

The 6th EU-ASIA Dialogue on Nanosafety

“The Role of characterization and how it is addressed in INISS-nano”

21 June 2023, 10.00-17.00 CET in Berlin, Germany



Characterization Research Efforts in Asian Countries

by Wannee Chinsirikul, Ph.D.
President of Asia Nano Forum
Executive Director of NANOTECH, Thailand



Japan



Korea



Malaysia



Taiwan



The Philippines



Thailand



Vietnam

OUTLINE

- **Asia Nano Forum (ANF)**
- **Characterization Research Efforts**
 - **Thailand (NANOTECH)**
 - **Korea (KoNTRS)**
 - **Malaysia (NNC & NanoMalaysia, MOSTI)**
 - **The Philippines (ITDI, DOST)**
 - **Taiwan (ITRI & Academia Sinica)**
 - **Vietnam (VAST)**
 - **Japan (ARIM Japan)**
- **International Activities: Connecting between Asia and EU**



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.

Website: <https://www.asia-anf.org/>

ANF Management Office Bearers



Wannee CHINSIRIKUL
President
NANOTEC, Thailand



Annabelle V. BRIONES
Vice President
DOST-ITDI, Philippines



Rezal Khairi AHMAD
Vice President
NanoMalaysia Berhad



Shuhei NUMAZAWA
Treasurer
JST, JAPAN



Pavadee AUNGKAVATTANA
Secretary
NANOTEC, THAILAND



Jason CHANG
Secretary
Academia Sinica, Taiwan

ANF Members (14 Institutes/10 Economies)

1. **BMK** / Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology, *Austria*
2. **NIT** / National Institute of Technology Srinagar, *India*
3. **TERI** / The Energy and Resources Institute, *India*
4. **INIC** / Iran Nanotechnology Initiative Council, *Iran*
5. **AIST** / National Institute of Advanced Industrial Science and Technology, *Japan*
6. **JST** / Japan Science and Technology Agency, *Japan*
7. **NIMS** / National Institute for Materials Science, *Japan*
8. **KoNTRS** / Korea Nano Technology Research Society, *Korea*
9. **NanoMalaysia Berhad**, *Malaysia*
10. **NNC** / National Nanotechnology Centre, MOSTI, *Malaysia*
11. **ITDI** / Industrial Technology Development Institute, DOST, *Philippines*
12. **Academia Sinica**, *Taiwan*
13. **NANOTEC** / National Nanotechnology Center, *Thailand*
14. **VAST** / Vietnam Academy of Science and Technology, *Vietnam*



01

Standardization

02

User-Facility Network

03

Nano Safety and Risk Management

04

Commercialization

Establishment & History of ANF Summit (ANFoS)

Phuket, Thailand 2004

Melbourne, Australia 2005

Hong Kong 2006

Kuala Lumpur, Malaysia 2007

Abu Dhabi, UAE 2008

Taipei, Taiwan 2009

Singapore 2015

Suzhou, China 2014

Tsukuba, Japan 2013

Bangkok, Thailand 2012

Tehran, Iran 2011

Hanoi, Vietnam 2010

Seoul, Korea 2016

Johor Bahru, Malaysia 2017

Taipei, Taiwan 2018

Tagaytay, Philippines 2019

Austria (Virtual Meeting) 2020

Thailand (Virtual Meeting) 2021

Malaysia (Hybrid Meeting) 2022

KoNTRS
Korea Nanotechnology Research Society
2023
5-6 July

Characterization Research Efforts in Asian Countries



Japan



Korea



Malaysia



Taiwan



The Philippines



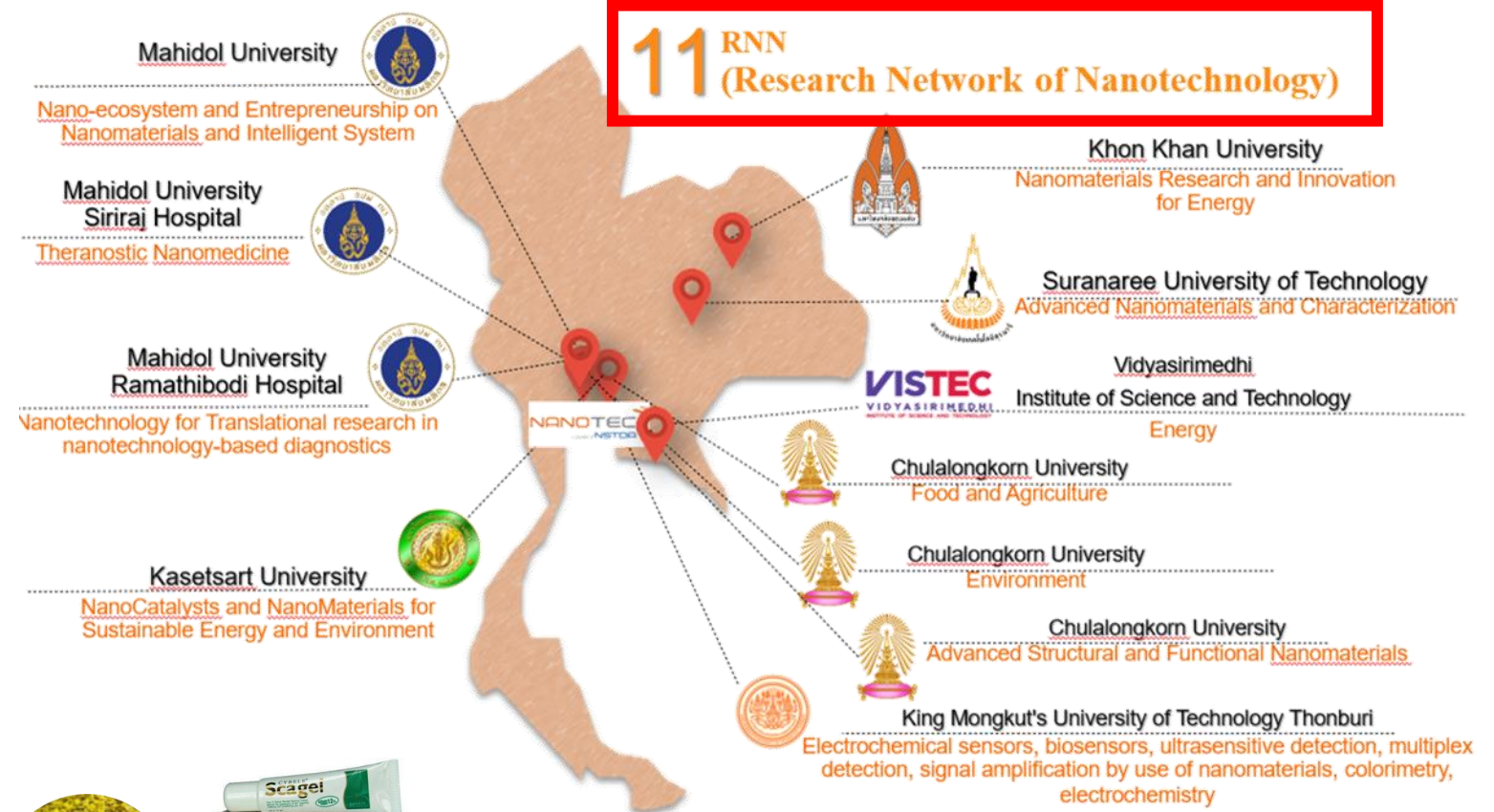
Thailand





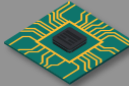
Vietnam

Collaboration of RNN Thailand towards Social and Industrial Applications R&D, Characterization, Scale-up and Tech Transfer Mechanism

11 RNN
(Research Network of Nanotechnology)



Human resources : 2000+

-  Nanochemistry
-  Nanoanalysis
-  Nanoengineering + Materials / Biotech / Digital Multidisciplinary

2000++
Publications

120+
Commercialized products/Industrial process

>10%
IP Utilizations



Cosmeceutical Products



Portable sensor for Pesticides Detection



E-nose/Digitization of Senses



E-nose/Digitization of Senses



Chelation Technology for Agriculture (Micronutrient NanoFertilizer & Animal Feed)

Advanced Nano-characterization and Safety Research Group >> Nanocharacterization Research Team (NCH)

has focused its research and measurement service activities on nanoscale physico-chemical characterization and standardization

Advanced Nano-characterization and Safety Research Group

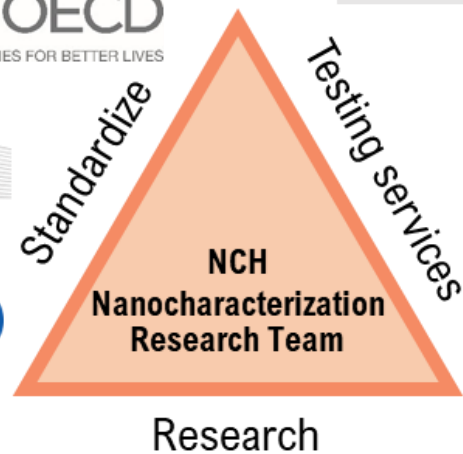
Nanohybrids and Coating Research Group



Nanocatalysis and Molecular Simulation Research Group

Nanoencapsulation Research Group

Responsive Materials and Nanosensor Research Group



Product labeling



Targeted nanoproducts

- Water repellent
- Cosmetic
- Anti-bacteria



- Material synthesis & design (MD)
- Characterization technique improvement (CTI)
- Sample preparation method for characterization (SPC)



Collaboration and Training



Nanostructure and Mechanical Characterization

Nanoscale Identification and Analysis

Chemical Identification

Nano Stability Analysis





Nanotechnology Association of Thailand (NAT)

Nano label (NanoQ)



Nanoproduct

- Final products ready to use
- Contain nanomaterials
- Anti-bacterial property or Water repellance property



Intermediate Nanoparticle

- Contain nanomaterials
- Non final product
- Need further processing step e.g. polymer contain nanomaterial enforcement



Nanoencapsulation

- Nano encapsulated bioactive compounds or herbal extract
- Encapsulated particles size in range 300-500 nm
- Non-specific shell depend on the final products



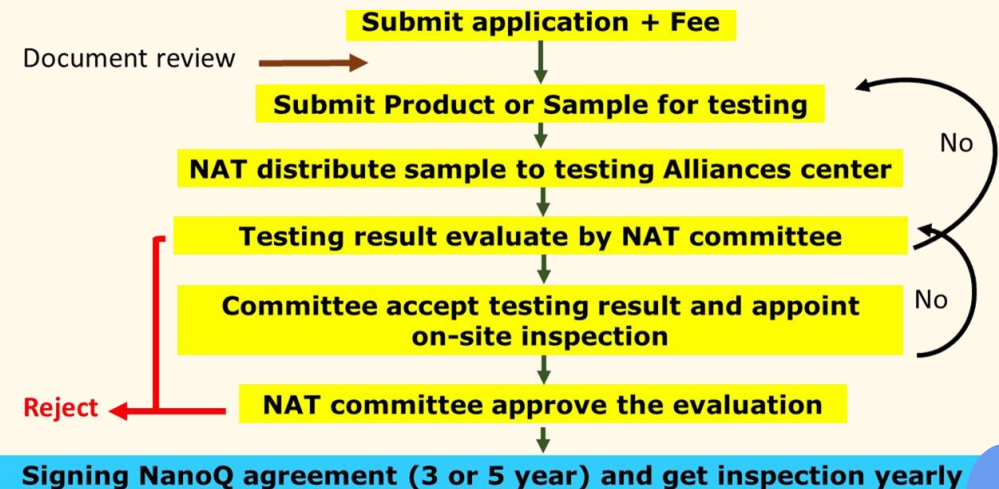
Raw Material

- Primary Nanomaterial in range of 1-100 nm
- Ready to use for intermediate or mix in final products
- e.g. Nanosilver, Nanogold, Carbon nanotube, Graphene plate, Nanocalcium carbonate, Nanosilica

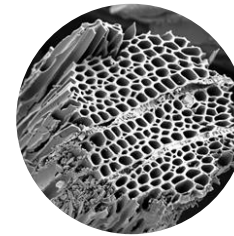
Nanoproducts and Alliance



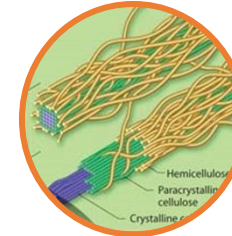
Apply for NanoQ



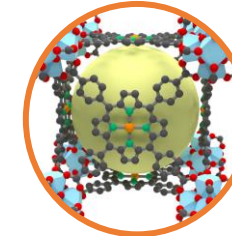
NanoCatalyst and Adsorbent



Nano carbon



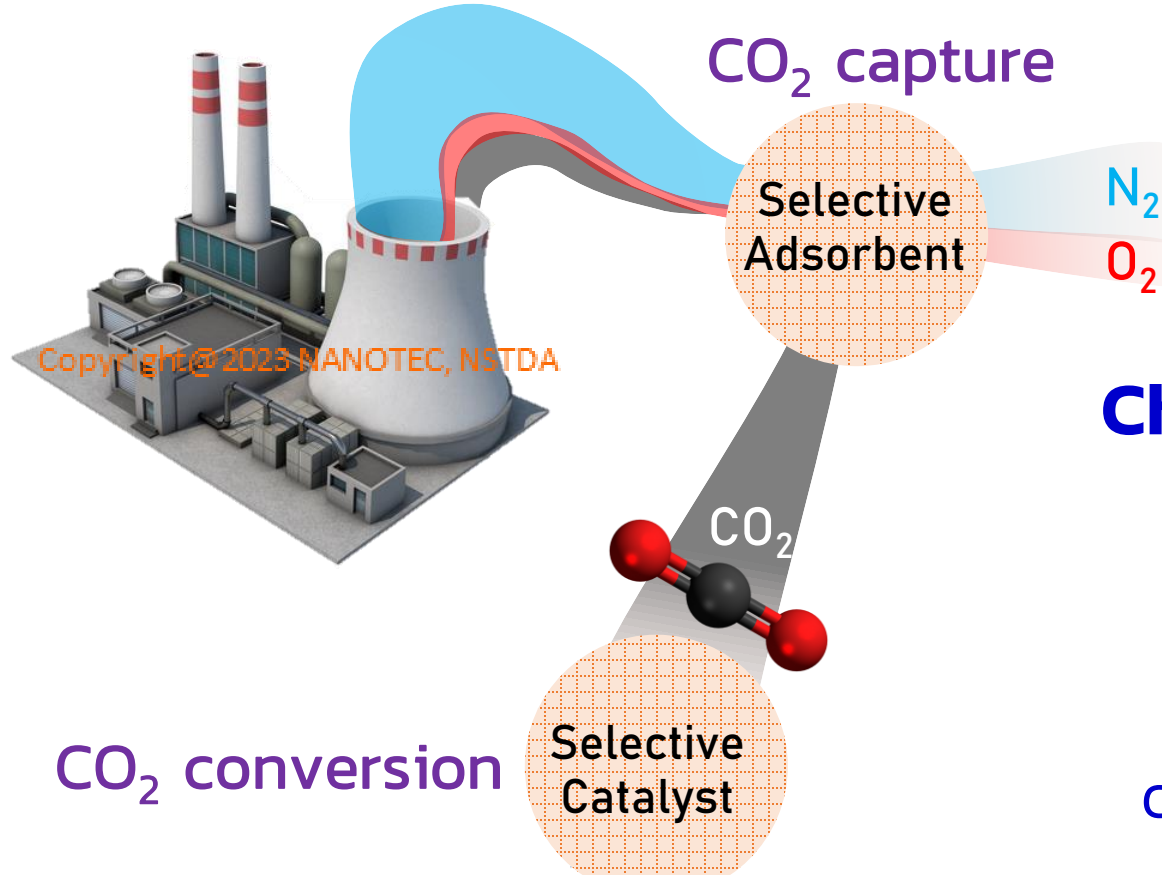
Functionalized cellulose



Metal-organic frameworks



Membranes



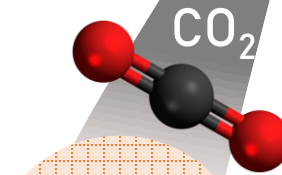
CO₂ capture

CO₂ capture

Selective Adsorbent

N₂
O₂

CO₂ conversion



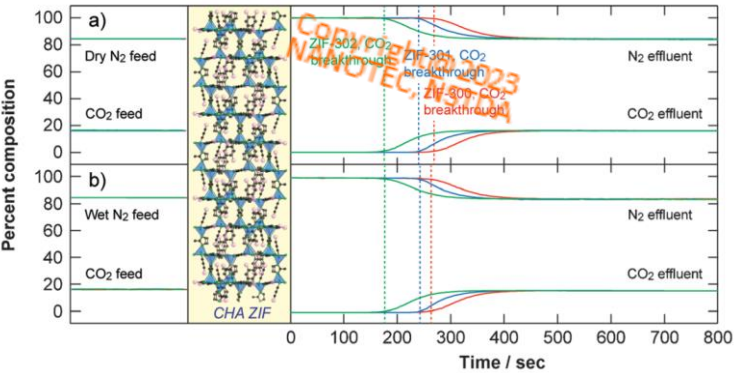
Selective Catalyst

Olefins Methanol
Carbon Carbonate

Characterization



CO₂ adsorption analysis



Multicomponent gas breakthrough analysis



CO₂ conversion analysis



Operando X-ray absorption spectroscopy (Synchrotron)

Initiatives by *Korea Nanotechnology Research Society (KoNTRs)*

Characterization Research Highlights in Korea National Safety Metrology Center at KRISS

➤ New Technologies and Standards for Nanosafety Research

Shape and Chemical Characterization of Nano-plastic particles

PiFM (Photo-induced force microscope) images
→ Shape and chemical composition of nano-plastic particles

<Images of PiFM nano-plastic particles>

Conjugated Ligand evaluation of nanoparticles

- Physico-chemical properties of ligand-conjugated nanoparticles by using XPS and ToF-SIMS imaging

<ToF-SIMS images of Ni-NTA conjugated Fe₃O₄ nanoparticles>

New technology of organoid for nanosafety

- New technology for organoid nanosafety study

Digital holography for Daphnia heart monitoring

- Heart rate measurement of Daphnia with nanoparticles

<Results of Daphnia heart rate measurements>



Initiatives by National Nanotechnology Centre and Nano Malaysia, MOSTI

The Malaysian Nanotechnology Landscape

- 290 nanotechnology laboratories
- 638 nanotechnology characterization equipment
- 261 nanotechnology research projects
- 266 nanotechnology IP
- More than 100 commercialized nanotechnology products

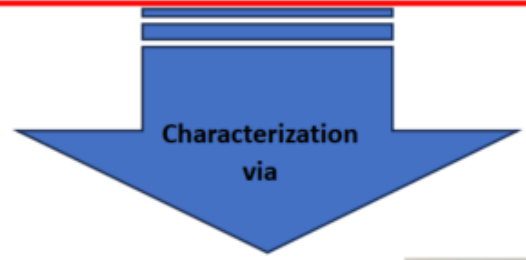


*info retrieved from Rangkaian Makmal Nanoteknologi Kebangsaan (RMNK), MOSTI Malaysia and NanoVerify website

The premier characterization initiative in Malaysia is pioneered through the **NANOVerify Programme**, a certification scheme recognized by the Malaysian Government.



The **NANOVerify Programme** is a certification programme operated by NanoVerify Sdn Bhd a wholly owned subsidiary of NanoMalaysia Berhad. It is a certification programme for processes and products with claims of **nano-elements in the range of 1 to 100 nm**, as well as performance enhancements related to such elements.



Transmission Electron Microscope ((TEM)



Field emission scanning electron microscope (FESEM)



BET Surface Analyzer



Raman spectrometer



Particle size analyzer via Dynamic light scattering method

*the equipment used for characterization is chosen based on the characteristics and features of the nanotechnology products.

*proper sample preparation plays an important role before characterization via the selected equipment can be done.

Initiatives by **National Nanotechnology Centre and Nano Malaysia, MOSTI**



Upcoming Program 2023

co-organized with:



- 1) **4 & 5 JULY** – Hands-on technique via electron-based characterization using FOUR equipment such as Hitachi Variable Pressure Scanning Electron Microscope (SEM), Hitachi Cold Gun Field Emission SEM, Hitachi Schottky Hot Field Emission SEM and Hitachi Atomic Resolution SEM / STEM
- 2) **21 & 22 AUGUST** – Workshop on X-ray based characterization equipment Small Angle X-Ray Spectroscopy and X-Ray Fluorescence
- 3) **9 OCTOBER** – Learning on how to operate laser-based characterization equipment RAMAN Spectroscopy
- 4) **23 OCTOBER** – Hands-on Laser based characterization equipment in Dynamic Light Scattering Particle Size Analysis

Initiatives by **Department of Science and Technology (DOST) – Industrial Technology Development Institute (ITDI)**

10 Commercialization
nanomaterial

& 2 nano-enabled
products

- under the project “Environmental, Health, and Safety Research in the Risk Assessment of Nanomaterials” *to determine the physical and chemical properties which can influence the effects on biological systems using analytical equipment* such as transmission electron microscope (TEM), scanning electron microscope (SEM), atomic force microscopy (AFM), dynamic light scattering (DLS) for particle size analyzer, Fourier Transform Infrared Spectroscopy (FTIR) and X-ray diffractometer (XRD)

- Participated in **two (2) International Interlaboratory Comparison** organized by NANOTEC-Thailand on nanomaterials size measurement using TEM, AFM, and SEM

- Organized the **1st Local Interlaboratory Comparison on nanomaterial size measurement using TEM, AFM, DLS, and SEM**

- Participated in the ASEAN Workshop on Training on Advanced Materials Characterization Techniques for Young Researcher from ASEAN Member Countries organized by Singapore and Thailand on **X-ray Photoelectron Spectroscopy (XPS), X-ray Fluorescence (XRF), X-ray Micro CT and SEM**

- Organized the ASEAN Workshop on Training on Advanced Materials Characterization Techniques for Young Researchers from ASEAN Member Countries on **Auger Electron Spectroscopy (AES), Time of Flight Secondary Ion Microscopy (TOF-SIMS), and TEM**



Initiatives by *Industrial Technology Research Institute and Academia Sinica*

Nanomaterials Registration Management

➤ **Regulations of New and Existing Chemical Substances Registration**

Issued by Taiwan EPA on 23 Nov. 2021

Article 8

For a new chemical substance meeting the circumstances of being a substance used for the purposes of “Scientific Research and Development”(SRD) or “Product and Process Orientated Research and Development”(PPORD); or having other special forms, in addition to registering the new chemical substance in accordance with the required information items of the Regulations, the registrant shall fill in and submit the following documents to the central competent authority:

I. Registration form for SRD and PPORD

II. Registration form for nanoscale chemical substances

➤ **Guidance for New and Existing Chemical Substances Phase 1 Registration (Draft)**

Issued date: **Sept. 2022**

Nanomaterial: Clause 3.2.6; Appendix 5

Registration types based on estimated annual manufactured or imported quantity

- Small Quantity Registration(<100 kg/y, Level 1)
- Simplified Registration(<1000 kg/y, Level 1)
- Standard Registration (>1000kg/y, Level 1 to 4, submit hazard and exposure assessment)

Initiatives by *Industrial Technology Research Institute and Academia Sinica*

Occupational safety

Many chemical fume hoods are used for controlling nanoparticle emission during **nanomaterial handling processes**. **To protect nanopowder handling workers**, Taiwan ILOSH (Institute of Labor Occupational Safety and Health) and National Yang Ming Chiao Tung University have been investigating the leakage control efficiency and its relationship with different operation conditions for **3 different fume hoods: constant air volume (CAV), air curtain (AC), and constant air volume (CAV) hoods**.

The **nanoparticle source (nano-titanium dioxide TiO₂ or sodium chloride NaCl)** was released from inside of the fume hood to simulate the nanoparticle handling operations. For the CAV hood, the leakage percentage of nanoparticles is 13.76% when the sash is fully open. The leakage percentage is decreased to 0.34% when the sash is changed to the half open. In comparison, the leakage percentage of the VAV hood is lower than that of the CAV hood which is just 0.37% when the sash is fully open. The leakage percentage is further decreased to 0.10% when the sash is half open. Similarly, the air curtain (AC) hood also has less leakage percentage of about 0.18% and 0.17% when the sash is fully open and half open, respectively. The results show that the leakage of nanoparticle is higher for the CAV hood when the sash is fully open since the face velocity of 0.3 m/s which is lower than the recommend value of 0.5 m/s. In comparison, the VAV hood can maintain a constant face velocity of 0.5 m/s when the sash is open at any height. It is worth noting that the leakage percentage is below to 0.2% for all three types of fume hoods when the sash is half open indicating good nanoparticle leakage efficiency. **In summary, the VAV and AC fume hoods control nanoparticle emission effectively compared to the CAV hood.**



STANDARDIZATION ACTIVITIES

ASIAN NANO FORUM - ANF

ANF NEWSLETTER
Activities of January – June 2022
ISSUE NO.40 | SEPTEMBER | 2022

The 1st ANF ExCo Meeting (Virtual Meeting)
Wednesday 26 January 2022, 3:00 – 5:00 p.m. (Bangkok - ICT, GMT+7:00)

ANF Newsletter Topic:
- Overview by ANF President
- Activities in Member Countries
- Calendar of Events
- Acknowledgements

TCVN TIÊU CHUẨN QUỐC GIA

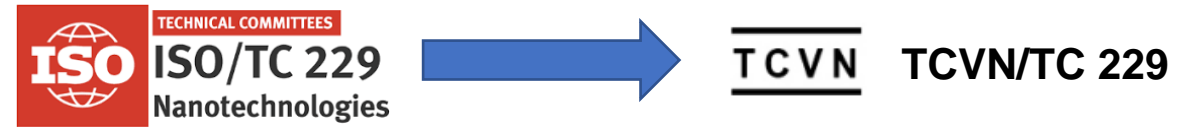
TCVN 13712:2023
Xuất bản lần 1

THUỐC BẢO VỆ THỰC VẬT –
XÁC ĐỊNH HÀM LƯỢNG NANO BẠC BẰNG
PHƯƠNG PHÁP PHỔ HẤP THỤ NGUYÊN TỬ
*Pesticides – Determination of silver nanoparticle content
by atomic absorption spectrometry method*

TCVN 13712:2023: National Standard on AgNPs for pesticides (published on March 2023)



Vietnam National Standards Technical Committee on Nanotechnology TCVN/TC 229 (Established on May 2022)

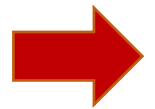
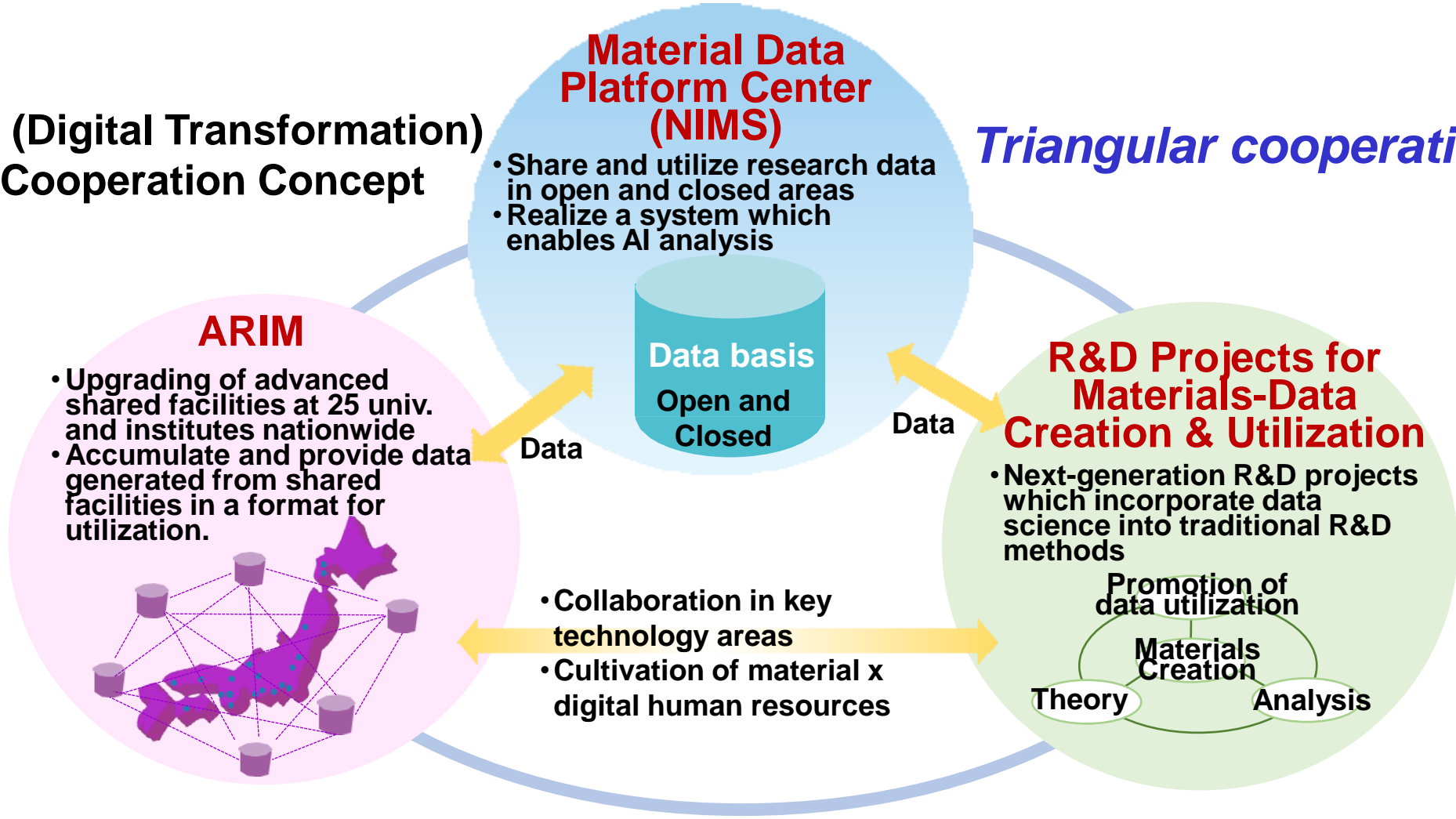


Reference and Adoption from ISO (May 2023)

1. ISO 19749:2020-Nanotechnologies – Measurements of particle size and shape distributions by scanning electron microscopy
2. ISO 21363:2020-Nanotechnologies – Measurements of particle size and shape distributions by transmission electron microscopy
3. ISO 17200:2020-Nanotechnology – Nanoparticles in powder form – Characteristics and measurements
4. ISO/TS 19808:2020-Nanotechnologies – Carbon nanotube suspensions – Specification of characteristics and measurement methods
5. ISO/TR 13121:2011-Nanotechnologies – Nanomaterial risk evaluation

Japanese Government Strategy for Materials Innovation

Materials DX (Digital Transformation) Platform Cooperation Concept



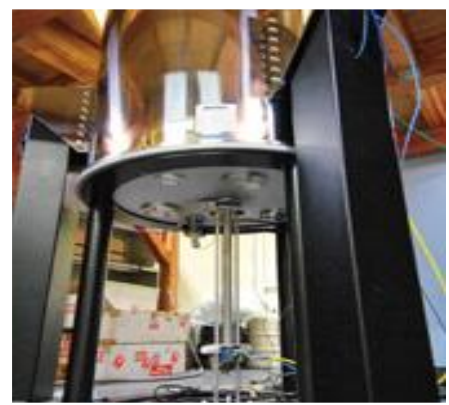
ARIM: **A**dvanced **R**esearch **I**nfrastructure for **M**aterials and Nanotechnology

ARIM provides user facility services with advanced equipment & skilled experts in the field of nano/micro fabrication, measurement/analysis, and materials synthesis

Facility & Equipment



XPS



NMR



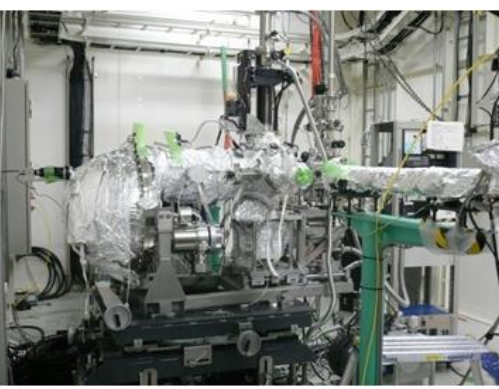
Ultra-High Resolution S/TEM



Aberration Corrected STEM



Technical Assistant



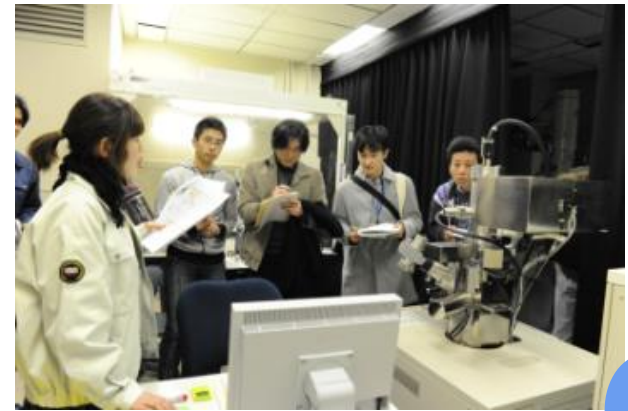
Hard X-ray XPS



Electron Probe Micro Analyzer (with FE gun)



TOF-SIMS



Training



International Network Initiative on Safe & Sustainable Nanotechnology

A concept paper “**International Network Initiative on Safe and Sustainable Nanotechnologies (INISS-nano)**” was published on ZENODO website on 21st June 2021 via <http://doi.org/10.5281/zenodo.5004929>



Committee members and coordinators form ANF

- 1) Dr. Ali Beitollahi (Iran Nanotechnology Innovation Council, Iran)
- 2) Dr. Wanee Chinsirikul (ANF President 2022-2023 & NANOTEC Thailand)
- 3) Dr. Ting-Kuo Lee (ANF President 2020-2021 & National Sun Yat-sen University, Taiwan)
- 4) Dr. Alexander Pogary (Republic of Austria, Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology, Austria)

Contributors from NANOTEC

- 1) Dr. Pavadee Aungkavattana (NANOTEC Thailand)
- 2) Mr. Ramjitti Indarprasirt (NANOTEC Thailand till Sept. 2021; from Oct. 2021 onwards: private)
- 3) Dr. Waluree Thongkam (NANOTEC Thailand)

Initiatives by **National Nanotechnology Center (NANOTEC), NSTDA**

2 Inter-laboratory comparison (ILC) Workshop

- **The 1st Inter-laboratory comparison (ILC) workshop 2018**
24 September 2018
- **3 types of Polystyrene Latex and TiO₂ Nanoparticles**
- **Specific Measurements Instruction for SEM, DLS, AFM**

18 Participating Laboratories

7 Nation: Indonesia, Iran, Malaysia, Philippines, Taiwan, and Thailand

- **The 2nd Inter-laboratory comparison (ILC) workshop 2019**
6 January 2020

Discussion on the analytical results of size measurements for gold nanoparticles among participating laboratories.

14 Participating Laboratories

4 Nations : Iran, Malaysia, Philippines, and Thailand





Measurement method/test development for Nanocharacterization:

The 1st Inter-laboratory comparison

The 2nd Inter-laboratory comparison

18 institutes from 7 countries

No.	Material	Nominal size [nm]	Volume [mL]	Concentration* [%solid]	Manufacturer
T1	TiO ₂ /P25	20	-	-	ACCOR
P2	Polystyrene	60	15	1	Thermo Fisher Scientific
P3	Polystyrene	150	5	1	NANOTEC
P4	Polystyrene	580	5	1	NANOTEC

Asia

- Indonesia
- Iran
- Malaysia
- Philippines
- Taiwan
- Thailand

Nanoparticle Characterization

- Supplementary Comparison on Nanoparticle Size

CERTIFIED REFERENCE MATERIALS:

- GOLD NANOPARTICLE
- SILVER NANOPARTICLE
- POLYSTYRENE NANOPARTICLES

Measurement results of ~10 nm Gold

Measurement results of ~20 nm Silver

Measurement results of ~30 nm PLS

Measurement results of ~100 nm PLS

Measurement results of ~300 nm PLS

Science and Technology Capability

Key results: 1) National Institute of Metrology (NIMT) informed the results of the Inter-Laboratory comparison to Participating Laboratories.
 2) Nowadays, the Certified Reference Materials of NANOTEC comprise of Polystyrene Nanoparticles 1 & 1.5 & 150 μm and 300 & 500 nm

FUTURE 2023



VISTEC
VIDYASIRIMEDHI
INSTITUTE OF SCIENCE AND TECHNOLOGY

NANOTECH
a member of NSTDA



NANO
THAILAND 2023

NANOTHAILAND 2023

The 8th Thailand International Nanotechnology Conference

“Nanotechnology for Sustainable World”

29 November – 1 December 2023

Venue : Dusit Thani Hotel, Pattaya, Thailand





**Thank you for
your attention**