Driving Research Collaboration through ANF Infrastructure Network

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Editors:
Hongfang JIN
Hiro AKINAGA
Ramam AKKIPEDDI
Lerwen LIU
Welcome Message from ANF Infrastructure Working Group

Globally we see an increasing need for diverse high end techniques and sharing of infra-structure, to pursue nanotechnology related research. In order to promote and create better awareness of the infrastructure available on the micro/nano fabrication and characterization facilities, an ANF user facility network data base has been created. The idea is to put together an easily accessible common data base, to benefit ANF members in enhancing further collaborations and cooperation. Various member economies have displayed the infrastructure available with details of their capabilities and the equipment in operation. Access to these facilities would however, be as per the protocols prevailing in the respective institutions. It is hoped that this information would be useful to the research community to promote further ties in collaborative activities.

Ramam AKKIPEDDI (IMRE, Singapore)
Hiro AKINAGA (AIST, Japan)

ANF Infrastructure Network
A significant investment on nanotechnology facilities has been made in 4 centers as indicated below:

- Vietnam Academy of Science and Technology - VAST, campus in Hanoi;
- Hanoi University of Science and Technology - HUST
- Vietnam National University in Hanoi VNU-Hanoi
- Vietnam National University in HoChiMinh City VNU-HCM.

Two institutes of Vietnam Academy of Science and Technology (Institute of Matterials Science and Institute of Physics) have established official collaboration with the Synchrotron Light Research Institute (SLRI) at Nakhon Ratchasima, Thailand for using of the facilities of synchrotron source of that institute.
Iran Nanotechnology Laboratory Network (INLN)

INLN was established in 2004 with the aim of creating a proper infrastructure for providing university researches and industry R&D with high standard laboratory services. INLN shares more than 870 equipment from 58 member laboratories from governmental and private sectors which located in 14 provinces throughout the country.

INLN’s main areas of activity are as below:

- Publication of information, news and reports about the capabilities, plans, equipment and facilities of the member laboratories and events of the network through INLN website (www.nanolab.ir);
- Improving the quality and quantity of services of the network members by annual evaluation and ranking system;
  - Providing member labs by several supports in the following areas:
    - Training workshops for member labs’ staffs;
    - Maintenance, upgrading and calibration of laboratory equipment;
    - Implementation of ISO/IEC17025 standard in the member labs;
    - Consulting member organizations for purchasing new equipment.
- Establishing expert workgroups to facilitate knowledge flow, mentoring and teamwork among INLN’s members;
- Publication of "Iranian Journal of Laboratory Knowledge (IJLK)" as a scientific e-journal;

Growth in the number of services provided by INLN members (2005-2012)

www.nanolab.ir
The “Nanotechnology Platform” is a nationwide user facilities platform covering three technological areas:

- Nano-characterization
- Nanofabrication
- Molecular Synthesis and Analysis

Organized:
- 3 sub-platforms corresponding to 3 fields above
- One center coordinating the overall program
- Totally 25 institutions contribute to the platform

Since the declaration of “Nanotechnology Era” by Mr. Clinton in 2000, integrated networked partnership of user facilities has evolved throughout the world. In Japan, the “Nanotechnology Support Program” started in 2002 on four major fields of technologies, nano-fabrication, nano-evaluation, nano-synthesis and SOR, followed by the “Nanotechnology Network Program” started in 2007 and the “Nanotechnology Platform Program” from 2012, along with many other resembling projects/consortium throughout the country, including “TIA-Nano” (Tsukuba Innovation Arena for Nanotechnology), “NANOBIC” (Global Nanomicro Technology Business Incubation Center), and “NBCI” (Nanotechnology Business Creation Initiative).

The introduction focuses on the Nanofabrication Platform, which consists of 16 participating institutions throughout Japan, from Hokkaido, the northernmost, and to Kyushu, the southernmost part of Japan. The representative institution is the Kyoto University, and one can easily receive information from the coordinators on the available machines and technologies to materialize your project by clicking the “consulting” button on the top page.

The major facilities you can access through the Nanofabrication Platform include, electron beam lithography machines, UV lithography machines, dry etching machines, thin film deposition machines and evaluation machines such as SEM (scanning electron microscope), TEM (transmission electron microscope).

Sponsored:
by MEXT (Ministry of Education, Culture, Sports and Science & Technology).

Aims:
- promoting interdisciplinary researches in nanotechnology
- Collaborations among industry, government and academia leading to the innovation
- Human resource development through the platform activities.

Nanotechnology Platform Program

Since the “Nanotechnology Platform Project”, including “Nanofabrication Platform” is supported by MEXT (Ministry of Education, Culture, Sports, Science and Technology), all the items that are solved by using the Platform are required to submit a one-page report to the supporting institution, and also to pay the determined charges to the institution. The report includes (1) aims of the project; (2) the facilities used in the project, (3) results of the work, and would be open to public through MEXT. The details will be given by contacting the coordinators through the homepage, or consulting your acquaintance in the Nanofabrication Platform.
The researchers of the MacDiarmid Institute (Victoria University of Wellington) comprise a large fraction of New Zealand’s capability in nano-science and technology.

The nanofabrication and processing resources include facilities for growth (PLD, UHV-cluster deposition), for processing (e-beam, optical and imprint lithography, plasma etching) and finally characterisation (TEM, SEM, AFM, STM, electrical, optical spectroscopy).

Theory and modelling work is supported by access to the BlueFern supercomputer. Our capital infrastructure is of high quality and, very importantly, maintained and operated by skilled technical support staff.

www.macdiarmid.ac.nz/research/nanofabrication-and-devices
Six Nano-infrastructure centers depend not only on field of study but also on regional service, centralized public facility offering the services to promote nanotechnology R&D for academia, research institute and industry:

- Providing nano research equipment & process services
- Training professional manpower of nanotechnology
- Supporting the commercialization of nanotechnology

Through a close cooperation between industry, university and institute, Korea has achieved excellent results. The total number of Industry-University-Institute cooperation service is 51,101.

- Industry(24,712) / University(17,860) / Institute(8,529)
- An increase of 10% compared with the previous year

ANF infrastructure network have produced good progress in a wide range of fields in Korea. Of note, the cumulative case of patent application, patent registration and published articles has reached more than 500 in 2012.

- Patent application : 150
- Patent registration : 37
- Published articles at home and abroad : 356

Also, the case of technology transfer and technical support has amounts to about 100.

- Technology transfer : 11
- Technical support : 87

www.kontrs.or.kr
In Malaysia, there are eight main research institutions with various capabilities in nanotechnology research. Five of the institutions are Malaysian NND (National Nanotechnology Directorate) COEs (Centres of Excellence) while the other three are research universities.

† **Ibnu Sina Institute for Fundamental Science Studies (IIS), Universiti Teknologi Malaysia**

IIS has been consistently producing high-quality papers every year, and this includes indexed journals and proceedings. In 2012, IIS researchers managed to produce 75 journals and five patents in the field of nanotechnology.

† **Institute of Microengineering and Nanotechnology (IMEN), Universiti Kebangsaan Malaysia**

Since its incorporation in 2002, IMEN has been consistent in pursuing the R&D of micro and nanoelectronics. This is shown by their achievement in producing 20 patents for various applications including MEMs sensor, energy harvester and carbon monoxide sensor.

† **Centre of Innovative Nanostructures and Nanodevices (COINN), Universiti Teknologi PETRONAS (UTP)**

Since its incorporation, COINN’s researchers have been actively involved in nanotechnology research. As a result, 13 patents were granted or filed for various applications including nanosensors, nanoparticles and polymer fabrication. In 2005, one of their publications titled “Synthesis of Optimum-diameter Multiwalled Carbon Nanotubes (MWNTs) for Mechanical Reinforcement Applications” won a silver medal in PECIPTA (formerly known as IPTA R&D Expo).

† **Institute of Nano Electronics Engineering (INEE), Universiti Malaysia Perlis**

Since INEE was incorporated, its researchers have been heavily involved in nanotechnology R&D. As a result, 22 patents were filed and/or granted since 2009, mostly in the fabrication and application of nanogap biosensors.
NEMS/MEMS Research Laboratory, MIMOS
At MIMOS, a great emphasis has been put on Intellectual Property (IP) as it is important for Malaysia to move up from being a user to the inventor of technologies. Therefore, knowledge generation particularly through IP creation is encouraged at all levels of work in MIMOS. MIMOS has filed and/or granted 14 patents for inventions related to nanotechnology.

Institute of Advanced Materials (ITMA), Universiti Putra Malaysia
In terms of intellectual properties, ITMA has managed to acquire 14 patents in areas such as thin film processing, agents for cancer treatment, carbon nanotubes and energy storage.

Nano Opto-Electronics Research Lab (NOR LAB), Universiti Sains Malaysia
NOR Lab has been successful in acquiring and/or filing for 5 patents since its incorporation.

Nanotechnology and Catalysis Research Centre (NANOCAT), Universiti Malaya
NANOCAT has been actively producing indexed journals and proceedings every year. NANOCAT researchers have managed to produce 329 journals and 23 patents in related nanotechnology research.

www.nanomalaysia.com.my
IMRE - SERC Nanofabrication, Processing & Characterization (SnFPC)

The SNFC group manages the maintenance and operation of the relevant IMRE facilities, and encourages researchers from other organisations to base associated research projects here.

The IMRE facilities include a large clean room which is purpose-built for research work into a variety of different materials, and an impressive range of major equipment.

SNFC employs dedicated staff that are trained and experienced in the use of its specialist equipment. These staff are on hand to train and assist new users of such facilities, offer the service of baseline processes and characterization as well as to contribute in research projects whenever necessary.

Scope and Objectives

- **SNFC encompasses a network of world-class facilities** and expertise from across the SERC Research Institutes and the Singapore Universities.
- **SNFC offers an extensive range of characterization, nanofabrication services** and advice to all parties across Singapore.
- **The range of baseline fabrication processes** offered by SNFC is **constantly being updated** through the results of research projects across the SNFC user community.
- **The dedicated facility staff are highly trained** in the use of the equipment and its associated processes.
- **The SNFC staff are available as team members for research projects, for consultancy or service work** or to train new users on the equipment.

www.imre.a-star.edu.sg/facilitiesequipment.php
Core Facilities of NPNT, Taiwan

- Core Facility for Nano Lithography and Nano Biotechnology, NTU
- Core Facility for Nano Fabrication and Nano Characterization, NCTU
- Nano-science and Technology Center in Central Taiwan, CCU/NCHU
- Core Facilities for Southern Taiwan Nanotechnology Research Center, NCKU
- Nano-laboratory for Kaohsiung and Ping-Tung Area, NSYSU
- Interdisciplinary Bio-medical Imaging Research Center, NSIRC
- Nano Common Laboratories, ITRI
- Center for Microscopy and Nano - Analysis, NTU
- Advance Research Facility for Nanoscience and Nanotechnology, SINICA
- Nano-science and Technology Research Center in Eastern Formosa, NDHU

Core Facility for Nano Fabrication and Nano Characterization, Department of Electrical Engineering, Graduate Institute of Electronics Engineering, NCTU

17% of the total users come from non-university research institutions and industrial labs:
- 11% - Industrial Technology Research Institute, Academia Sinica, other national labs
- 6% - R & D teams of high tech companies

One example for the collaboration with industrial partners is the center’s capability in optics related measurements. They can perform Raman spectroscopy measurement, the broadband reflection and transmission spectrum characterization, and the quantum efficiency measurement. They can help the optoelectronic companies to characterize their devices in the early stage of development. So the center serves as a platform for the development of new products for some of the high tech companies.

Infrastructure Project of Nanoscience and Technology Center in Central Taiwan - Department of Mechanical Engineering, CCU; Department of Physics, NCUE

By leveraging the research on atomic force microscopy and nanoindentation with collaboration with the Dentistry Department of the National Chung Kung University, a joint research with Kinik Company Ltd. was established to study the tribological properties of soft pads aimed at life increase of the soft pads used in wafer polishing.

Southern Taiwan Nanotechnology Core Facility Service Project, Center for Micro/Nano Science and Technology, NCKU

At present there are six sorts of technology:
- nano lithography fabrication,
- failure analysis and nanostructure processing,
- nanoMark inspection,
- nanomechanical inspection,
- optical inspection, and
- microstructure and chemical composition analysis.

Based on the developed six sorts of technology, 59 advanced instruments, and great achievements and KPIs, this project will establish the “Academic-Industry Alliance of Micro/Nano Fabrication and Inspection Technology” as a platform to fulfill the needs of small and medium enterprises of the alliance and assist them in increasing product value and enhancing their international competition ability. The alliance will provide members with micro/nano fabrication and inspection technology related service:
- technical promotion and counseling,
- training courses,
- talents introducing and technology transfer, and
- conferences and information of nano industry trends to solve members’ problems from developing products and strengthen their competition ability.

In a word, by the pragmatic platform, interaction between the industry and the academic will greatly be activated and large impact will be brought to industry-academic technology cooperation.

Under the resource-sharing system, CMNST provides fabrication and inspection service for all areas in Taiwan. At present, CMNST serves alliance members, such as
Taiwan Semiconductor Manufacturing Company, China Steel Corporation, CPC Corporation, Advanced Semiconductor Engineering Inc., Taiwan’s Premier Chemical & Electronic Chemical Material Manufacturer. Advanced ceramics nanotech co.,LTD, Solar Applied Materials Technology Corporation, Everest Textile Co., Ltd. and so on. In 2011, 23 companies with 149 cases were served and dealt and the totals revenue was 968,439 NTD; while in 2012, 31 companies with 153 cases were served and dealt and the totals revenue was 1,172,442 NTD. Companies served by CMNST are listed in the following table.

- **UST Nanotechnology Core Facility Service Proposal**, Center for Nanotechnology, Materials Science, and Microsystems, NTHU

BioMedical NanoImaging Core Facility, Institute of Physics, Institute of Physics, SINICA

The recent work in microangiography opened the door to complete 3D imaging of large vascular network for entire tumors or organs, followed by zoomed-in examination of vessels nanostructures at the cellular level.

- **Advance Research Facility for Nanoscience and Nanotechnology**, Institute of Physics, SINICA

Large areas (1cm x1cm) of gold Nanoslit arrays were successfully fabricated using the 100kV e-beam writer system supported by the nano core facility center at the Academia Sinica.

- **Center of Advanced Spectro-Microscop**, Center for Condensed Matter Sciences, NTU

The center established the first STEM (FEI Tecnai 200 kV) in Taiwan, featuring a 2-Å electron probe and a high-energy resolution EELS setup (energy resolution, 0.15 eV). Using this STEM-EELS combination, they have unraveled the existence of bright and dark surface-plasmon modes in coupled Au nanoparticles.

In addition, the center firmly demonstrated the STEM-EDX resolution of 1.47 Å and its profound applications in tackling the chemical inhomogeneity in semiconductor devices. This achievement represents a significant breakthrough in the analytical electron microscopy and the STEM-EDX combination has now become a standard attachment to Cs-STEMs worldwide since May 2011 (FEI).

- **Core-facilities for Nanoscience and Nanotechnology in Kaohsiung - Pingtung Area**, Center for Nano Science & Nano Technology, NSYSU

- **Infrastructure Project of Nanoscience and Technology Center in Taichung area**, Department of Chemistry, NCHU

- **Nano-science and Technology Research Center in Eastern**, Nano-science and Technology Research Center, NDHU

  - **Micro Raman Spectrometer JOBIN-YVON T6400**: Raman spectroscopy is a spectroscopic technique used to both quantitatively and qualitatively analyze the structure and composition of unknown materials. The sample can be either in solid, liquid or even gas phase. JY-T6400 micro Raman Spectrometer is the most excellent one in the world, which is the only one Raman system with versatile functions such as extra-high resolution, UV-Raman and temperature-dependence.

  - **SQUID**: Studies of superconducting materials are a popular research topic, but a few focused on the magnetic properties of binary nanocrystals. The researchers undertook a study to investigate the magnetic mechanism of superconductor of binary nanocrystals.

  - **Bio-AFM**: This instrument has played an important role in the studies in cell biology, bacteriology, and virology. The information yield by this machine is considered very difficult to be provided by other techniques. As a result, this machine has provided a novel approach in the researches of biomedical sciences.

  - **FCFM**: Additionally, when compared with TiO2-based photocatalysts, In2O3@CaIn2O4 treatments did not induce significant cell death and tissue damage, implying a superior biocompatibility. These findings suggest that In2O3@CaIn2O4 may have potential application in the development of a safer and highly bactericidal photocatalyst.

  Source: SINICA, NTU, NSYSU, NCHU, NDHU and NPNT

Contact: npntoffice@nctu.edu.tw
National Nanotechnology Center (NANOTEC)

The lab is equipped with the state-of-the-art equipment for various nano-scale measurements and characterization and provides any testing services for internal and external customers.

Contact: Nuttapun SUPAKA, nuttapun@nanotec.or.th

✧ Using nanotechnology to add value for cosmetic industry

NANOTEC in collaboration with Kasetsart University, Thammasat University, Srinakharinwirot University and PTT Global Chemical Public Company apply nanotechnology to add value to the Press Mud and change to the high-value nano-material for cosmetic industry and functional ingredients to nutraceutical products. The research program composes of 2 research projects: “Product Development of Nanostructure Lipid Carrier from Sugarcane Wax for Application in Sunscreen and Moisture Nail Lotion” and “An Economic Analysis of Worthiness on Sugarcane Wax Production as Carriers for Delivery System of Bioactive Compounds. These two projects were awarded research fund from Thailand Research Fund (TRF) and National Research Council Thailand (NRCT) via the Strategic Basic Research Programme (Fiscal year 2556, project will start on Aug 2556- Jul 2557).

✧ Advancements and developments of solid-state nanopores sensors

Researchers at National Nanotechnology Center (NANOTEC), Thailand and Imperial College London (Department of Chemistry), United Kingdom have studied the advancements of solid-state nanopores for the purpose of highlighting selected developments that will benefit scientists.

An entire section of the study is devoted to highlighting various chemical and bio-molecular modifications and explores how these permit the development of novel sensors with specific targets and functions. The review is completed with a discussion on novel detection strategies using nanopores.

“The field of solid-state nanopores in particular is young and exciting” said Dr. Deampen Japrung a member of the research team at NANOTEC. “Novel technologies are continuously pushing the limits and boundaries of fabrication methodologies and techniques that were born out of the semiconductor electronics industry. This momentum has been carried forward to state of the art fabrication techniques and newly discovered materials”.

The study was supported in part by a European Research Council starting grant and a Leverhulme Trust research grant.

The researchers reported their work in a paper published by Chemical Society Review with an Impact Factor of 23.76.

www.nanotec.or.th/en