRNA is dedicated to substantially enhancing research outcomes across continents in this important field by promoting effective collaborations, exposing researchers to alternative and complementary approaches from other fields, encouraging forums for postgraduate students and early career researchers, increasing nanotechnology infrastructure, enhancing awareness of existing infrastructure, creating technology pipelines and IPRs, facilitating technology incubation, transfers and commercialization, connect with industries and promoting international links. DTD-RNA is achieving these goals through its dedication to bringing together all the various groups working in the field of Nanotechnology and related areas across continents. https://www.teriin.org/projects/dtd-rna/events.php



In the first six months of this year (2022) Three (3) Summer school, Two (2) Hands on Training Programs, One (1) E-Winter school and One (1) Webinar on subject including (i) Electrolysis

of Water were organized which are nanotech activities for training researchers, regulators, farmers and industries across the globe. The details of each of the training program and webinars are presented hereafter.

1. E- Winter School on Advanced Applications of Nanotechnology for Food and Environment conducted" on 15 February 2022

The rapid development of nanotechnology has facilitated the transformations of traditional food and agriculture sectors, particularly the invention of smart and active packaging, nanosensors, nanopesticides and nanofertilizers. Numerous novel nanomaterials have been developed for improving food quality and safety, crop growth, and monitoring environmental conditions.

The TERI-Deakin Nanobiotechnology Centre conducted an e-winter school (online mode) on the "Advanced Applications of Nanotechnology for Food and Environment" on 15 February 2022. The intense one-day program aimed to promote research perspective and impart transformative educational experience to students, young researchers, and industrial participants.

The winter school included five different themes on theory and practical sessions. In Session I, the experts shared the existing state of the art on nanomaterials, the challenges involved in the synthesis, characterization, and their applications in agriculture. Session II was based upon 'natural biodegradable polymer-based nano-composites'. The invited talks were focused on the extraction of cellulosic materials from agro-waste and their applications in different areas. Session III was based on 'nanomaterials for rapid detection and food sensors' where portable nanosensing devices' design and application aspects were discussed. In particular, the Session focused on the portable and onsite nanosensors developments for food contaminants, pathogens, and other toxicants and their validation priorities, such as sensitivity, specificity, and precision. Session IV was based on developing food pigments from algae with improved bioavailability and stability for applications

TERI-Deakin Nanobiotechnology Centre (TDNBC) organized Instructor - led live hands-on training modules and Lecture Series for imparting training/ skill development of the scientific community, industries, and other stakeholders having interest in nanobiotechnology.

An invited talk was delivered on 'food preservation using novel nanofibers' in Session V. The speaker discussed the development of green polymeric nanofibers and their utilization in food packaging and preservations via incorporations of active biomolecules.

Various experimental videos were also shown during the Winter School to understand better the topics discussed above. Through participatory learning experiences facilitated by multidisciplinary faculty-student interactions, interactive lectures, and innovative learning methods, the program helped the participants explore numerous opportunities in the said areas.

2. The first HANDS ON TRAINING MODULE (Offline): Instructor-led live hands-on-training conducted, and lecture delivered on the "Synthesis and Characterization of Nanomaterials" on 22 February 2022

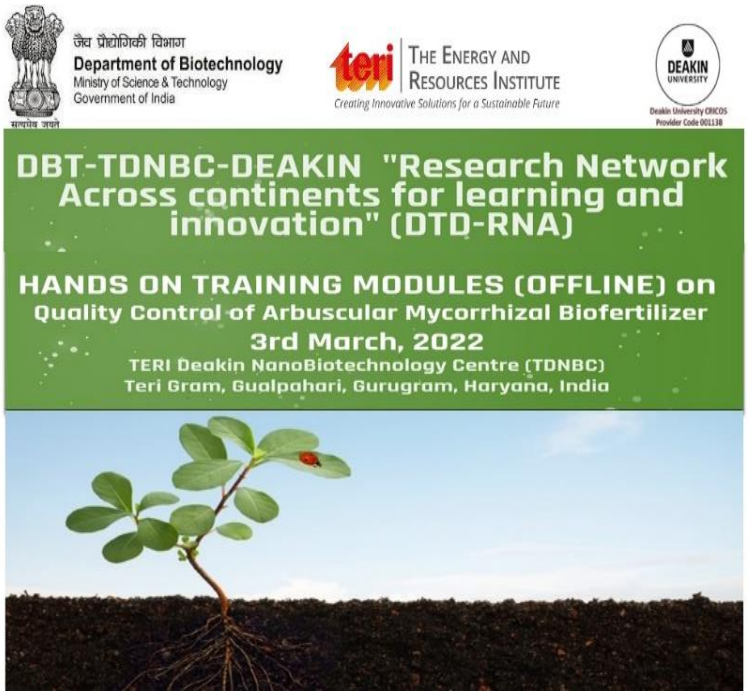
Nanotechnology is a promising science with wide applications from cosmetics, food products, clothing, and household appliances to fuel catalyst, disease treatment, and renewable energies. Nanotechnology is also being applied to various industrial and purification processes by interfacing the nanomaterials with biological molecules or structures, "green technology" to enhance environmental sustainability, and "renewable energy" to develop new ways to capture and store and transfer energy.

The TERI-Deakin Nanobiotechnology Centre (TDNBC) in collaboration with the Department of Biotechnology, Government of India hosted an in-person instructor-led live hands-on-training program to share the knowledge of synthesis and characterization of nanomaterials. The training sessions were held on February 22, 2022 at TDNBC, Gurugram.

Nanotechnology constitutes one of the many critical aspects of the contemporary trends of science and advanced technologies globally. TDNBC is one of the pioneer institutes working in this area. The said training modules were unique learning propositions to the participants and aim at equipping them with the evolving concepts, tools, practices, perspectives, and approaches in nanotechnology. These modules also strive to develop a sound knowledge base, collaborative analysis, and ability to appreciate varied views of a vibrant group of mixed (academia and industry) participants. The training pedagogies in different modules were aptly aligned to their specific needs and foster more effective comprehension through participative learning. The interdisciplinary faculty at TDNBC, offering these programs, was a perfect blend of knowledge, experience, and training skills.

3. The second instructor-led live hands-on-training conducted on quality control of arbuscular mycorrhizal bio-fertilizers on 3 march 2022

Bio-fertilizers based on mycorrhizal fungi represent a natural way to enrich the soil in respect of environmental balance. Arbuscular mycorrhizal fungi (amf) are the most common symbiotic association between terrestrial plants and microorganisms, which are known to improve plants development and growth, especially under stress conditions. The potential for application of amf in agricultures is an agro-ecological approach to allow better use of soil nutrient reserves. That receives increasing consideration for their prospective application for sustainable agriculture



The TERI-Deakin Nanobiotechnology Centre (TDNBC) with support from Department of Biotechnology, Government of India hosted an in-person instructor-led live hands-on-training program to share systematic and practical knowledge about ‘Quality Control of Arbuscular Mycorrhizal Biofertilizers’. The training sessions were held on 3 March 2022 from 10:00 AM to 3:30 PM at TDNBC, Gurugram.



4. Summer School on "Advanced techniques on Microbiological Biotechnology" on 11 May 2022

A summer school on "Advanced techniques on Microbiological Biotechnology" organized by TERI-Deakin Nanobiotechnology Centre (TD-NBC) along with International Iberian Nanotechnology Laboratory (INL), Braga, Portugal through DBT -TDNBC - DEAKIN – Research Network Across continents for learning and innovation (DTD-RNA) network. The one-day program with 9 M.Sc. Biotechnology student was chaired by Dr. Pushplata Singh, Director, TERI-Deakin Nanobiotechnology Centre (TDNBC), Gurugram, India & Dr. Shruti Shukla, Fellow, TDNBC. The program has been successfully organized by Dr. Shovon Mandal, Fellow, TDNBC, Dr. Amritpreet Kaur Minhas, Associate Fellow, TDNBC and Dr. Leena Johny, Associate Fellow, TDNBC on 11 May 2022.

The training program included two different sessions, Session I focused on '**Demonstration on morphological and molecular characterization techniques of Arbuscular Mycorrhizal fungi'** where the participants were briefed about the different mycorrhizal structures formed during the symbiotic association along with demonstration of the staining techniques used to define the mycorrhizal spore characteristics using microscopic analysis. This was followed with molecular characterization where extraction of genomic DNA from mycorrhizal spore was demonstrated and explanation regarding different instrumentation utilized to analyse the extracted genomic DNA was shared with the participants. Session II was based upon '**Demonstration on Algae culturing techniques and biochemical Characterisation**' where the discussion was focused on basis of selection of algal habitat for different applications (agriculture, carotenoids, and biofuels). Experts shared their recent accomplishments with participants to enhance the society's understanding of the existing state of the art on algal biology and other resources to identify challenges.

The session II was followed by the visit to outdoor microalgal pilot scale production facility where the experts showed the possible solutions to overcome the challenges and knowledge gaps in the downstream processing of microalgae at pilot scale with a central focus on maintaining the quality of the products and biomass.

Overall, it was a dedicated forum to discuss 'How microalgae can be a great advantage for industrial applications?' and 'How can they be promoted and exploited in a better manner?' Hence, experts demonstrate the approaches for effective cultivation strategies with main emphasis being on the downstream processing via offline platform.

There was an overwhelming response from the students who participated actively in the program and have gained valuable learnings that would help them in achieving their research goals.



5. Summer School on "Nano-based Solutions for Agriculture and Environment" on 17 May 2022.

A summer school on "Nano-based Solutions for Agriculture and Environment" was organized by TERI-Deakin Nanobiotechnology Centre (TD-NBC) along with International Iberian Nanotechnology Laboratory (INL), Braga, Portugal through DBT –TDNBC – DEAKIN – Research Network Across continents for learning and innovation (DTD-RNA) network. The one-day programme with 9 MSc Biotechnology students was chaired by Dr. Pushplata Singh, Director, TERI-Deakin Nanobiotechnology Centre (TDNBC), Gurugram, India. The programme has been successfully organized by Dr Ruchi Agrawal, Associate Fellow, TDNBC and Dr Suneeti Singh, Research Scientist, TDNBC on 17 May 2022.

The summer school included two major sessions. Session, I focused on an overview of nanotechnology and its applications in different field. Subject expert of nanomaterials, Dr. Suneeti Singh gave a detailed lecture on "Introduction to Nanotechnology and Its Application for Environmental Health and Safety", where the participants were briefed about the various nanomaterials and mechanisms for their synthesis along with a brief on the impact of nanotechnology in agriculture. The session continued with laboratory visit and demonstration on nanomaterials synthesis and their characterization
via different techniques such as DLS, Zeta potential, FTIR, and UV spectroscopy and toxicity evaluation of nanomaterials.

In Session II Dr. Ruchi Agrawal talked about the 'Bio-based Nano materials and Nano polymers' and introduced the young minds with various methods for the synthesis of nanomaterials and various tools for their characterization which was followed by the Demonstration of the 'Process

for the extraction of polymers from Agro-residues via Hydrothermal Fractionation of Biomass'. The sessions were followed by an hour-long brainstorming Q&A and an Interactive session.

Overall, it was a dedicated forum to discuss the 'Alternate Solutions for Nanotechnology' which are cost-efficient and eco-friendly and 'How can they be promoted and exploited in a better manner?' There was an overwhelming response from the students who participated actively in the programme, and they have gained valuable learning that would help them in achieving their research goals.

6. E-Summer School program on "Nanosafety Challenges: Rethinking Nanosafety" on 18 May 2022

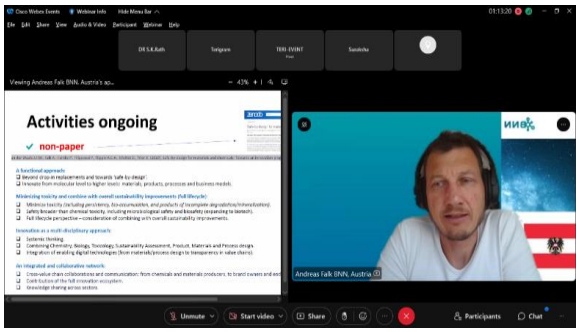
Globally, as multiple nanoproducts are reaching the application and commercial stages, it becomes vital to understand any potential risks associated with their synthesis and application. However, due to unique physicochemical properties these nanoparticles also tend to have complex interactions in environment and interfere with the assays, detection, and estimation systems. Factors like these pose great challenge in their overall safety assessments.

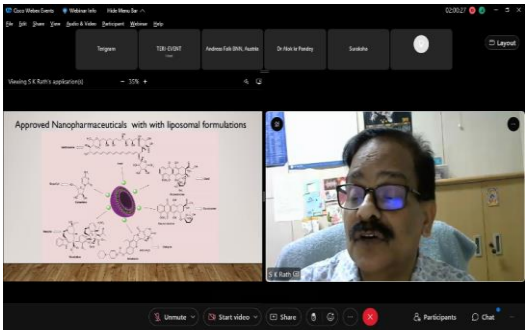
The **Teri-Deakin NanoBiotechnology Centre (TDNBC), Gurugram, India**, in association with the Department of Biotechnology, Government of India under "DBT-TDNBC-Deakin-Research Network (DTD-RNA)" for learning and innovation across the continents, organized E-Summer School program on "Nanosafety Challenges: Rethinking Nanosafety" on 18 May 2022.

The winter school was aimed to spread advanced knowledge about Nanosafety challenges. Young researchers, students, and technocrats participated in this program to learn new insights into the thematic area.

The program began with the welcome address by **Dr. Pushplata Singh, Director – Teri Deakin Nanobiotechnology Centre, Gurugram**, followed by an introductory virtual tour of TERI and TDNBC nano-research achievements and facilities. The program was moderated by Dr Palash Kumar Manna, Senior Scientist, TDNBC, TERI.

The scientific session started with a keynote talk by **Mr. Andreas Falk, Chief Executive Officer Bionanonet Forschungsgesellschaft Mbh (BNN), Austria**, on Nano-Safety Challenges and Way Ahead for Global Collaboration. He briefly explained the challenges and focused on leading the way in global research nanosafety partnerships and tackling scientific and societal challenges in various areas.

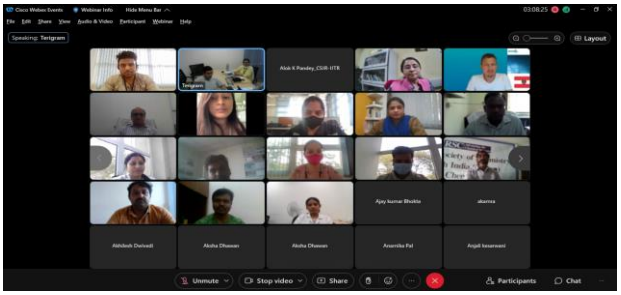




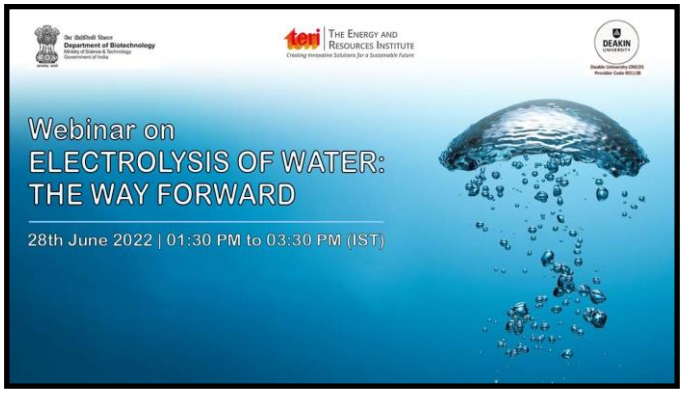
Dr. Srikanta K Rath, Chief Scientist, Division of Toxicology & Experimental Medicine CSIR-Central Research Drug Institute, India, delivered a perceptive talk on the Safety of Nano Pharmaceuticals. He explained the basics of the safety challenges involved.

The last lecture was presented by **Dr. Alok K Pandey, Senior Scientist, Systems Toxicology & Health Risk Assessment CSIR-Indian Institute of Toxicology Research, India**, who delivered an insightful talk on the Nanomaterial Toxicology: Methods and Challenges. He explained the methods and challenges one may face during the synthesis and characterization of nanomaterials.

After each session, an interactive Q & A session was held. The E-Winter School platform was attended by more than 70 participants across the globe.



7. Webinar on "Electrolysis of Water: The Way Forward" on 28 June 2022

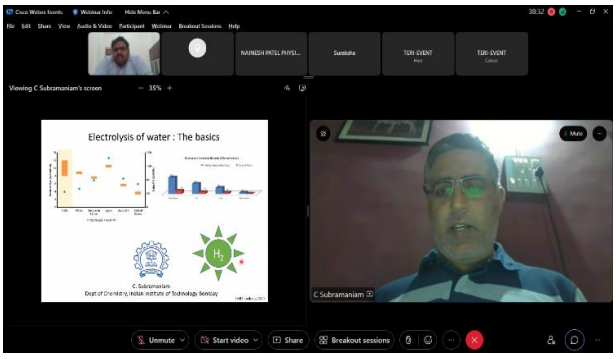


Water electrolysis has come a long way since its discovery around 200 years ago. The world is working remarkably to cope with the energy demand and replace conventional fossil-fuel-based energy with affordable, reliable, and cost-effective green energy sources like hydrogen. The electrolysis of water is one of the go-to techniques for the same. However, the choice of catalyst, electrolyte and operating conditions play a significant role in energy generation and pilot/industrial-scale production. **A clean hydrogen economy could be the answer to transitioning out of fossil fuel use. Being the most abundant element on the Earth and making up more than 90% of all known matter, it can be seen as the most feasible renewable resource available.**

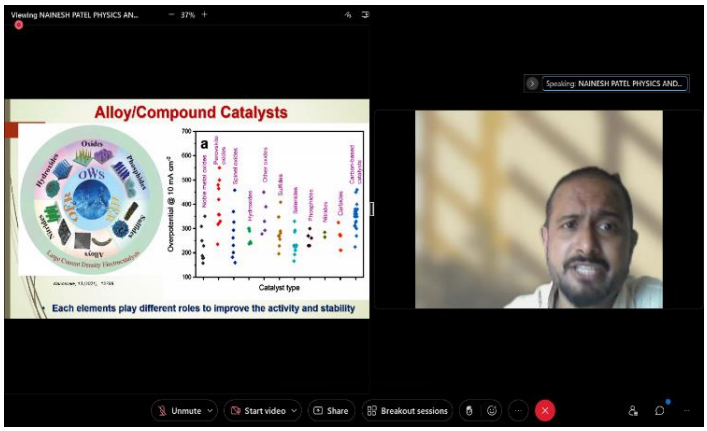
The Teri-Deakin Nanobiotechnology Centre (TDNBC), Gurugram, India, in association with the Department of Biotechnology, Government of India under "DBT-TDNBC-Deakin-Research Network (DTD-RNA)" for learning and innovation across the continents, organized a webinar on "Electrolysis of Water: The Way Forward" on 28 June 2022.

This Webinar was a great platform to recall the history and understand the present and future potential of water electrolysis in green energy generation. We aimed to bring together participants from academia, industry and regulatory bodies and brainstorm about water electrolysis's role as a future energy source.

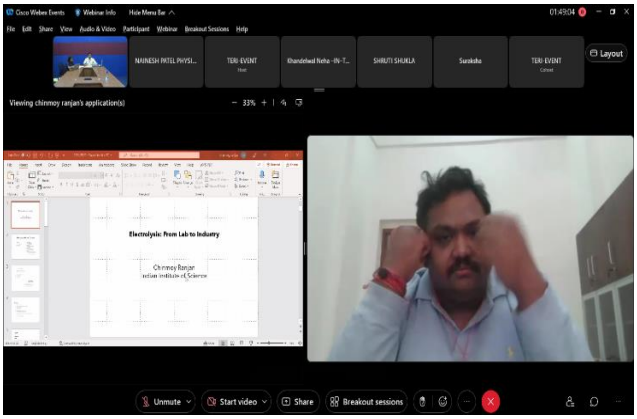
The program began with the welcome address by Dr Palash Kumar Manna, Associate Fellow– Teri Deakin Nanobiotechnology Centre, Gurugram, followed by an introductory virtual tour of TERI and TDNBC nano-research achievements and facilities. The program was moderated by Dr Shruti Shukla, Fellow, TDNBC, TERI.



Electrolyzer technologies have been gaining more attention as they serve as a potential hydrogen production method capable of producing high-purity hydrogen from water and meeting hydrogen demands at various capacities. The scientific session started with a talk by **Prof. Subramaniam Chandramouli, Assistant Professor, Indian Institute of Technology Bombay, India, on Electrolyser Technology: The Basics.** He briefly explained the water electrolysis technologies for hydrogen production, which are discussed in the context of different electrolysis processes, including the historical development, theoretical thermodynamic, and electrochemical principles.

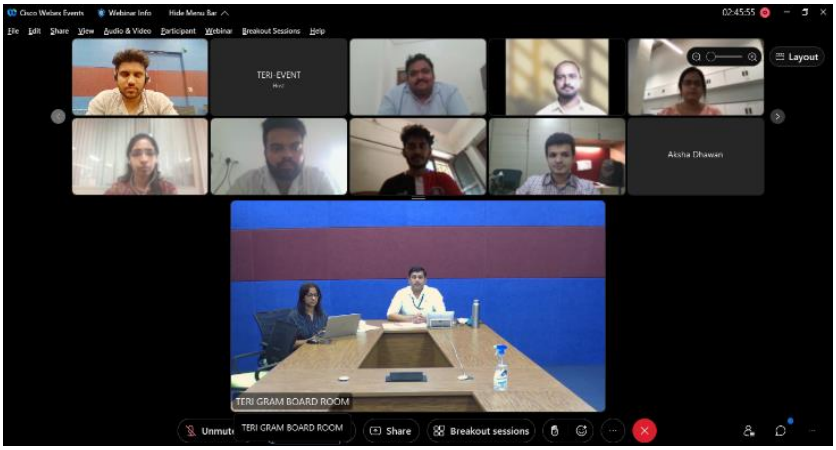


Water electrolysis is a well-established commercial technology; nevertheless, its practical application for the mass production of hydrogen is still limited as it suffers from several significant obstacles. With the advancement in the field of nanotechnology, the problems can now be addressed effectively. **Prof. Nainesh Patel, Associate Professor, Christ University India, delivered a perceptive talk on Water Electrolysis: The Role of Nanotechnology.** He explained that the field of nanotechnology is integral for advancing a more green economy with the characterization of novel catalysts, which will ensure the quality of the catalyst is quantifiable and the use of nanomaterials as catalysts.



A revitalization of organic electrosynthesis has incited the research community to adopt electrochemistry as a green and cost-efficient method for activating small molecules to replace highly toxic and expensive redox chemicals. The last lecture was presented by **Prof. Chinmoy Ranjan, Assistant Professor, Indian Institute of Science, India, who delivered an insightful talk on Electrolyzers: From Lab to Industry.** He explained the commercialization of wide-scale electrification of organic synthesis. He highlighted the perspective and the advances made in large-scale flow electrosynthesis, its future trajectory while pointing out current methodologies' main challenges and critical improvements.

After each session, an interactive Q & A session was held. The Webinar was attended by more than 45 participants across the globe.

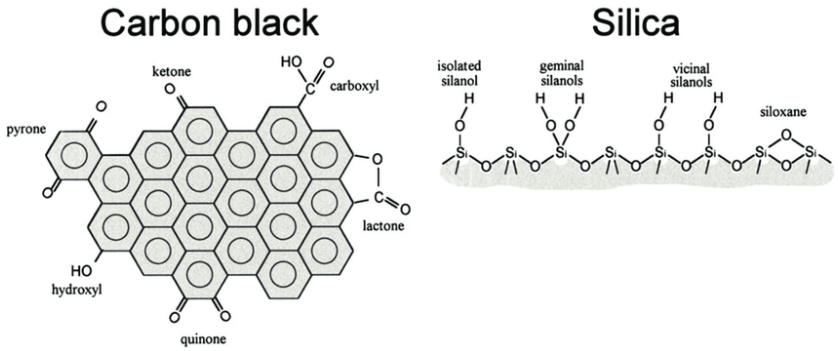


Activities in Member Countries

IRAN

1. Development of a Standard for Measuring Carbon Black and Silica Concentration

The latest meeting of national committee of nanotechnology standards was resulted in approval of a national standard on determining the concentrations of carbon black and amorphous silica.



The latest meeting of national committee of nanotechnology standards (meeting no. 102) was held on 1 November 2021 to discuss and review the final draft of national standard entitled as "Nanotechnology- a method for determining the concentrations of Carbon black and amorphous Silica in the nanoparticle size range in the atmosphere of a mixed powder production environment" Ferrous carbon and amorphous Silica nanomaterials are used in various consumer products such as rubber products, insulation materials, etc. Despite the widespread use of this type of nanomaterial, determining the concentration of each specific nanomaterial in a mixed powder environment has been known as a barrier to setting specific exposure limits of nanomaterials for workers who are commonly exposed to those nanomaterials. This standard provides guidelines for quantifying and detecting concentrations of Ferrous Carbon nanoparticles and amorphous Silica based on size in air samples collected from an industrial production environment.

This national standard was developed with the participation of experts from universities, Iran National Organization for Standardization, industrial companies, and Iran Nanotechnology Innovation Council.

2. A Contract Signed for Commercialization of Iranian Anti-viral Mask

By signing an agreement contract with an industrial company, anti-viral mask developed by Sepanta Mehr Mandegar company is another step closer to commercialization and mass production.

The company uses nanotechnology to produce masks able to remove viruses, bacteria, and fungi. The company has succeeded in launching semi-industrial production scale.

It is worth mentioning that this product was exhibited in German A+A exhibition. This exhibition is one of the largest exhibitions in the world held every two years in Düsseldorf, Germany.

3. A National Standard for Nanomaterials Effect Evaluation of Protein Structure

A national standard was developed for specification of measurement protocols and test conditions for changes of secondary structure of a protein occurred due to its interaction with nanomaterials using UV-CD spectroscopy.

The 106th session of the national committee for nanotechnology standards was held virtually on 27 January 2022, and the standard "Nanotechnology - Evaluation of secondary structure of protein interacting with nanomaterials using UV-CD" was approved.

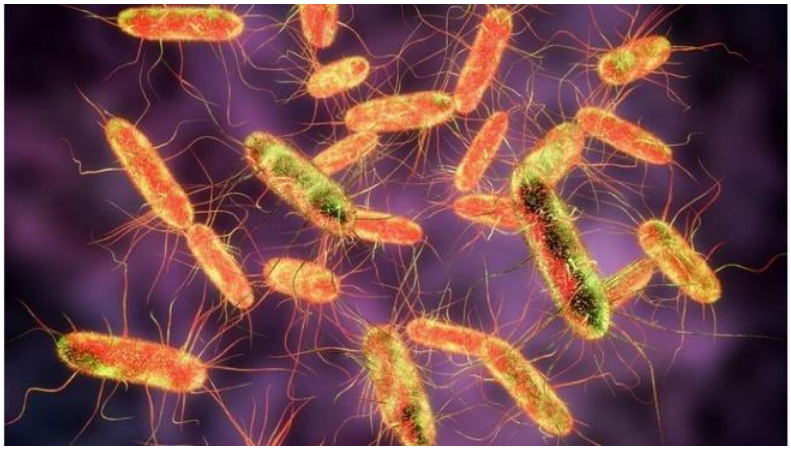
This national standard specifies measurement protocols and test conditions for changes of secondary structure of a protein occurred due to its interaction with nanomaterials using UV-CD spectroscopy. This standard is not used for characterization of changes in formulation of irregular proteins.

The international standard, ISO 23459 (published in 2021), was used as a source for development of the mentioned national standard. This standard was developed with the participation of several researchers from the country's different universities.

4. Identification of Salmonella typhi in Human Blood Serum Using Nano-biosensor

Researchers at University of Tehran successfully developed a biosensor for the identification and measurement of Salmonella typhi (S. typhi) in human blood serum with high sensitivity and accuracy.

The sensor can measure the amount of Salmonella typhi in patient blood with a detection limit of one picogram per milliliter.



Dr. Ghorchian, a professor at the Biochemistry and Biophysics Research Center of the University of Tehran, highlighted the significant achievements of this study, “in this process, carbon quantum dot (CQD) particles were used. Carbon quantum dot particles have received much attention due to their unique optical properties with high biocompatibility and good solubility in water. The research team successfully produced new carbon quantum dot particles with considerable optical and magnetic properties with an optical efficiency of 86%. They were used to design an optical biosensor to detect S. typhi in human serum with high sensitivity and accuracy.

Salmonella is usually transmitted through contaminated food or water to the feces or urine of patients. Contaminated fruits, vegetables, dairy products, as well as insects can transmit the infection.Semiconductor particles or quantum dots are usually made of heavy metals, especially cadmium and selenium. These quantum dots have proven to be powerful inorganic fluorescence nanomaterials. However, most high-performance quantum dots are limited due to the toxicity of their constituent metal elements. Compared to semiconductor quantum dots, carbon (graphene) quantum dots exhibit properties such as low toxicity, excellent solubility, and considerable chemical inertia. "Given that most carbon materials are cheap and available, increasing production scale can significantly reduce manufacturing costs," Ghorchian said, "also, considering the results of this research, the developed biosensor can be utilized as a rapid detection kit."

For the next step, the team wants to study the electrical and electrochemical properties of these quantum particles with similar heme structure to design and make various products for several applications. Results of this project was published at Biosensors & Bioelectronics journal entitled “High-performance porphyrin-like graphene quantum dots for immuno-sensing of Salmonella typhi.”

5. Workshop on Nanofiber between Iran and Thailand

On 5 April 2022, Iran Nanotechnology Innovation Council (INIC) and Thailand's National Nanotechnology Center (NANOTEC) held a virtual workshop on nanofiber.

This workshop aimed to bring Iranian and Thai professors, researchers, and scientists together to exchange research ideas on nanofiber and identify various opportunities for applying nanofiber technology in related industries.

Leading Thai and Iranian scientists from renowned universities and institutions joined the workshop to exchange their research ideas, knowledge, and work experiences among peers.

In addition, a few companies shared their achievements in applying nanofibrus in industrial and consumer markets as well as manufacturing related industrial machinery.

6. Optimization of Fetal Sex-linked Diseases Diagnosis with Nano Biosensor

Researchers of an Iranian university successfully diagnosed fetal sex using a biosensor based on triple nanocomposite PANi-RGO-GNPs and DYS14 gene in the blood plasma of pregnant women in the 7th to 9th weeks of pregnancy.

"By earlier diagnosis, screening of pregnant women who are likely to give birth to a baby with sex-linked diseases is made possible that increase the likelihood of treatment and control of congenital diseases," Mehdi Malmir, a PhD student at Bu Ali Sina University who is working on this project said, "thus, mother's physical and mental problems as well as possible costs reduce."

Fetal sex-linked diagnosis was conducted in this project by identifying the DYS14 gene using Apt/PANi-RGOGNPs/Au electrode, which is a part of the Y chromosome genome, in the blood plasma of pregnant women. This research project can be commercialized by making a special kit and also using DNA nano biosensors. By changing the desired sequence attached to the electrode surface, other bacteria and viruses could also be detected.

The project results were presented in an article published in Biosensors & Bioelectronics journal entitled "Label-free E-DNA biosensor based on PANi-RGO-G*NPs for detection of cell-free fetal DNA in maternal blood and fetal gender determination in early pregnancy."

7. The Ninth Empowerment Camp for Nanotechnology Promotional Institutions Was Held

As part of its duty on promotion and education of nanotechnology across the country, Iran nanotechnology innovation council (INIC) has facilitated formation of several promotional institutions mainly in the universities and continuously support their activities.

The ninth empowerment camp for nanotechnology promotional institutions was held with the presence of 110 academic promotional institutions' liaisons and trainers for three days from 7 to 9 March 2022 in Tehran. During this three-day camp, various programs, and courses such as training workshops, teamwork course and team competition, overview of funding regulations of Nanotechnology Education Foundation (NEF), networking and transferring successful experiences among nanotechnology promoters were provided. The program also covered other skill development courses including communication principles, social network and branding, introduction to national nano competition, principles of negotiation and persuasion, and teamwork.

8. Iranian Nanotechnology Products Market Growth

The market for nanotechnology products made in Iran has amounted to over $550 million in 2020 with a 7.3% export share, according to a review reported by Iran Nanotechnology Innovation Council (INIC). Among the various industrial fields, the construction sector has the lion's share in the Iranian nanotechnology market.

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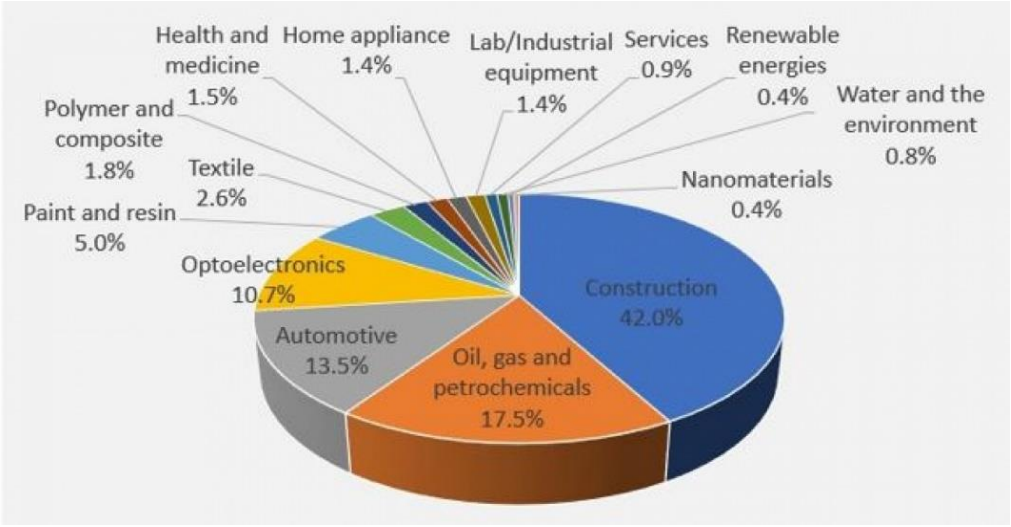
To Have access to precise statistics and accurate information on domestic and international markets of nano products, the Iran Nanotechnology Innovation Council (INIC) conducts a survey of companies manufacturing nanotechnology products and equipment at the national level every year.



In its latest survey conducted in 2021, product sales and export information for 2020 of more than 320 manufacturing and service-providing companies active in the field of nanotechnology, whose products own Nanoscale certification from INIC were collected and verified through a census of nanotechnology companies and completing financial forms. The results obtained from the survey were also completed using market research methods based on the available valid facts.

9. Optimization of Industrial Wastewater Treatment with Nanosorbent

Researchers at Noshirvani University conducted research on using an adsorbent combination of carboxymethylcellulose-cellulose-nickel for the treatment of industrial wastewater containing nano-pollutants with potential for commercial production.

In this research, a new and cost-effective adsorbent was proposed and synthesized using emulsification method. Optimal hydrodynamic and physical properties confirmed their potential use as an adsorbent for the treatment of industrial wastewater containing nano-pollutants.

“Various processes such as copolymers are available to treat water, which can be divided into three mechanisms including freezing, combining, and adsorption. Extended Bed Adsorption (EBA) is a promising and practical separation method for biosynthetic product adsorption that has been studied in downstream process development. In this project, a new specially designed carboxymethylcellulose-cellulose-nickel composite adsorbent is fabricated by immersing water in an oil emulsion to create a stable development,” Meysam Sadeghi, PhD student in Noshirvani University said, "the innovation of this project is the synthesis of a new adsorbent along with comparing the results of using carboxymethylcellulose-cellulose-nickel adsorbent with the DEAE.”

The results obtained for the effect of particle size of the chemical structure of carboxymethylcellulose-cellulose-nickel composite on expansion properties of the substrate showed that at a uniform expansion coefficient, the larger chemical structure had a higher flow rate. In addition, it was observed that the smaller chemical structure forms a lower experimental value of the final velocity (Ut) and a more stable substrate. In order to commercialize the project, it is necessary to consider the use of adsorbents at industrial and semi-industrial scales as well as optimization of parameters affecting ligands to achieve optimal efficiency in the developed medium and evaluate their performance in columns with larger scales. The results of this study were published in an

article in Journal of Hazardous Materials entitling: “Treatment of nano-oil polluted wastewater in an expanded bed adsorption column based on carboxymethyl cellulose-cellulose-nickel composite beads.”

10. 5th Generation of Packaging in Iran

During an interview Dr. Lesankhosh, CEO of the company, Baspar Pishrafteh Sharif, emphasized on the development of the first international standard for smart and active nano-packaging as one of the company's major strategies for business development.

"Since 2015, in cooperation with the Standard Organization (Iran Nanotechnology Innovation Council represents Iran in ISO/TC229 sub-committee), development of a standard related to intelligent and active nano-packaging has started. After five years of continuous of intense work, the development of this standard was completed and accepted by ISO,” Lesankhosh said. Developing and adopting such standard is an important act for facilitating international business in advanced packaging.

Dr. Lesankhos said: "Five generations of packaging technologies have been experienced over the last decades. In the first generation, the vacuum packaging was used; meaning that gases, including oxygen, were removed. In the second generation, in addition to removing oxygen, inert gases such as carbon dioxide or nitrogen were pumped into the packaging. Then companies moved on to adsorbents such as dehumidifiers or oxygenators. Nowadays adsorbents are added as additive materials in producing various types of packaging.

As Dr. Lesankhosh stated, in order to maximize product durability, a special combination of gases should be injected inside the packaging. Thus, for example, completely different combinations of gases are used for cucumber packaging in comparison with that of cherry packaging. This Iranian company produces and sells special nano-packages as well as nano masterbatches to different customers.

11. Design of Convergent Membranes for Highly Efficient Separation of Lithium Monovalent Ions

This research was conducted through a mutual collaboration of researchers from Iran and Australia. As the result of the project a convergent membrane was made to extract lithium ions and characterize them.

It is predicted that due to the growing need of industries for lithium, the demand for this element will increase further in a few years and it will become a more important and strategic element. Therefore, a number of research have been carried out to extract this important element from available resources. Seawater as a rich source of lithium ions can meet a significant portion of human needs for this vital substance. However, separating it from other ions present in the seawater is a challenging process. The future of lithium-based energy storage systems relies heavily on efficient separation of this element. Recently, biological ion channels with asymmetric cavity structures were considered as one possible approach to come across such challenge by researchers. However, the artificial reproduction of such a complex biological structure is technically challenging.

In this research, a highly tunable design concept was introduced to fabricate monovalent ion-selective membranes with asymmetric sub-nanometer pores in which energy barriers are implanted. The energy barriers act against ionic movements, which hold the target ion while facilitating the transport of competing ions. The membrane consists of bilayer metal-organic frameworks (MOF-on-MOF), possessing a 3.4- to 6 angstrom passable cavity structure. The ionic current measurements exhibit an unprecedented ionic current rectification ratio of above 100 with exceptionally high selectivity ratios. The results of this study were published in Advanced Materials journal entitling “Designing Angstrom-Scale Asymmetric MOF-on-MOF Cavities for High Monovalent Ion Selectivity”.

12. Granting “Nano Namad” License to An Industrial Company for Nanotechnology-based Car Air Filters

Behran Filter Company was able to receive the first “Nano Namad” license for its car air filter production line.

Using nanotechnology in the production of light and heavy vehicle's air filters through applying nanometer fibers on the filter surface, "Behran Filter" has been able to increase the durability of the filter and significantly improve the filtration efficiency.

After various stages of inspection and evaluation of the two products to receive the “Nano Namad” license, they were assigned for the two light and heavy vehicle's air filter products. A “Nano Namad” license (meaning nano-mark in Farsi) is a license assigned by the National Standards Organization based on compliance with the approved processes in nanotechnology

production line as well as the quality criteria in final products. It is hoped that this license will standardize various nanotechnology-based products in the country, improve their quality, expand markets of these products, increase consumer confidence, and finally prevent possible misuse of nanotechnology in society.

13. Nanocoating Using Ultrasonic Spray System

Sharif Solar Technology Development Company has succeeded in providing an ultrasonic spray system that can be used to create nanometer coatings of different thicknesses.

An Iranian company has succeeded in providing an ultrasonic spray system that can be used to create nanocoating using stable Nano colloid solution. This device has the possibility of layering on circular and cylindrical surfaces.

Coating using conventional spray methods creates droplets of different sizes, which reduces the quality of the formed layer. The ultrasonic method makes it possible to form droplets of very small size with uniform distribution. Ultrasonic spray method can be used with stable colloidal solutions to make controlled nanocoating.

The USS-40C Ultrasonic Spray is designed for precise coating using a variety of inks or nanoparticle solutions. The movement of the ultrasonic nozzle can be programmed, and a certain level can be sprayed for a certain time. The distance between the nozzle and the sample can be adjusted manually. The solution is injected into the nozzle through a syringe pump.

Sharif Solar is a knowledge-based company formed because of successful cooperation of some of researchers and graduates in the field of solar cells at Sharif University of Technology. Sharif Solar focuses on development and production of laboratory equipment. In addition to equipment, the company manufactures a wide range of laboratory materials used in solar cells and provides extensive services in the field of solar cell fabrication and analysis.

14. 915 Iranian nanoproducts exported to various countries in five continents

Iranian nanotechnology products are being produced and marketed in more than 15 industrial fields based on technologies developed inside the country.

Until March 2022, 915 nanotechnology –based products have been produced and marketed in more than 15 industrial fields based on domestic technologies developed inside the country. The development of nanoproducts export programs in recent years and opening of several export offices in various foreign markets have provided the basis for the entry of Iranian nanotechnology goods, equipment, and services to global markets. So far, Iranian nano products have been exported to 49 countries in 5 continents.

42% of the products are sold in construction market segment; while oil, gas and petrochemicals sectors have 17% share in nanoproducts. More than 13% belong to the field of automotive industry, and almost 10% of nanoproducts are produced by optoelectronics companies.

15. Powder Lubricant Production in Iran

Nano powder lubricant was developed and commercially produced by Iranian scientists and entrepreneurs.

"Zhikawa Construction Company is one of the leading companies in producing building materials," Mr. Tahbaz said, "more than 60 different products are produced in Zhikawa, including a variety of additives, lubricants, and concrete-related compounds." The companies R&D division worked on development of a super-lubricating powder with steady demand in the market. The company could succeed in development and production of this product. This powder lubricant has now reached the commercialization stage.

In addition to the mentioned product, the company also produces other nanotechnology-based products. "After getting acquainted with antibacterial property of some of the nanomaterials, we started to use this type of nanomaterial in a group of products. Finally, construction products with antibacterial properties entered the company's product portfolio," Tahbaz said.

16. Unveiling of Four Iranian Devices in Cancer Diagnostics and Treatment at the Iran Lab Expo

Four Nano Hesgar Sazan Salamat Arya Company devices in cancer diagnostics and treatment at the Iran Lab Expo were unveiled.

Nano Hesgar Sazan Salamat Arya Company devices were unveiled at the Iran Lab Expo. Cancer Detection Probe (CDP) for real-time diagnosis of involved margins and lymph nodes during breast cancer surgery, Impedance Tumor Detection Probe (ITDP), Positive Electrostatic Cancer Therapy (PECT) for malignant tumors and real-time Blood ROS detection system (BROS), and designed and built by Dr. Abdolahad's research team, can be used for diagnosis, and treat cancer.

According to Dr. Abdolahad, the first device is the Cancer Diagnosis Probe, a device for identifying margins and lymph nodes involved in cancer, which is designed to detect the remained cancerous cells in the cavity-side of the patient's body after tumor removal. This device has also received a license from the Iran Ministry of Health and Medical Education.

The second device, ITDP, is an impedance-based diagnosis probe that helps the radiologist determine the mass's condition in the patient's breast and its risk to the patient. In this method, the system's needle-shaped 2-electrode probe enters SLNs or ALNs under ultrasound guide, and without any tissue extraction, the radiologist can judge the risk of the tumor. This information helps physicians make the best decision when in doubt about a biopsy.

The third device is a device that uses electrostatic for cancer therapy of the malignant masses. This device has a patch placed on the patient's body, and its high electrostatic charge disrupts the proliferation and growth of cancer cells. Another application of this device is to concentrate

drugs with positive charges in the cancerous tumors and reach their cells in a targeted manner. So, thanks to this technology, many drugs can be used for cancerous tumors.

Dr. Abdolahad adds that the fourth device, BROS, is a device that detects ROS (reactive oxygen species) levels in the blood that is used for breast cancer detection. When a mass in breast cancer becomes malignant, the ROS in these cells decreases. This device can measure the amount of ROS in the blood of patients with cancerous mass and show that the amount of ROS is reduced compared to standard samples. If the concentration of ROS decreases, it is a pre-warning revealing that the tumor is malignant. Notably, there is more ROS in benign tumors than in malignant tumors.

Nano Hesgar Sazan Salamat Arya employs advanced technologies to design and manufacture medical equipment and products to diagnose and treat cancer. The company's main objective is to produce and commercialize innovative high-tech products in the medical field.

17. Treatment of Cancerous Masses Using Magnetic Nanoparticles

Researchers at the University of Isfahan, in collaboration with researchers from University of Ilmenau in Germany, conducted research on magnetic nanoparticles for medical applications.

The research aims to investigate the specific loss potential of nanoparticles prepared for the treatment of cancerous masses using magnetic transduction method.

“In this work, magnetite nanoparticles as well as magnetite nanoparticles replaced with zinc and samarium were made using co-precipitation method. The nanoparticles were coated with citric acid and pluronic copolymer F127, in which acceptable stability was observed for ferroflux for a long time (several weeks),” Morteza Mozaffari, associate professor at University of Isfahan, said, “despite their large size, nanoparticles are well dispersed in the fluid and samples with low concentrations showed very good dissipation.” These nanoparticles can be used for targeted drug delivery and to improve MRI and MPI imaging. Based on the data obtained from various experiments, despite the large size of nanoparticles dispersed in the solution and the large magnetic interaction between them, ferroflux remained floating in an aqueous medium (pH 5.5) for a long time and showed good stability. The experiments showed that these samples were very good options for use in the treatment of cancerous masses by magnetic resonance imaging. Referring to the innovative features of the project, Mozaffari said: "Replacement of samarium

ions in iron oxide nanoparticles for extraterrestrial applications, which is less common than replacement of other rare earth ions, is coated with F127, citric and pluronic acid, which is very biocompatible and commonly used in medicine." "They are suitable, and the very good stability of the nanoparticle market, despite their large size, is a feature of this research."

The results of the project were published as an article in the journal of Scientific Reports entitling “Heat dissipation in Sm3+ and Zn2+ co-substituted magnetite nanoparticles coated with citric acid and pluronic F127 for hyperthermia application.”

Activities in Member Countries

JAPAN

Latest Strategic Proposals on Materials/Nanotechnology in CRDS of JST

Since its establishment in 2003, the Center for Research and Development Strategy (CRDS) who is an affiliated institution of Japan Science and Technology Agency (JST) has made a significant contribution nationally as a public think tank by independently carrying out the investigation and analysis and by making proposals on science, technology, and innovation policy and/or research and development strategy. CRDS issued following three strategic proposals in the field of materials and Nanotechnology in the fiscal year of 2021-2022. (Available in Japanese Language at *https://www.jst.go.jp/crds/report/report01/index.html*).

1. Control of Generation and Decomposition of Modular Structures for Materials Circulation - Sustainable Element Strategy

This proposal describes a new material design concept which enables the flexible control of the stability and decomposition of inter-block bonds through the generation and decomposition of modular structures composed of multiple blocks, with the aim of realizing sustainable material circulation. This is a research and development concept that aims to develop materials with an awareness of the flow of materials after use. Here, "block" refers to the constituent unit of a Modular Structure, such as the main phase (Nd-rich phase) and the sub-phase (grain boundary phase) in permanent magnets, the matrix (resin) and the filler (fiber) in composite materials, and the two-dimensional atomic layer thin film that constitutes layered materials. By carrying out research and development based on this concept, we aim to make it possible to make materials highly functional and multifunctional, which cannot be achieved with a single material phase (block), and to contribute to the realization of a circular society by solving waste disposal problems, reducing environmental impact, and reducing resource supply risks through decomposition controllability between blocks.

As we work toward the achievement of the SDGs and the realization of Society 5.0 proposed by Japanese government, and as digital transformation (DX) accelerates after the global pandemic of the new coronavirus infection (COVID-19) that broke out at the end of 2019, the requirements for various products are becoming increasingly sophisticated not only in terms of performance, but also in terms of environmental and energy impacts. The materials that make up the core components of these products are required not only to improve single performance but also to satisfy various functions simultaneously. In these materials, many critical elements are contained. In this context, the "Elemental Strategy" proposed by Japanese government to solve these problems is becoming increasingly important(https://elements-strategy.jp/en/about/outline) . With the recent changes in foreign countries' resource policies and the disruption of supply chains triggered by the expansion of COVID-19 infection, it is necessary to formulate a new materials development strategy in order to secure resources in a sustainable manner and to maintain the international competitive advantage of materials, devices, and manufacturing technologies in which Japan has so far, an advantage. While we pursue new functions and usefulness in materials and products, there is a growing concern about the environmental impact of products made of new materials and general-purpose products manufactured and consumed in large quantities and their waste disposal problems. The growing social attention in these issues has led to the idea that we should depart from the conventional mass-production, mass-

consumption, mass-disposal society and build a circulating society instead, which could change manufacturing drastically. Based on the concept of "inverse manufacturing" proposed in Japan in the 1990s, the construction of recycling systems for various products such as home appliances has progressed, but it can be said that it is just a shift from mass production, mass consumption, and mass disposal to mass production, mass consumption, and mass recycling, and the question remains whether this is the sustainable manufacturing that we should be aiming for. It is said that 5% of the energy consumed in the world is used for metal separation, of which 80% is for crushing and grinding. To reduce these energy consumptions and realize a circulating society with low environmental impact, it is necessary to pursue material circulation from the product level to the materials level. At present, however, both academia and industry are lacking in such efforts. Looking at the trends in science and technology to meet the increasing social demands from the materials aspect, for example, inorganic materials have evolved from single-element materials to multi-element materials, composite materials have evolved to control structures with complex combinations of multiple compositions, and polymer materials have evolved to control structures with higher-order hierarchical structures. Materials science and technology for precise control of complex structures and higher-order hierarchical structures has not yet been established. In separation and recycling technology, while physical separation technology developed from ore dressing and chemical separation technology developed from smelting (high temperature wet separation process) have been developed individually, the fusion of physical and chemical separation technologies is evolving into the development of localized, selective, and highly precise separation technology that concentrates energy only on the part that needs to be decomposed. In the background above, this proposal focuses on the control of generation and decomposition of modular structures as a common target for materials creation (arterial side) and materials separation and recycling (venous side) and proposes to promote R&D toward the realization of a sustainable circulating society by targeting the flexible control of the stability and decomposition of inter-block bonds. By achieving this, we will demonstrate that there is technological potential to not only satisfy the functions demanded by society when materials are used, but also to contribute to the reduction of environmental impact and material recycling after materials are used. The R&D issues to be addressed in implementing the R&D strategy include "designing new materials with new functions by controlling modular structures," and the "establishment of the science of the generation and decomposition of modular structures" and "advancement of common basic technologies" that are necessary to make this possible. In order to implement the "design of new materials with new functions by controlling modular structures," it is important to consider the following points: 1) how to combine multiple blocks to achieve the advanced functionality and multifunctionality required in the materials, and 2) how to achieve a low-cost decomposition process to reduce environmental impact and achieve material circulation. In order to control the stability and decomposition of inter-block bonds, it is necessary to establish the "science of generation and decomposition of modular structures" through the elucidation of deterioration and destruction mechanisms in existing materials and scientific understanding of current separation and recycling processes. In addition, in promoting the above-mentioned R&D, it is necessary to advance simulation and measurement technologies in combination with data science that can handle more complex physical and chemical processes. In particular, it is necessary to develop simulation techniques for non-equilibrium and unsteady states, including decomposition processes, and to build a database of dynamic phenomena that can track the time evolution of reactions and processes. In addition, it is necessary to develop

new process technologies for the generation and decomposition of modular structures, as well as high-throughput experimental methods and real-time process measurement methods to support them.

2. Innovation of dynamical measurement under operation to elucidate material & device functions - Next-generation operando measurement

This proposal describes a measurement method that measures chemical, biochemical, and physical dynamic phenomena occurring in materials, living organisms, and devices under actual use, operating, and manufacturing environments, and links these phenomena to elucidation of the functions of the measured objects. This method is called “operando measurement”. Now, there is a strong demand for development of fuel cells and batteries with improved performance that will be effective in preventing global warming, and catalytic materials that promote energy saving and low environmental impact. In response to these demands, operando measurement is attracting much attention because the method possibly elucidates the functions of the measured materials and devices. Operando measurement has already been applied to catalysts and battery materials, providing useful information that is qualitatively different from the static and fractional information of materials and devices in a non-operating condition provided by conventional methods.

However, there are several problems with the present operando measurement. For example, the present measurement does not always reproduce the actual environment of the measured object. As a result, the results measured on the nano-scale structure of the measured object do not reflect the actual situation under its operation. The spatial and temporal resolutions are insufficient for elucidating the functions. The measurement and analysis processes are difficult for users who are not familiar with such a measurement. Due to these problems, we cannot fully elucidate the functions of the measured objects by utilizing the present method. Additionally, we are applying the current operando measurement methods to only a limited range of research fields.

This proposal aims to solve the above problems in the present operando measurement, establishing the “next-generation” operando measurement. Here, we refer to the following as the next-generation operando measurement: an innovated measurement method that provides enough information enabling a direct approach for the core of functions of the object and expands the application areas beyond the present catalysts and batteries to other areas of materials and devices, even living organisms.

To establish the next-generation operando measurement by solving the above problems, we will discuss the following four issues:

(i) Development of an optimal “model environment” that corresponds to the R&D needs which can produce experimental data to elucidate functions of the measured objects, and which also expands applications to wide range of materials and devices, particularly to biological tissues.

(ii) Construction of a sophisticated measurement system and development of measurement / data science technologies that connect between different scales to measure and analyze highly complex hierarchical structures in materials, devices, and biological tissues on multiple temporal and spatial scales, elucidating the relationship between the structures and their functions.

(iii) Development of measurement instruments and technologies with high resolution (time, space, energy, etc.) to raise the level of existing technologies and to extract information on inside of materials, devices and biological tissues, and interfaces between materials.

(iv) Development of measurement technologies based on data science to achieve the next-generation operando measurement sooner by utilizing data science technologies to make measurement and analysis more advanced and efficient.

The next-generation operando measurement will create and develop new scientific fields driven by measurement techniques for heterogeneous, unstable, and transient complex systems. Looking back at the history of scientific discoveries in various fields, this new technique has the technological potential to bring innovation and open up new science.

3. Basic technologies for wireless and optical convergence toward advancing next-generation communication

This proposal discusses how to create and establish innovative basic technologies for next-generation high-performance communication allowing the smooth connection between physical and cyber space. The key approach toward the goal is to combine technologies from the fields of wireless and optical communications, or electronics and photonics in other words, which have been so far developed without intensive interactions between each other, and to enhance the communication capabilities in terms of high speed, large capacity, and low latency. The converging technologies will initiate the developments of novel science and technologies that will be crucial for next-generation communication. In the proposal, we focus on the terahertz (THz) region, the frequency range between the current communication bands in wireless and optical networks, which has not been well explored. For the advanced use of this unexplored frequency band of electromagnetic waves, we raise the strategic research areas as the following.

(i) Research and development for the use of unexplored frequency regions. To significantly increase the data rate and capacity, it is desirable to use the terahertz band (100 GHz to 1 THz), which is a frequency region above the millimeter wave band of several tens of GHz. However, in such a high-frequency region, there will be problems such as suppressed diffraction, an increase in absorption of electromagnetic waves in the atmosphere, a decrease in power efficiency of radio wave generation, difficulty in signal amplification, and an increase in transmission loss of conductors and dielectrics. Thus, it will be difficult to transmit radio waves for long distances. To overcome these issues, research and development is necessary on array antenna technology that transmits radio waves only to the desired direction, active use of radio wave reflection / transmission, high-efficiency terahertz wave oscillators / detection elements / amplifiers, new substrate material / conductor structure / dielectric material for low transmission loss, and high-frequency material characteristic evaluation method / evaluation tools.

(ii) Research and development for advanced use of wireless communication and optical communication schemes. Within the limited frequency band, it is necessary to develop technology that achieves higher speed and larger capacity with various multiplexing technologies. In addition, we will also work on extreme massive connectivity technology that makes possible the simultaneous connection to many terminals including automobiles and IoT sensors, which will be required as a future communication system,

and technology for highly reliable communication with extremely low latency to ensure real-time control. Furthermore, to produce various system configurations that take advantage of the features of wireless and optical communication, we will also work on technology that performs mutual efficient conversion between wireless signals and optical signals, and analog-digital conversion at high speed and efficiency. Since software technology plays an important role in the configuration of various systems, it is important to consider the cooperation with software when conducting research and development of these hardware technologies.

(iii) Research and development for low energy consumption, high reliability, and low cost. The functional requirements as the basic technology for next-generation communication are the above (i) and (ii). However, in response to social requirements such as CO2 reduction of network systems, and reliability and resilience as social infrastructure, as well as utilizing the basic technology not only in communication systems but also in application fields such as computer networks consisting of data centers and edge computing, radar systems, and IoT sensors, it is necessary to conduct research and development aiming at low energy consumption, high reliability, and low cost. This requires not only the pursuit of characteristics at the material and device level, but also the implementation of functional modules through the integration of various components. Therefore, it becomes important to conduct research and development of heterogenous integration technology that integrates different materials and devices such as optical devices, advanced CMOS digital devices / circuits, high-frequency analog devices / circuits, and compact antennas with advanced massive MIMO.

(iv) Basic technology and materials research that support technological evolution. In addition to the research subjects that can be realized by continuous development making the best use of existing technologies, there are also challenging goals that are difficult to achieve just by the simple extension of existing technology. Even discontinuous evolution of technology will be required sometimes to respond to such challenging goals. To respond to these sophisticated communication requirements, it is also important to promote research in a wide range of related basic fields, such as basic research in condensed matter physics, optical science, and emerging materials / process technologies.

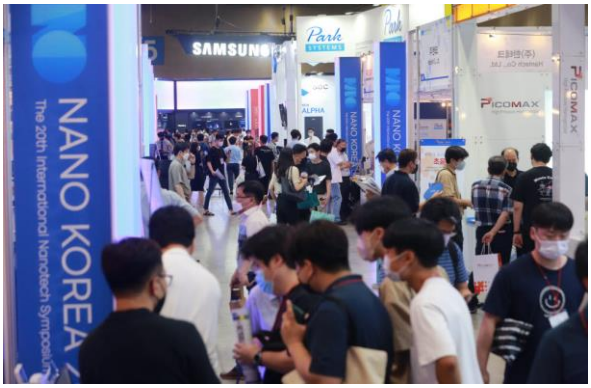
Activities in Member Countries

KOREA

NANO KOREA 2022

NANO KOREA, Korea's largest symposium and exhibition on nanoscale science and technology, was held from July 6 to 8, 2022 at KINTEX in Ilsan, Korea as an on off-line hybrid event with the slogan of 'Nanofabrication: Connecting Science and Technology for Better Life'.

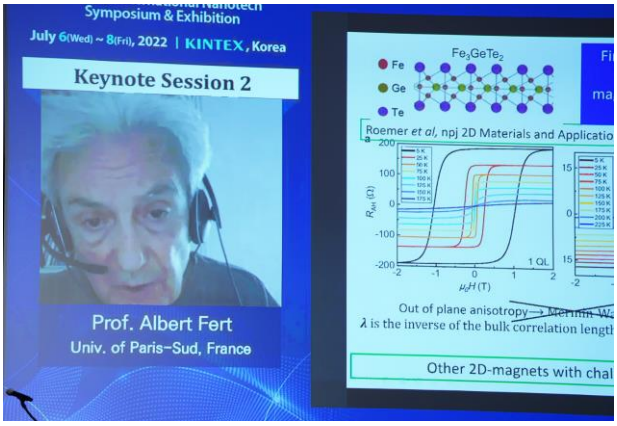
To celebrate the 20th anniversary of NANO KOREA, various meaningful programs and events were opened to the public as well as researchers in nanoscience. A TV program co-produced by the organizing committee and YTN was broadcasted to the public under the theme of "Future Technology, Nano that Makes Dreams Real" through various platforms a week before the event. At the opening ceremony attended by over 200 experts in the nanotechnology field, a commemorative video containing the history and achievements of NANO KOREA over the last 20 years was released. In addition, the "NANO KOREA 20th Anniversary Special Exhibition Booths," which presents innovative products with core nanotechnology applications that have been successfully developed over the past 20 years and advanced nanotechnology in the future industry, was displayed in the exhibition hall and opened to over 10,000 participants during the event.



For keynote speeches, Nobel Prize winner Professor Albert Fert of Université Paris-Saclay delivered the online lecture titled '2D magnets: from physics to spintronic devices magnets' to the participants real-time. The symposium programs, including technical sessions, public sessions, special sessions, and poster sessions all be held in a hybrid format to increase the participation rate of domestic and foreign registrants. The technical session covered important

issues in nanoscience and nanotechnology and consisted of 12 different technical departments. In particular, this year, the Young Scientist Awards were awarded for the first time to 55 oral presenters who presented their excellent research during the technical sessions. In addition, the public session is for teenagers encountered nanotechnology and provided short practical experience in nanotechnology experiments. There were over 3,900 participants in the symposium this year, which ranked the highest number of participants ever, and the number of participants increased to 61% compared to the previous year after overcoming the COVID-19 crisis over the past two years.

NANO KOREA will continue to serve as a prominent national platform for disseminating and exchanging the latest research achievements and promoting the industrialization of nanotech-based products. The organizing committee plans to make the event more appealing with increased nano-convergence industrial contents, considering the nano-based technology grows its portion in the 4th Industrial Revolution.



Activities in Member Countries

MALAYSIA

National Nanotechnology Centre (NNC) and NanoMalaysia Berhad (NMB) Jan 2022 to Jun 2022

1. National Nanotechnology Policy and Strategy 2021-2030 (DSNN)

Following its launch on 15 November 2021, NNC embarked on a nationwide roadshow to create awareness and gather input on the implementation of DSNN. The program kicked off at the Central Zone in Putrajaya, 2-3 February 2022, followed by North in Penang (7-8 March), East in Terengganu (28-29 March), Sarawak (17-18 May), Sabah (22-24 May) and the final destination Southern Zone in Johore (30-31 May).

2. National Nanosafety Study: Stakeholder Engagement

Early findings from the national study project titled 'Benchmarking Risks of Nano-Products in the Local Market 'were shared with represents from ministries, academicians, researchers, and the industry. This event was held as a hybrid on 10 March 2022 with a total of 43 participants and 22 were present physically at Everly Hotel Putrajaya.

3. Nanotech Talk 2022 Webinar

The Nanotech Talk 2022 webinar series was held from 4 to 6 April 2022. In this series the focus was on the current market, development, issues, and the future of Industrial Revolution 4.0 through applications that focus on nanotechnology in the food safety sector. Speakers shared about business opportunities under the nanotechnology market especially in the food safety sector, and there were sharing sessions with partners who have collaborated with NanoMalaysia. The webinar series was held in collaboration with the National Science Week 2022 (MSN 2022).

4. National Nano Products and Technology Roadmap 2021-2025

The National Nano Products and Technology Roadmap 2021-2025 launched by the Minister of Science, Technology and Innovation Malaysia on 13 April 2022 is the main supporting document to the National Nanotechnology Policy and Strategy 2021-2030. Implementation of this roadmap is expected to create over 30,000 jobs with GDP increase amounting to RM151 billion within the next 5 years.

5. Malaysia's Minister of Science, Technology and Innovation visited NanoMalaysia's office

On 14 April 2022, the Minister of Science, Technology and Innovation, Dato Seri Dr Adham Bin Baba visited NanoMalaysia's office in Kuala Lumpur and met with the management team lead by NanoMalaysia's Chairman, Professor Emeritus Dato 'Ir. Dr Mohamad Zawawi Bin Ismail, and NanoMalaysia's CEO, Dr Rezal Khairi Ahmad where the Minister was updated on NanoMalaysia's activities and achievements. This was the Minister's second visit to NanoMalaysia following an earlier visit in 2021.

6. Visit by Malaysia's Minister of Science, Technology, and Innovation to NanoMalaysia's project partner graphene-based coolant

On 18 April 2022, the Minister of Science, Technology and Innovation (MOSTI), YB Dato' Sri Dr. Adham Baba, the Secretary General of the Ministry of Science, Technology and Innovation (MOSTI) Datuk Zainal Abidin Abu Hassan; and Dr. Rezal Khairi Ahmad, Chief Executive Officer of the NanoMalaysia Berhad Group (NMB), held a technical visit to Blue Snow Consulting & Engineering Sdn Bhd Blue Snow). The visit was to evaluate the innovative product produced by Blue Snow, which is a graphene-based nano-liquid that can replace water as a

medium in cooling systems, as well as the feasibility of this material to be used in all refrigeration-based centralized commercial air conditioning systems to reduce energy consumption.

7. REVIVE Workshop

NanoMalaysia organised the first workshop for REVIVE (Rapid Electric Vehicles Innovation Validation Ecosystem) Intercontinental Hotel Kuala Lumpur on 26 April 2022. REVIVE is national level programme to convert ICE (Internal Combustion Engine) vehicles including buses, trucks, motorcycles, and cars into EVs. This initiative aims to enable the adaptation of EVs in an alternative way compared to buying new EVs which are generally 20-50% more expensive. New job opportunities will be created and, simultaneously, improve the skills of workshops and local workers. Strategic cooperation is being worked on between the government, agencies, industry, academia, and EV user members to achieve the comprehensive goal of conversion to electric vehicles by the year 2023/2024. REVIVE involves collaboration with the following strategic partners:

Related Agencies	Function/ Roles
Higher Education Department, (JPT) Ministry of Higher Education (MOHE)	Technology Collaborator & Campus Validation
Road Transport Department (JPJ) Ministry of Transport (MOT)	Regulations
Malaysian Green Technology and Climate Change Corporation (MGTC) Ministry of Environment and Water (KASA)	Low Carbon Mobility
Malaysia Automotive Robotics and IoT Institute (MARii) Ministry of International Trade and Industry (MITI)	Automotive Sectoral Policy
Department of Standards Malaysia (Standards Malaysia) Ministry of International Trade and Industry (MITI)	Conversion Standards
Malaysian Investment Development Authority (MIDA) Ministry of International Trade and Industry (MITI)	EV Task Force Secretariat and FDI
Public Works Department (JKR) Ministry of Works (KKR)	Government Vehicles and Services
General Insurance Association of Malaysia (PIAM)	Insurance

8. ISO/TC 229 Nanotechnologies Interim Meeting

Malaysia participated in the ISO/TC229 Working Group meeting held virtually 9-20 May 2022. Malaysia (DSM) and Colombia (ICONTEC) lead the revision of ISO/TS 12091:2014 Occupational risk management applied to engineered nanomaterials – Part 2: Use of the control banding approach. Malaysia continues to develop the draft document, registered as a Preliminary Work Item (PWI 4963), titled 'Radiotelemetry-spectral-echocardiography Based Real-Time Surveillance Protocol for *In Vivo* Toxicity Detection and Monitoring of Engineered Nanomaterials (ENM)'. The project group webmeeting was held on 18 May 2022.

9. Visit to Floraponic Farm Malaysia (FFM) aquaponics project

On 18 June the Menteri Besar of Perak, Datuk Seri Saarani Mohamad and the Malaysian Minister of Agriculture and Food Industry (MAFI) Datuk Seri Ronald Kiandee visited Floraponic Farm Malaysia (FFM) aquaponics project in Manong, Perak to assess firsthand

NanoMalaysia Berhad's innovative agriculture programme. FFM @ Manong is a large-scale collaborative aquaponics project between NanoMalaysia Group and Flora Niaga Sdn Bhd and is an initiative by MOSTI to further identify technological solutions to handle food security issues facing the nation.

FFM @ Manong in Manong, Perak is funded by NanoMalaysia Berhad under the REVOLUTiONT programme. REVOLUTIoNT, is an initiative under the National 4IR Policy that was introduced by the government in 2021. It is one of the policy's keys pillars that focuses on nanotechnology and the development of The Internet of Nano Things (IoNT) products and applications to enhance solutions for various applications, including food and agriculture and aligns with the National Nanotechnology Policy & Strategy 2021 – 2030. With REVOLUTIoNT, NanoMalaysia aims to develop innovative ecosystems that will help democratise the food supply chain to be more resilient, sustainable and address concerns of food security. FFM @ Manong is one of NanoMalaysia Berhad's projects which utilises a combination of aquaculture-agriculture, integrated with nanotechnology. The objective of this project is to offer an alternative for protein and vegetable nutrient sources by employing Nano Solar Energy Panel (NLEP) as a power generator.

10. OECD WPMN

Malaysia participated in the 22nd OECD Working Party on Manufactured Nanomaterials (WPMN) meeting held in Paris, 27-29 June 2022.

Activities in Member Countries | THE PHILIPPINES

The Philippines is known to have abundant natural resources. For the past years, the Industrial Technology Development Institute (ITDI) of the Department of Science and Technology (DOST) has been developing methods for producing nanomaterial from indigenous materials, namely, nanoclay, nanoprecipitated calcium carbonate, nanozeolite, and nanosilica. Among these nanomaterials, nanosilica can be used as drug delivery systems carriers.

There is a growing interest in the Drug Delivery System (DDS) to improve the bioavailability of pharmaceutical drugs by attaching this drug to a carrier that will control the drug release rate. DOST-ITDI developed a porous inorganic carrier from nanosilica that was synthesized from local rice hull ash (RHA). Characterization results such as Fourier Transform Infrared Spectroscopy (FTIR), Thermogravimetric Analysis (TGA) and UV-VIS Spectrophotometer showed that nanocarriers synthesized from RHA are comparable with the nanocarriers from commercially available nanosilica.

Turmeric extract was reacted with the local y developed nanocarriers, and curcumin had an evident attachment to the nanocarriers based on the results of UV-VIS analysis. Incorporating curcumin from turmeric extract into the developed nanocarriers showed a promising development. The study is ongoing to optimize the drug loading process, including different pharmaceutical drugs and other herbal medicines, as well as kinetics studies on drug sorption-desorption.

DOST-ITDI also conducted a study to develop an innovative, flexible piezoresistive sensor for smart device gestures for speech applications. Selective laser sintering (SLS) technology was used to 3D print the flexible sensors using carbon nanotube additive mixed into SLS TPU powder. Electrical, mechanical, morphological, and other properties of the sensors were characterized. The study is ongoing to optimize the parameters and prototyping further.

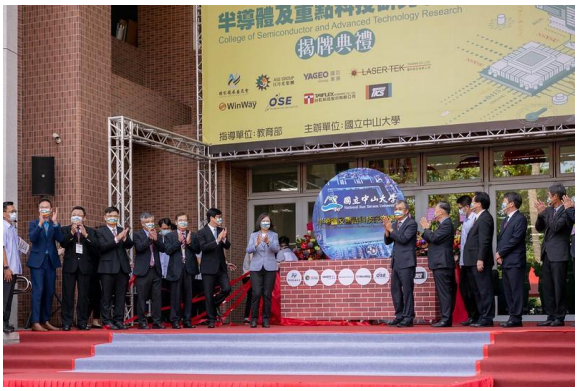
To further increase the current pool of nanotechnology experts in the Philippines, DOST-ITDI collaborated with MAPUA University for a doctorate in materials science and engineering specializing in a nanotechnology by research program. This Ph.D. degree starting this August will help accelerate science, technology, and innovation that can improve lives and positively impact society. In support of this doctorate, a webinar series on nanotechnology was conducted by Dr. Maria Cynthia Goh, a DOST Balik Scientist and a professor from Toronto, Canada, to inspire more graduate students to pursue the said Ph.D. degree.

Activities in Member Countries

TAIWAN

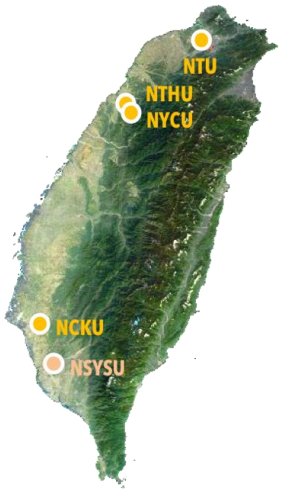
1. The Fifth Semiconductor Talent Cultivator in Taiwan

National Sun Yat-sen University (NSYSU) and seven local companies in Kaohsiung inaugurated the institution's College of Semiconductor and Advanced Technology Research on 22 July 2022, the latest local university to set up a semiconductor talent cultivator. The semiconductor industry is vital in Taiwan, generating output of more than US$133.71 billion last year, Taiwan President Tsai Ing-wen told the ceremony. NSYSU plays an important role in cultivating talent in the industry, with the seven companies investing about US$30 million to foster chip testing and packaging, and electronic components talent over the next 10 years, Tsai said.



According to the "*National Key Fields Industry-University Cooperation and Skilled Personnel Training*" Act promulgated in May 2021, there are currently 5 academies collaborated with industry have been established by leading universities in Taiwan to boost innovation of industry-university cooperation in national key fields and innovation of the training of skilled professional personnel for these fields to upgrade the effectiveness of the results of the research and development (R&D) achievements of national universities, train high level science and technology professionals, and enhance industry competitiveness.

- National Taiwan University (NTU)
  – *Graduate School of Advanced Technology*
- National Tsing Hua University (NTHU)
  – *College of Semiconductor Research*
- National Yang Ming Chiao Tung University (NYCU)
  – *Industry Academia Innovation School*
- National Cheng Kung University (NCKU)
  – *Academy of Innovative Semiconductor and Sustainable Manufacturing*
- National Sun Yat-sen University (NSYSU)
  – *College of Semiconductor and Advanced Technology Research*



Sources:

1. 中山大學半導體學院揭牌 https://www.president.gov.tw/News/26824
2. NSYSU semiconductor talent cultivator launched https://www.taipeitimes.com/News/biz/archives/2022/07/23/2003782235

2. Selenium-enriched agricultural products by using unique BNT

Erlin Town Office matches local farmer, Mu-Chi Juang, the leader of the 19th Red Dragon Fruit Production and Marketing Class, and Amber Nanotech Co., Ltd. (Amber Nanotech) to use the unique Bionic Nano Technology (BNT) developed by Amber Nanotech and add selenium of SUPEROSELEN to the red dragon fruit field test. After the SGS testing, the selenium-enriched red dragon fruit was successfully planted. In order to increase production and supply the market, Erlin Town Office held a memorandum of understanding of cooperation on selenium-enriched agricultural products in Erlin Town, Changhua County on 12 April 2022. Dr. Shih-Chieh Tsai, the mayor of Erlin Township, said "In order for Taiwan's agriculture to survive, it must use innovative technologies to transform, develop agricultural technology, and make agricultural products more competitive and functional."

Selenium (Se) is an essential trace element for organisms but cannot be synthesized in organisms by itself. It is the main component of glutathione peroxidase and participates in important biochemical reactions to remove peroxides in the body and protect cells and tissues. Avoid the damage of peroxides, help the human body detoxify, avoid cell membrane rupture, and activate the immune system, with anti-cancer, anti-oxidation, prevention of cardiovascular disease and other effects, fast metabolism, must be taken from the daily diet.

Amber Nanotech is the member of Taiwan Nanotechnology Industry Development Association (TANIDA) and Institute for Biotechnology and Medicine Industry (IBMI), respectively. Chun-Lun Chiu, the co-founder of Amber Nanotech, said that she is very grateful to Academician Pan-Chyr Yang, the vice president of IBMI, for his support for the industry to do a good job of 'selenium' all the time. In order to achieve this goal, Tz-Jium Liu, the chairman of Amber Nanotech, actively organized a technical team. By adhering to the three concepts of 'non-toxic, decomposable, and recycled', creating the unique BNT to produce selenium of SUPEROSELEN with high biological

activity, and working together with Erlin Town Farmers Association and local farmers, Chairman Liu trust him to promote precise, refined, and smart agriculture in Erlin Town, and set a milestone in agricultural product innovation!

3. The International Conference on Precision Nanomedicine in Theranostics

The International Conference on Precision Nanomedicine in Theranostics was held in conjunction with the 2022 Annual Meeting of Taiwan Nanomedicine Society (TNS) in Hsinchu, Taiwan on 22-23 July 2022. This event consists of Industry-Academia-Research Forum, Precision Health Trend Forum, and Alternatives to Animal Testing Forum, and attracts more than 350 participants including researchers, clinicians and industry partners who gathered to share about 150 research reports through poster oral briefing and poster exhibition. In addition to Prof. Kazunori Kataoka, Director General of Innovation Center of NanoMedicine (iCONM) and Editor of Journal of Biomaterials Science, Polymer Edition, more than 10 researchers and experts from United States, Japan, Australia, and Singapore were also invited to join this event via Webinar to give presentations about the latest development and trend of nanomedicine.

Prof. Jenn-Hwan Tarng, Vice President of National Yang Ming Chiao Tung University, indicated in the Opening Ceremony that the global nanomedicine market is expected to reach US$ 40 billion by 2030 at a compound annual growth rate (CAGR) of 13% from US$ 20 billion in 2020. Furthermore, Asia-Pacific area is growing faster than other regions. This June, TLC BioSciences (Taiwan Liposome Company, TLC), one of sponsors of this event, announced one of the largest deals seen in Taiwan's biotech sector that it has entered a commercialization agreement with Endo International plc (Nasdaq: ENDP) for rights in the United States to TLC599, a proprietary BioSeizer® sustained release injectable in Phase 3 development for the treatment of osteoarthritis pain.

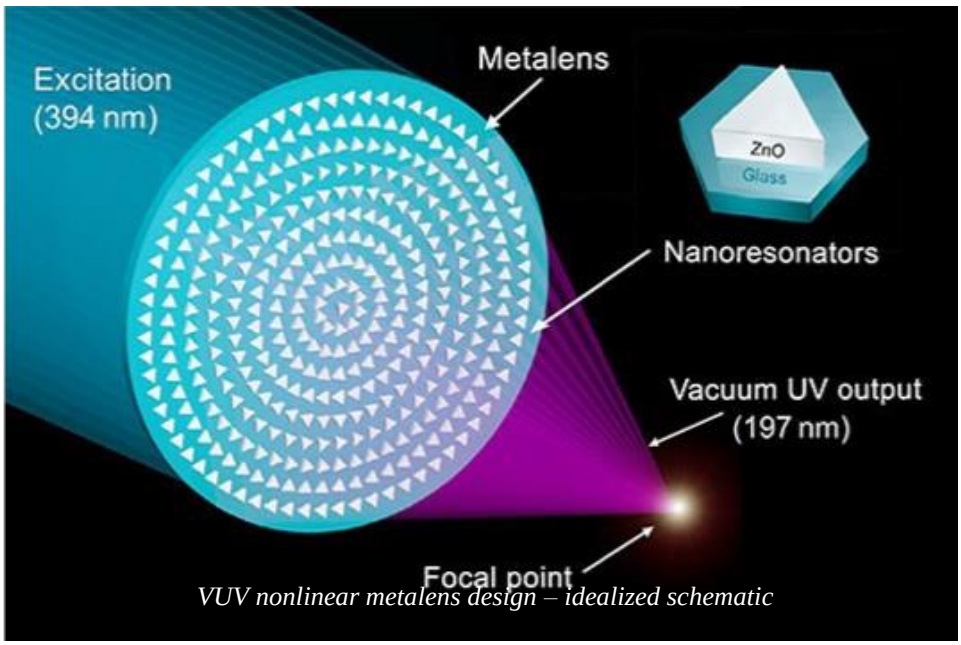
TNS was founded in 2019 and aims to promote the nanomedicine exchanges between researchers and practitioners, improve research study and industry technology, and create a sustainable environment. Prof. Chen-Sheng Yeh of National Cheng-Kung University was re-elected the Chairman at the 2022 TNS General Assembly on 22 July 2022. Prof. Yeh expressed that he will continue the talent cultivation of medicine generation, deepen the collaboration between nanomedicine societies of Japan and Korea, and broaden international exchanges.

Sources:

1. About the Conference https://www.tnsociety.com/Conference/
2. 奈米生醫國際研討會 產學界回響熱 https://money.udn.com/money/story/5724/6482070
3. TLC Announces TLC599 Agreement with Endo https://ir.tlcbio.com/news-releases/news-release-details/tlc-announces-tlc599-agreement-endo

4. Vacuum Ultraviolet Metalens

A fundamental study on vacuum ultraviolet metasurface lens (metalens) with a potentially disruptive technology for the ultraviolet optics market is published in *Science Advances* this April. This work provides a useful platform for developing low-loss VUV components and increasing the accessibility of the VUV regime. Dr. Ming-Lun Tseng, one of the three co-first authors and Professor of National Yang Ming Chiao Tung University, expressed that vacuum ultraviolet (VUV) light are photons with higher energies compared to visible light and is applicable to state-of-the-art technology like Photochemistry, materials analysis, and lithography by operating in a vacuum chamber. Nevertheless, it is strongly absorbed by regular optical materials. How to both generate the VUV light and manipulate it is always a critical issue and a limitation for scientists to explore the undiscovered potential.



VUV nonlinear metalens design – idealized schematic

The study demonstrates a metalens that both generates—by second-harmonic generation—and simultaneously focuses the generated VUV light. The metalens consists of 150-nm-thick zinc oxide (ZnO) nanoresonators that convert 394 nm (~3.15 eV) light into focused 197-nm (~6.29 eV) radiation, producing a spot 1.7 μm in diameter with a 21-fold power density enhancement as compared to the wavefront at the metalens surface. The reported metalens is ultracompact and phase-matching free, allowing substantial streamlining of VUV system design and facilitating more advanced applications.

This research was funded by Taiwan's Ministry of Science and Technology, National Taiwan University, the Shenzhen Science and Technology Innovation Commission, the University Grants Committee/Research Grants Council of China's Hong Kong Special Administrative Region, the Department of Science and Technology of China's Guangdong Province, the Department of Electrical Engineering of City University of Hong Kong, the Taiwan Ministry of Education's Yushan Young Scholar Program, the Research Center for Applied Sciences at Taiwan's Academia Sinica, the Robert A. Welch Foundation, the National Science Foundation, the Air Force Office of Scientific Research and the Defense Threat Reduction Agency.

Sources:

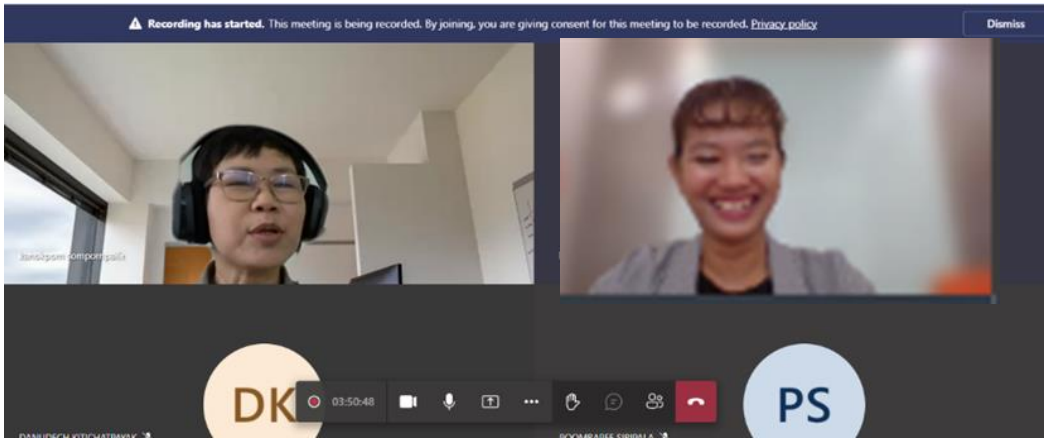
1. 應用半導體曝光微影！陽明交大與跨國團隊開發「真空紫外超穎透鏡」 https://technews.tw/2022/06/28/metasurface-lens/
2. Vacuum ultraviolet nonlinear metalens https://www.science.org/doi/10.1126/sciadv.abn5644
3. Rice 'metalens' could disrupt vacuum UV market https://news.rice.edu/news/2022/rice-metalens-could-disrupt-vacuum-uv-market

Activities in Member Countries | THAILAND

The National Nanotechnology Center (NANOTEC) is the leading agency on nanotechnology development in Thailand. Established on 13 August 2003, NANOTEC is one of four research agencies operating under the jurisdiction of the National Science and Technology Development Agency (NSTDA) and the Ministry of Higher Education, Science, Research, and Innovation (MHESI). NANOTEC has participated and conducted various nanotechnology activities under ANF Nano Safety and Risk Management working group as following:

1. NANOTEC – KMITL Nanosafety online workshop

On 16 March 2022, NANOTEC and the College of Nanotechnology at King Mongkut's Institute of Technology Ladkrabang (KMITL) have been organizing Nanosafety workshops to help build students and faculty understand of issues related to nanotechnology. Since 2020 due to the Covid 19 pandemic the workshop was conduction via webinar. The workshop goal is to introduce Nanosafety not only in the laboratory or research setting but also about the manufacture process the environmental concern, the related guidelines and Thailand national standard as well as the good governance on nanotechnology. To develop the safe and sustainable nanotechnology Nanosafety topic need to be include at the beginning of the research as well as the future advance materials related with Nanotechnology. At the end of the seminar students were very active to participate on the question-and-answer session.



2. NSTDA Annual Conference (NAC 2022) Webinar on Knowledge management:

Guidance on specifying manufactured nanomaterials, Guidance on nanomaterial risk evaluation and how to apply for volunteer industrial standard

On 29 March 2022, NANOTEC (Thailand) a member of National Science and Technology Development Agency (NSTDA) organizer the webinar Under the NSTDA Annual Conference (NAC 2022). The topic of the webinar on Knowledge management was focus on 3 topics as follow.

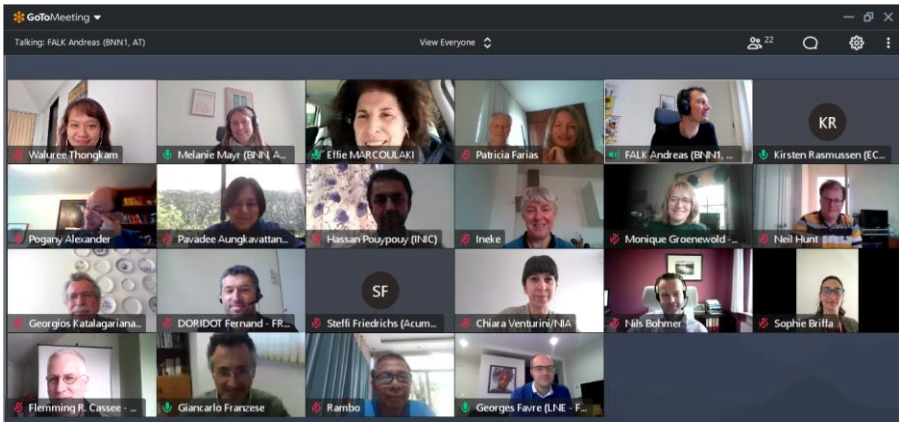
1. Guidance on Specifying Manufactured nanomaterials
2. Guidance on nanomaterial risk evaluation
3. How to apply for volunteer industrial standard.

NANOTEC speakers together with the speaker from Thailand Industrial Standard Institute (TISI) also answer the question from the attendee. The objective of this webinar is to transfer the knowledge about standard and support the implementation of Thailand nanotechnology national standard to all stakeholders. Attendees of the webinar included participants from the nine Nanosafety Network for Industry partners, academia, research agencies, and private sectors groups

3.Concept paper of “International Network Initiative on Safe and Sustainable Nanotechnologies (INISS-nano)”

On 8 April NANOTEC join the INISS-nano meeting as one of contributors for a concept paper “International Network Initiative on Safe and Sustainable Nanotechnologies (INISS-nano)” with the concept on “Network of the Network”. The goal of the meeting is to implement concept to the stage plan of action and the possible activities that will implement in four pillars as follow

1. Harmonisation
2. Support industrial understanding
3. Sharing/Facilitated Sharing or Resources/Infrastructures
4. Ethical Aspects.



4. Standard Developing Organization 2022

NANOTEC acting as a Standards Developing Organization (SDOs), has collaborated with the Thailand Industrial Standard Institute (TISI) to develop new Thailand National Standards Guidelines. On 28th April the SDOs committee start the 1st meeting on the National Industrial standard draft of Plai Extract and Capsicum Extract Nano-Encapsulated Particles.

5. Webinar on NanoQ and Nanosafety

On 31 May 2022, Nanotechnology association of Thailand and NANOTEC together with King Mongkut's University of Technology Thonburi organizer webinar on **"NanoQ and Nanosafety"**. The objective of this seminar was to disseminate knowledge and understanding related to the procedure of NanoQ label request for entrepreneurs in the cosmetic industry including stakeholders using nanomaterials in the production process and to promote entrepreneurs realizing the importance of products containing nanomaterials and the safety measure during production process including the National standard and guideline related with risk evaluation.

The seminar was focusing on 2 topics as below:

1. How to request NanoQ Label.
2. The principle of Nanosafety for entrepreneurs5

Speakers included Dr. Tanakorn Osotchan, Chairman of NanoQ, Nanotechnology Association of Thailand and acting deputy executive director, NANOTEC and Dr. Waluree Thongkam Senior Technical Officer at Nanosafety Alliance Section, NANOTEC. Attendees for the webinar were students, researchers, and start up enterprise.

6. 22nd Meeting of the Working Party on Manufactured Nanomaterials (WPMN) and the International NanoHarmony & NANOMET Workshop on nano-related OECD Test Guideline Development at OECD Conference Centre, Paris.

During 27–30 June 2022 the events were organized by the Organization for Economic Co-operation and Development (OECD). Dr. Pavadee Angkawatana presented the status of nanotechnology in Thailand in Tour de Table report and on 29 June 2022 presented on the topic "Regulation and Use of OECD TGs in Thailand" at the International NanoHarmony & NANOMET Workshop. Both event are the international dialogue and the cooperation on health and environmental policies relating to manufactured nanomaterials (MNMs) and other novel materials as well as discussed the challenges and best practice approaches for the development of Test Guideline. There was a special focus on the use of TGs in regulation from an international point of view.

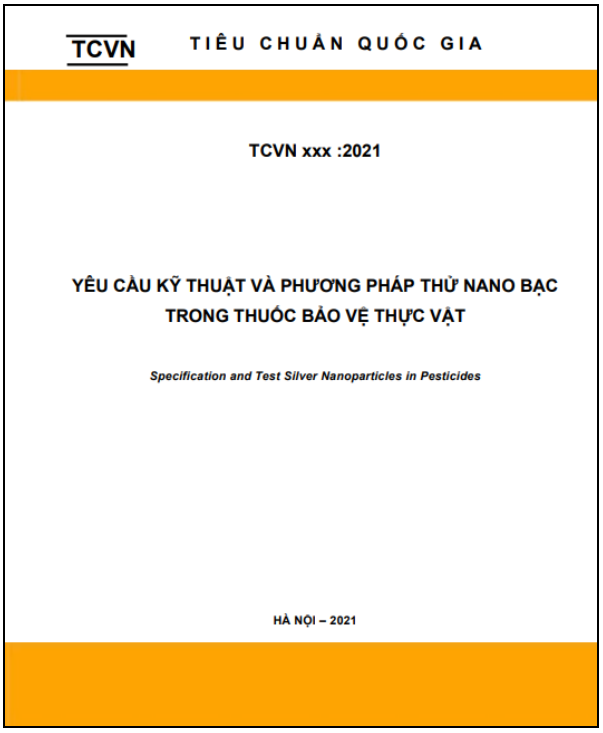
Activities in Member Countries | VIETNAM

1. Established National Standard Technical Committee on Nanotechnology

On 19 May 2022, the Directorate for Standards, Metrology and Quality (STAMEQ) - Vietnam Ministry of Science and Technology (MOST) established the National Standard Technical Committee on Nanotechnology, TCVN/TC 229 and Prof. Tran Dai Lam was appointed as a chairman. The Committee's mission is to update and introduce the latest issues in nanomaterials, nanotechnology, nanosafety and its hazards.

2. Vietnam standard for specification and test Silver Nanoparticles in Pesticides

The international standard ISO/TC 229 indicated a number of benchmarks on nanotechnology, but there is not one that can quantitatively analyze nanoscale content or size. In Vietnam, there are many plant protection products containing nano-silver at different concentrations (from 100 ppm - 1000 ppm), but their actual content of nano-silver could not be yet determined by a standard method. The safety of nanomaterials for human health and beneficial organisms requires the understanding of the concept and relationship between the characteristics of nanomaterials and the chemical and biological reactions that nanomaterials can cause at the molecular scale in living organisms (humans and animals, plants). Therefore, in 2020, the Plant Protection Department of Vietnam has established a national standard for specification and test Silver Nanoparticles in Pesticides. This standard has been approved in 2021 and will be published at the end of this year. The introduction of this standard provides a method for evaluating and controlling the quality of nano-silver pesticides on the market. Vietnam standard for specification and test Silver Nanoparticles in Pesticides was published in the end of 2022 which show as follows.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YÊU CẦU KỸ THUẬT VÀ PHƯƠNG PHÁP THỬ NANO BẠC TRONG THUỐC BẢO VỆ THỰC VẬT

Specification and Test Silver Nanoparticles in Pesticides

HÀ NỘI – 2021

3. Workshop on Application of nanomaterials in biomedicine, agriculture, and environment

For the past few years in Vietnam, the use of nanomaterials is not only applied in agricultural farming but is also considered an effective solution to replace traditional pesticides to control plant pests such as insects, microorganisms, and weeds. The growing application of nanomaterials in agriculture raises concerns for the health of consumers and the environment. For this reason, the Institute for Tropical Technology organized an annual workshop on "Application of nano-materials in biomedicine, agriculture and environment". The 2nd workshop on "Application of nano-materials in biomedicine, agriculture and environment" was held on 30th October 2021. The 3rd workshop will take place on 29th October 2022.

4. Nanomaterials in biomedical: research and commercial

The development of nanomaterials has resulted in a new route for the biomedical field. Many natural active ingredients are produced at nanoscale that have shown better effects than usual such as nano-curcumin, nano-quercetin, nano-rutin, some of them have been combined together to create a new fomular that present better properties. For example, the complexes between β-cyclodextrins and rutin, has a sphere structure with diameter around 30-50 nm, presents a higher antioxidant activity than pure rutin.

Some research results on nanomaterials have been developed for the purpose of commercialization. For example, gold and silver nanoparticles were incorporated into the antibacterial products such as mouthwash, nasalwash, handwas. In the Covid-19 pandemic, the nano-silver particles have been used into commercial products to disinfect masks.

The research on the properties of the complexes between β-cyclodextrins and rutin has been published on Journal of Molecular Liquids which show as follows.

Contents lists available at ScienceDirect

Journal of Molecular Liquids

journal homepage: www.elsevier.com/locate/molliq

Effect of cyclodextrin types and reagents solvation on the stability of complexes between B-cyclodextrins and rutin in water-ethanol solvents

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ABSTRACT

In this work, the solubility of rutin was *first* obtained in the water-ethanol solvents with small composition of co-solvent in the mixture at 25 °C. The results showed that the solubility of rutin improved with increasing ethanol content in the studied range 0–0.1 mol. fr. Solvation of hydroxypropyl-β-cyclodextrin in binary solvents was *first* studied by the method of interfacial distribution of the substance between two immiscible phases. It was found that when moving hydroxypropyl-β-cyclodextrin from water to the water-ethanol solvent, a decrease in the solvation of hydroxypropyl-β-cyclodextrin was observed. Complexation between rutin and β-cyclodextrin or hydroxypropyl-β-cyclodextrin was also studied in water and in the water-ethanol solvents. In the aqueous solution containing hydroxypropyl-β-cyclodextrin, the solubility of rutin was improved significantly and better than in the solution containing β-cyclodextrin. The stability of (rutin-hydroxypropyl-β-cyclodextrin) complex decreased with increasing the ethanol content and was determined by the sum of solvation of rutin ($\Delta_{tr}G_{Rut}$) and hydroxypropyl-β-cyclodextrin ($\Delta_{tr}G_{HPCD}$). This effect was also observed for the complexation reaction between quercetin and hydroxypropyl-β-cyclodextrin in our previous study.

1. Introduction

In organic chemistry, polyphenolic compounds are defined as a class of chemical compounds involving a hydroxyl group bonded directly to an aromatic hydrocarbon group. It is the most popular in antioxidant activity, anti-inflammatory, preventive and therapeutic effects of cancer and cardiovascular protection [1]. Polyphenolic compounds are often extracted from plants, such as, rutin from *Sophora japonica*, quercetin from onion, curcumin from turmeric, which are very popular in tropical countries. Rutin (RuT) is a glycoside which combines the flavonol quercetin and the disaccharide rutinose (α-L-rhamnopyranosyl-(1 → 6)-β-D-glucopyranose). It is a citrus flavonoid found in a diversity of plants such as citrus fruit. RuT is emerging as an important bioactive ingredient with manifold potential applications in pharmaceutical products since it is endowed with some interesting biological activities and is well known mainly for its strong antioxidant properties [1,2]. However, the aqueous solubility of rutin is poor, that influences on the absorption of the drug after oral administration [3]. To improve bioavailability, ensure maximum effectiveness of the treatment, reduce toxicity, the solubility of drugs have to be increased. Thus, cyclodextrins are used as host compound to form complexes with guest polyphenolic compounds with the aim of increasing their solubility. Cyclodextrins (CD) are a family of cyclic oligosaccharides composed of-(1,4) linked glucopyranose subunits by –(1,4) bonds [4]. The cyclodextrins molecules have a unique structure with a hydrophobic cavity and a hydrophilic surface which can form inclusion complex with many guest molecules. The inclusion complexation of CD with the bioactive compounds changes the physical and chemical properties of the guests; protects these compounds from environmental conditions and improves their solubility in water for increasing capacity to functionalize the products [5–7]. The complexes formed between CD and guest molecules were mainly stabilized by weak non-covalent interactions such as van der Waals forces, hydrophobic interactions, hydrogen bonding, and ion–dipole interactions among others [8]. The selective ability of cyclodextrins to form an inclusion complex with a guest molecule depends on the relative size of the cyclodextrin cavity to the size of the guest molecule or certain key functional groups within

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Antibacterial nano-silver in solution for masks, products from the research results of the Vietnam Academy of Science and Technology is show as follows.

Calendar of Events

nano tech 2023

1 – 3 February 2023
Tokyo, Japan
Hybrid Exhibition

6th EU-ASIA dialogue on Nanosafety

21 – 22 June 2023
Berlin, Germany

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