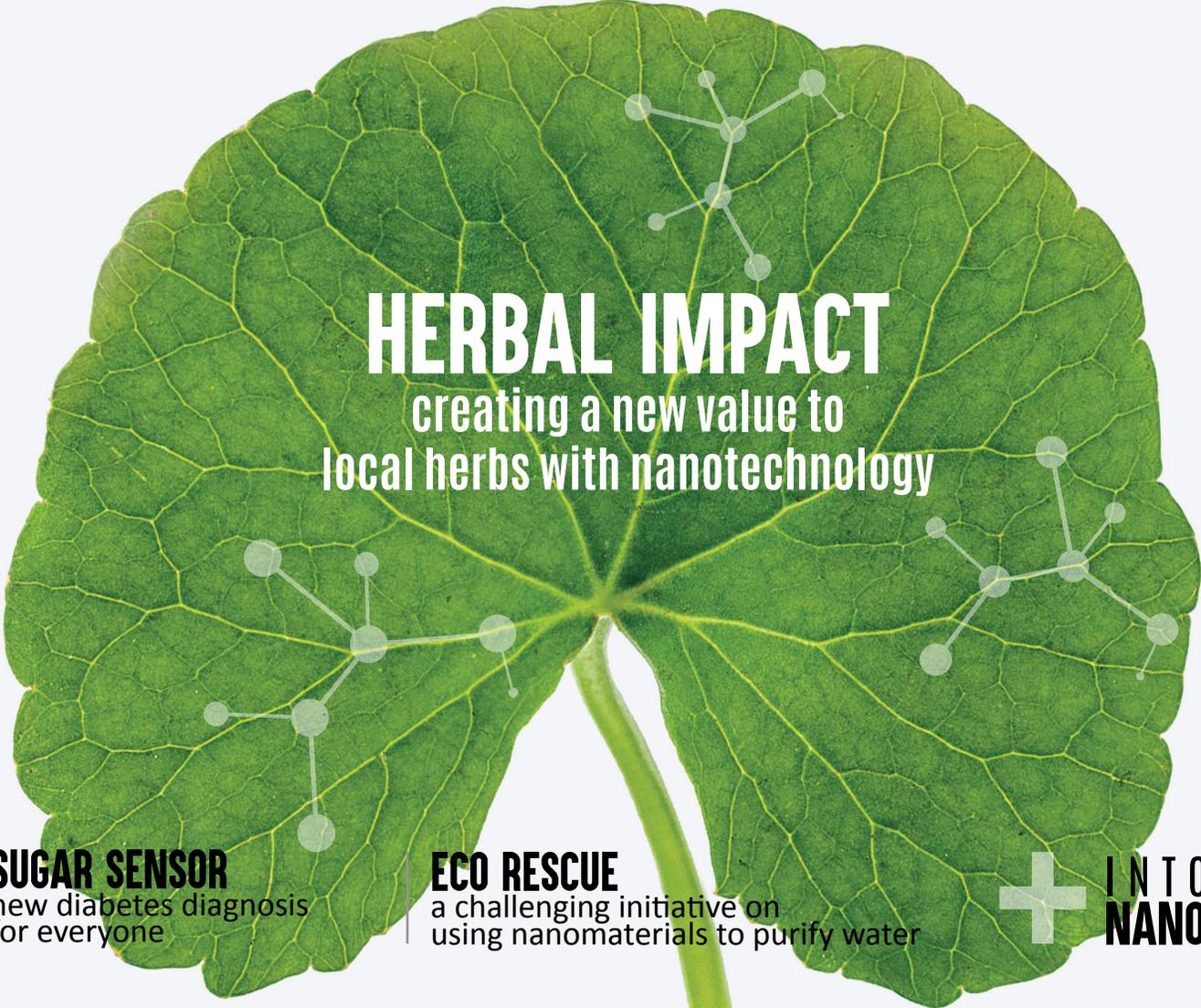


THE MAGAZINE FOR NANOTECHNOLOGY DEVELOPMENT IN THAILAND by NANOTEC

NANO

2017
ISSUE



HERBAL IMPACT

creating a new value to
local herbs with nanotechnology

SUGAR SENSOR

new diabetes diagnosis
for everyone

ECO RESCUE

a challenging initiative on
using nanomaterials to purify water



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NANOTEC

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for everyone



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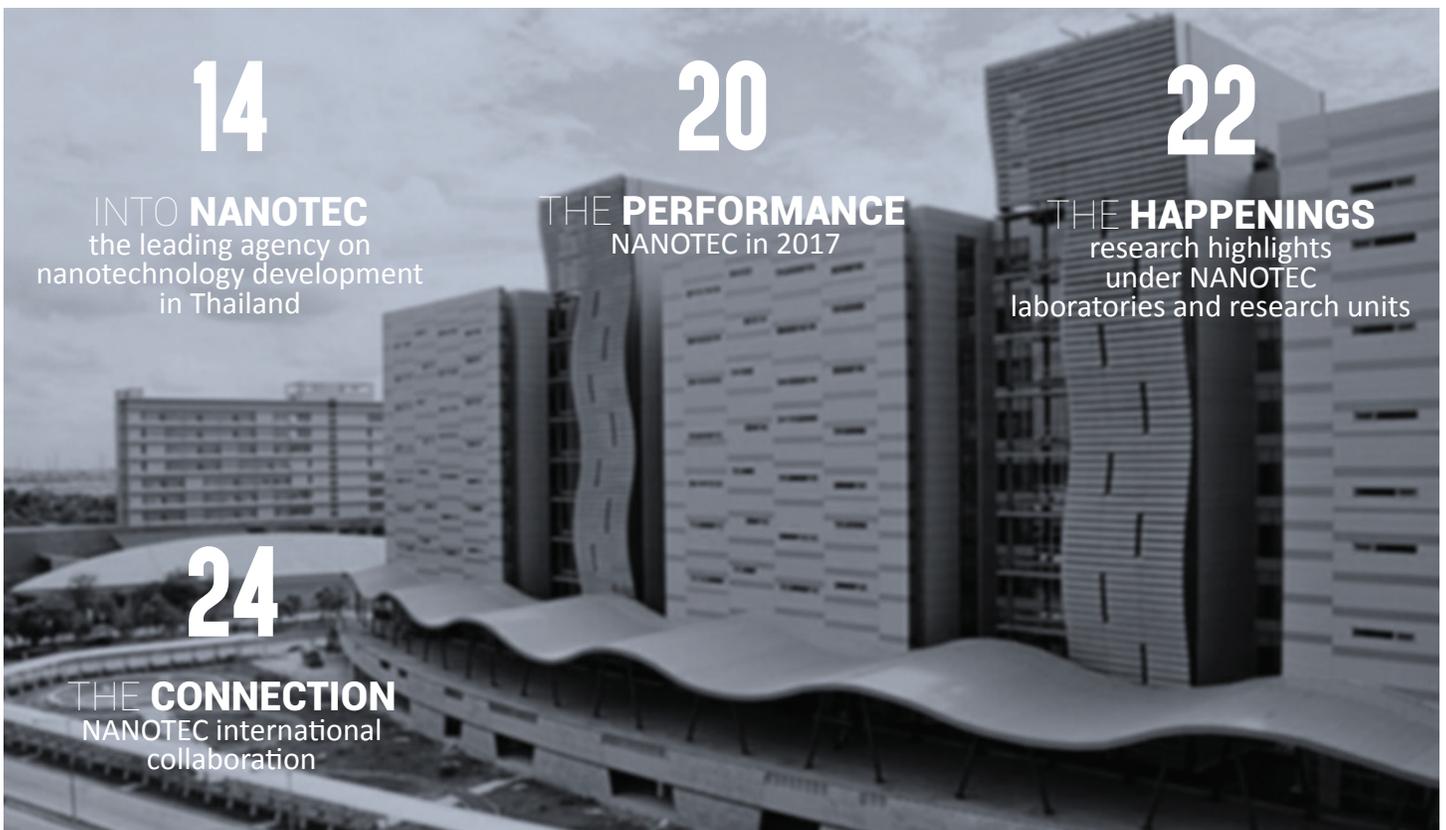
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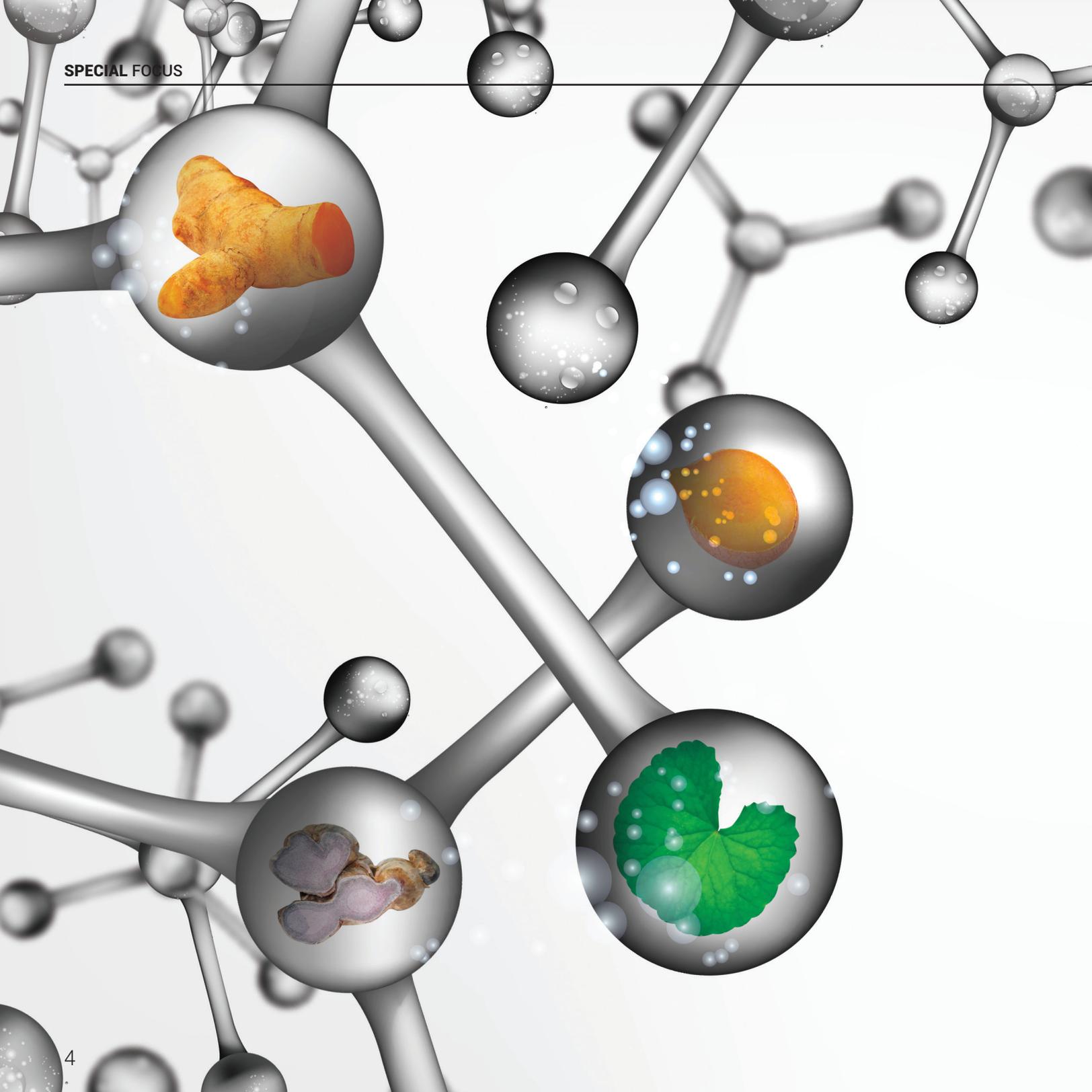
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HERBAL IMPACT

Creating a New Value to Local Herbs with Nanotechnology

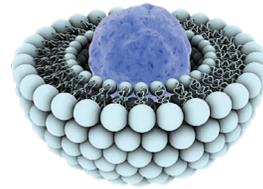
It is said that herbs are the gifts Mother Nature bestowed to mankind. Humans have utilised herbs' healing properties for thousands of years, dating back to Egyptian, Greek, and Roman times. In Asia, historical records showed that herbal usage began in India before spreading to China, Malacca and Thailand, whose climate is conducive to both the natural and cultivated growth of herbal plants.

The herbal product market saw rapid expansion both domestically and internationally, especially herbal extracts, with their sustained global demand. This is partly due to the public being more health and beauty conscious. Meanwhile, demographic changes, especially trending towards "aging society" also contribute to quick expansion of herbal product market. Last but not least, the resurgence in the popularity of herbs as cheaper (and relatively safe) alternatives to conventional medicines helped the herbal market to really take off.

Technologies available at NANOTEC to develop and create more value to Thai herbs

Natural Product
Extraction and
Characterization

Molecular
Biology and
Cell Signaling

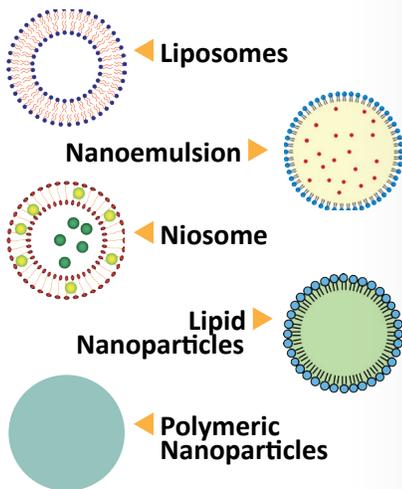


Nanoparticle
Synthesis, Design
and Encapsulation

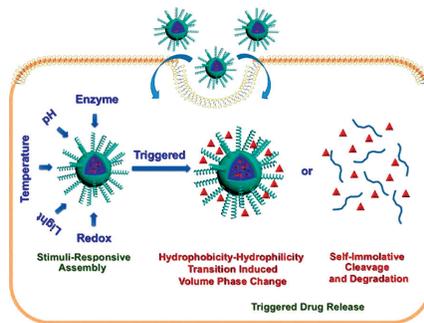
Product
Formulation and
Testing

Nano Encapsulation
Sub Technology

Nano-Encapsulation
Technology

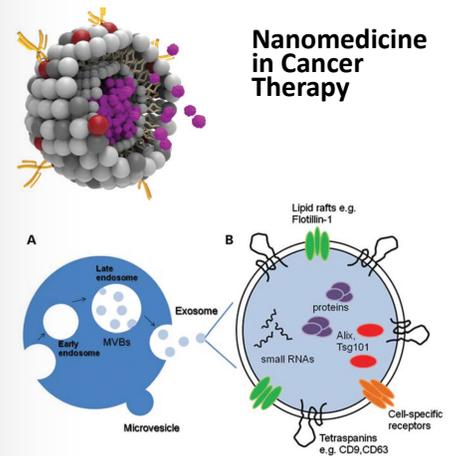


Stimuli-Responsive
Nanocarrier Technology



Stimuli Factor :
Enzyme, Light,
Temperature , pH

Targeting
Technology



Nanomedicine for Blood Brain
barrier Delivery , BBB

Examples of the application of nano encapsulation to Thai herbs

Nevertheless, Thai herb industry are still faced with quality issues, which are still well below international standards. This led to governmental concern, and Master Plan on Thai Herbal Development 2017-2021 has been set up to support Thai herb industry. Thailand's National Nanotechnology Centre (NANOTEC), under the National Science and Technology Development Agency (NSTDA) - the Ministry of Science and Technology, is among one of the many agencies responsible for pushing forward the vision.

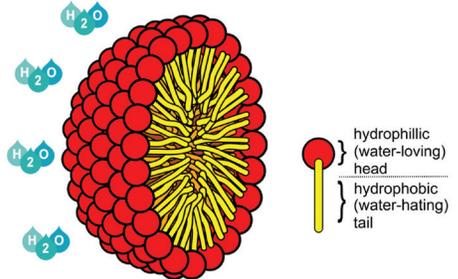
Under the Master Plan on Thai Herbal Development, NANOTEC is capable of developing and creating value to Thai herbs by means of the following technologies;

- Natural product extraction and characterisation
- Molecular biology and cell signaling
- Nanoparticle synthesis, design, and encapsulation
- Product formulation and testing

Moreover, nano encapsulation, one of the sub-technologies in nanotechnology, can be applied to cosmeceutical products such as gel and herbal extracts mixture which help reduce scars, and rice bran oil lotion which helps stimulate hair growth.

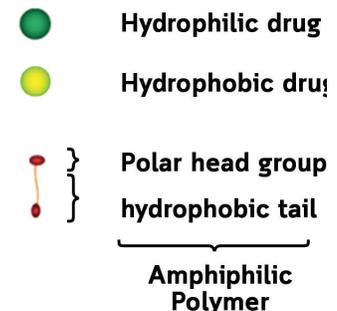
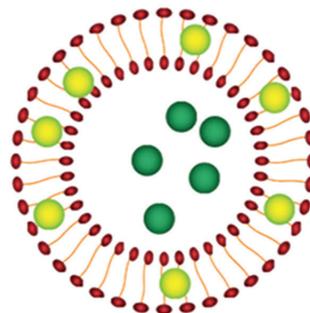
Micelle Technology

With its low surface tension, small particles, and fairly steady property, it is applied to Scagel, gel and herbal extracts mixture produced by Bangkok Botanica Co. Ltd., which recorded over 385 million baht in sales between 2015 and 2017. (making a total of 203.5 baht in net profit)



Niosome Technology

This form of nanoparticle was applied by Chao Phya Abhaibhubejhr Hospital to rice bran oil lotion to stimulate hair growth. From 2014 to 2017, its sales totalled 6.91 million baht. (or 3.97 million baht in net profit)



Reverse aging



Active reverse-aging ingredients

Synergy ^x

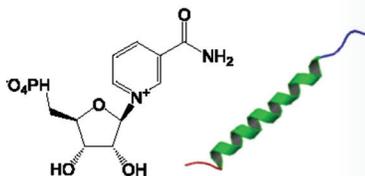
Herbal Extracts



Key reverse-aging ingredients obtained from the research and development of other supplements



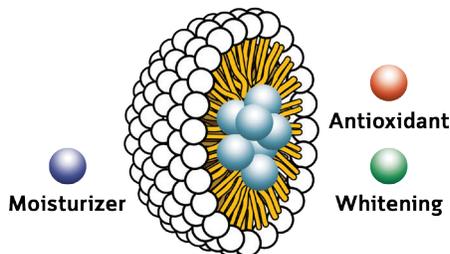
Other alternative nanoparticles with UV protection properties.



Guidelines on the development of Nanoencapsulation and formulation of sunscreen and reverse ageing products.

Nanoencapsulation & Formulation

Nanoencapsulation



gotu kola

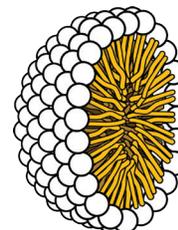
phlai



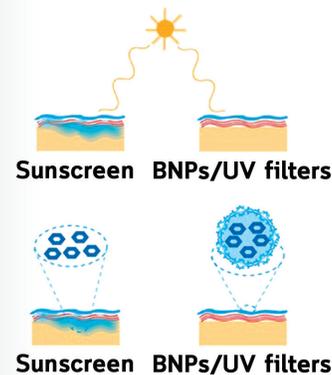
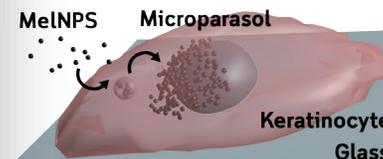
turmeric

black galingale

UV protection



Sunscreen Nano encapsulation



Plans are also afoot for NANOTEC to develop herbal extracts for sunscreen and reverse ageing products. Its National Advanced Nano-Characterisation Centre is also ready for particle production, product manufacturing, product safety and quality inspection.

By the way, phlai (*Zingiber montanum*), turmeric, black galingale (*Kaempferia parviflora*) and gotu kola (*Centella asiatica*) become the four key herbal products called “Product Champions” on the first section of the master plan and set four provinces which are Prachin Buri, Surat Thani, Chiang Rai and Sakon Nakhon as an “herbal city”.

Thai herbs have stood the test of time with their values to be further enhanced by nanotechnology. This means that local wisdom on herb usage will be sustained and even become known internationally.

The opportunity of Thai herb to the global market

On this day, market of global consumer health products in 2016 reaching THB7.68 trillion and market of global herb / traditional products is reaching THB1.31 trillion which the majority of revenue comes from dietary supplements. However, herbal / traditional products show uneven growth in the world, but Asia Pacific still dominates herbal / traditional market due to tradition. Moreover, Thailand, which used herbal as a traditional medicine grew at the fastest rates (68%) over 2011 – 2016 in herbal / traditional products retail value growth (Euromonitor International, December 2016).

And because the Prime Minister of Thailand concern about the value of Thai Herb, Master Plan on Thai Herbal Development, 2017-2021, has been set up which aims to become a leading exporter of raw materials for herbal production in the ASEAN region and increase double value of Thai herbal raw materials and products with a vision statement as “Thai Herbs for Health and Sustainable Economy”. The master plan composes of four core strategies, which are:

- 1) To promote Thai herbal plant products in response to the market demand in the country and overseas.
- 2) To develop the country’s herbal industry and market for reaching international markets.
- 3) To promote the use of herbal plants for medical treatment and health promotion.
- 4) To develop the Thai economy throughout the value chain of Thai herbal products.

For running Master Plan on Thai Herbal Development, the Government had set up a committee to work out such as the Ministry of Public Health, the Ministry of Agriculture and Cooperatives, the Ministry of Commerce, the Ministry of Tourism and Sports, the Ministry of Science and Technology, and the Ministry of Natural Resources and Environment and adopted the Abhaibhubejhr Business Model as a guideline to reach international herbal medicine and products standards.

SUGAR SENSOR

New diabetes diagnosis for everyone

Measuring of blood sugar and glycated hemoglobin (HbA1c) levels is a standard protocol for screening and monitoring of diabetes mellitus progression. However, blood sugar level is depending on food uptake before taking the measurement and HbA1c life cycle is somehow too long to be monitored in severe cases. In addition, in condition effecting red blood cell structure or hemoglobin production (hemolytic anemia, thalassemia and thalassemia carrier (40-50% in Thai population)), HbA1c level is not unrealizable. Therefore, measurement of glycated albumin, which is intermediated indicator outside red blood cell, could improve the way to control diabetes progression and treatment.

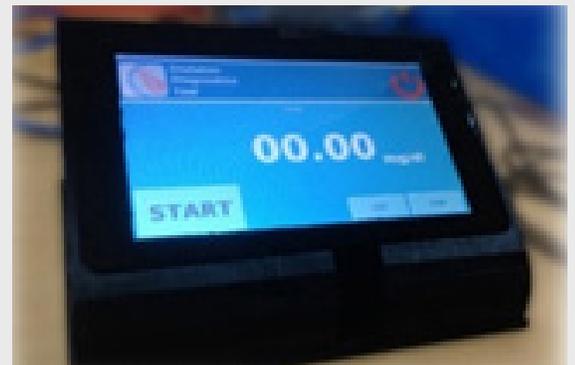
SugarAL sensor is glycated albumin detection kit, which based on aptamer binding and it has been developed for diabetes mellitus screening and monitoring. Both sensitivity and specificity of SugarAL sensor are higher than those of the commercial available (Immuno assay).

	FPG	OGTT	HbA1c	GHSA
● Biomarker	🔵	🔵	🔴	🔵
● No fasting	❌	❌	✅	✅
● Simple to use	❌	❌	✅	✅
● Sensitivity	❌	❌	✅	✅
● Limitation in RBC/Hb abnormality	❌	❌	❌	✅



Product Characteristics

● Trade	Sugar AL
● FDA approval	Not yet
● Biomarker	Glycated albumin
● Technique	Aptasensor
● Inventor/Owner	NANOTEC, NSTDA
● Sample types	Blood/Plasma/Serum
● Time	30 min
● LOD	50 µg/ml
● Specificity	>98
● Cost	\$ 2.5 (lab scale)



ECO RESCUE

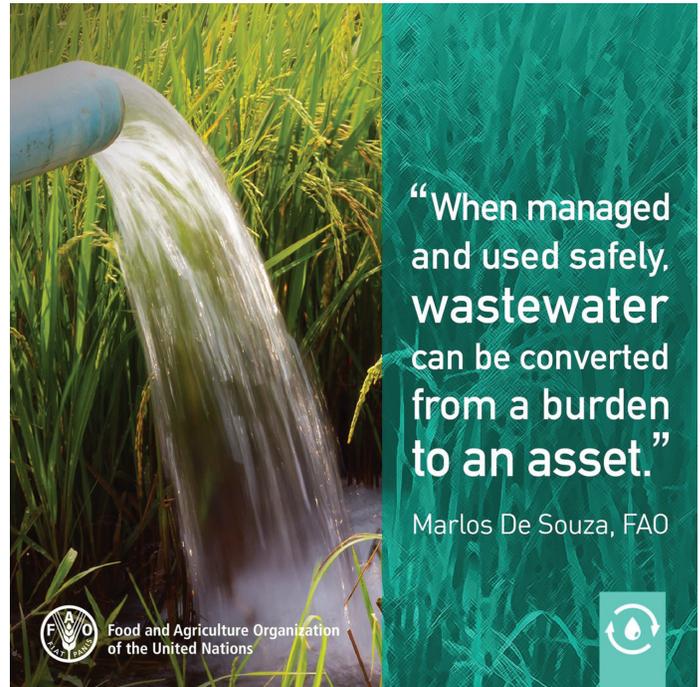
a challenging initiative on using nanomaterials to purify water

“Water” is the world’s quintessential component. However, 97.5 percent of the world’s water is salt water mainly found in the seas and oceans, with merely 2.5 percent being fresh water. Of this remaining 2.5 percent, most is locked away in glaciers and underground reserves, with the amount of “surface water” (in rivers, lakes, stream, canals, swamps, etc.), meaning the water than can actually be utilised, making up just one percent of the total fresh water volume.

Most of the water is used in agriculture, especially in Asia and Thailand where 75 percent of the water is dedicated to agriculture. The higher the food demand, the higher the demand for water. Therefore, the development of nanotechnology to reuse water as well as to desalinate is essential to human beings’ livelihood. Here are some examples of nanomaterials used in water treatment;

Graphene

Graphene is a nanomaterial consisting of carbon atoms arranged in a net-like shape similar to beehives. It is one carbon atom layer thick and is very sturdy. It is these desirable properties that catch the attention of scientists who utilised graphene in filters used in desalination, as it is found that graphene’s 1 millimetre pores and its thinness enable water molecules to be quickly sucked in through the pores, while other substances’ molecule cannot get through them in time. Thanks to this, we can filter out salt from water while using less energy compared to the usage of RO membrane filter, which requires a lot of energy to operate.



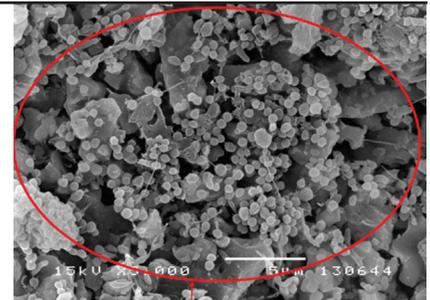
Nanosilver (Nano-Ag)

This material is widely touted and used over the past decade thanks to its excellent bacteria-killing properties. Hence, scientists generally apply Nanosilver to a variety of water filtration materials, including RO membrane filter, ceramic filter, and carbon filtration substance, to disinfect water, reduce the accumulation of bacteria on the surfaces of filtration materials, reduce the formation of biofilm and membrane clogging.

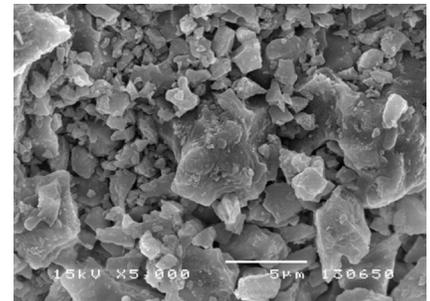
To ensure safety when using Nanosilver to filter water for consumption, the World Health Organisation has stipulated that the amount of silver contaminated in the water shall not exceed 1,000 micrograms per litre.

Nanotitanium Dioxide (Nano-TiO₂)

This is the nanometre-sized particle of Titanium Dioxide, making it more sensitive to chemical reactions as the contact surface per weight has increased. Thanks to this property, scientists have employed “Nanotitanium Dioxide” to get rid of contaminants in water, as photocatalytic processes are cost-effective, environment-friendly, and are capable of decomposing several types of organic substances and contaminated chemicals in water, such as paint used in cloth dyeing, phenol, pesticides, dioxine, and various forms of solvents. However, practical application of the photocatalytic processes, especially in large-scale water treatment system, remains a challenge for scientists to overcome.



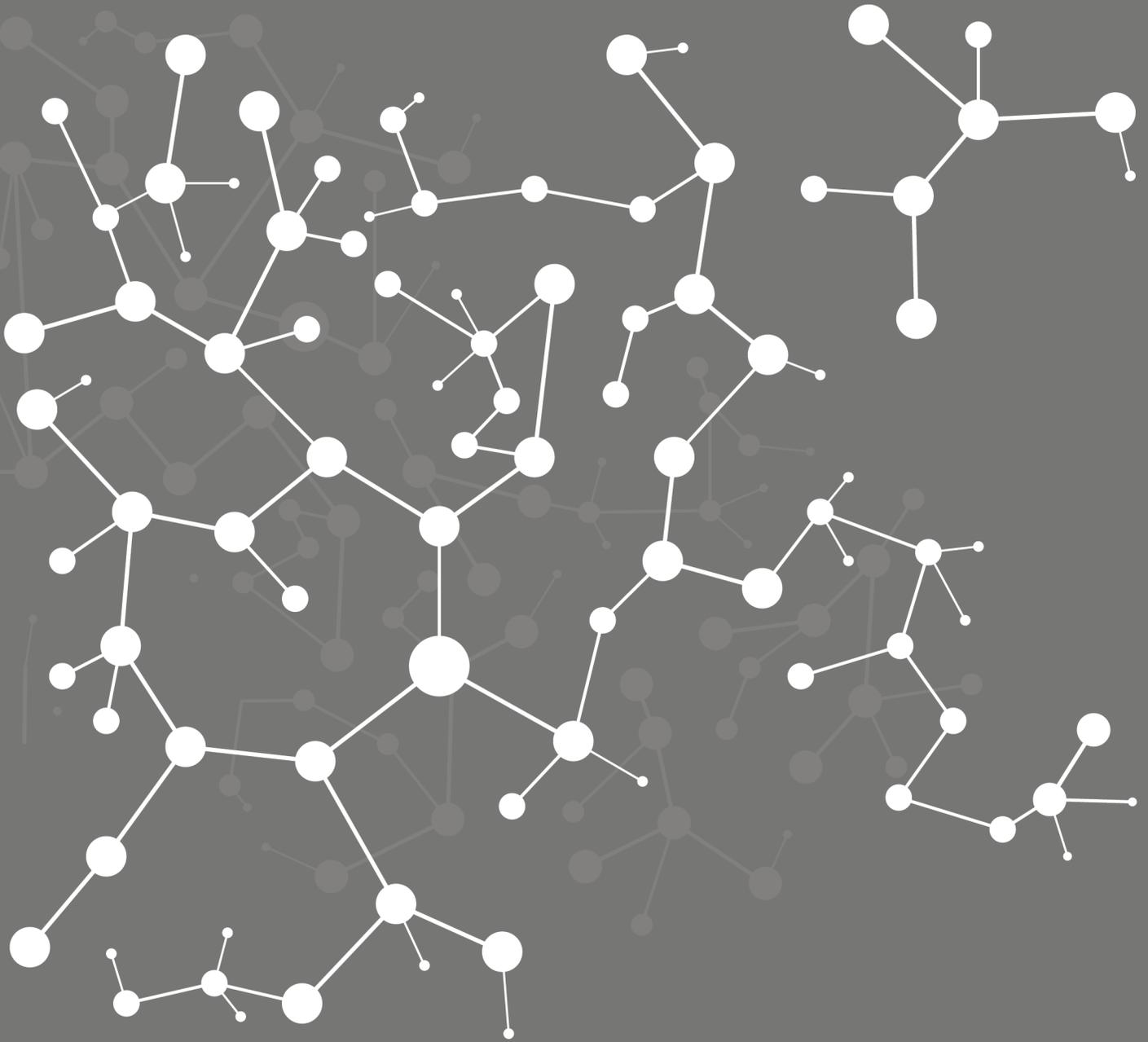
S. aureus growth on ceramic filter



No growth of S. aureus on Ag ceramic filter



ceramic filter containing nanosilver



INTO
NANOTECH 

THE LEADING AGENCY ON NANOTECHNOLOGY DEVELOPMENT IN THAILAND

3 PLATFORM TECHNOLOGIES

Nanomaterials Design and Synthesis

Ability to synthesize nano-scale materials, with desired and designed structure and properties, including utilizing computational tools to predict properties of the nanomaterials.

Nanosystem on Engineering and Advanced Manufacturing

Ability to fabricate nano-structure and nano-scale devices, especially for electronics and sensor applications.

Nanoscale Characterization on Metrology, Standards and Safety

Ability to develop nanoscale physio-chemical characterizations and standardization and methodology for safety investigation based on available guidelines and standards, as well as alternative scientific procedures for the best practice

NANOTEC, established on 13 August 2003, is one of four research agencies operating under the jurisdiction of the National Science and Technology Development Agency (NSTDA) and the Ministry of Science and Technology (MOST).

MISSION

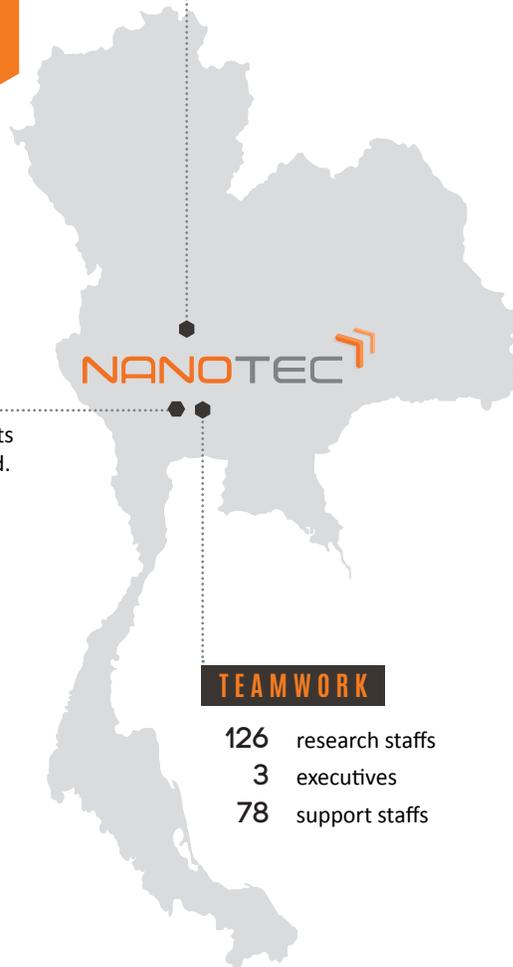
To conduct and support research, development, design and engineering in nanotechnology, and transfer the technology to industrial and service sectors in a constructive manner to increase Thailand's competitiveness, promote social awareness and improve the quality of life and the environment.

VISION

NANOTEC for the benefits of Thailand and Mankind.

TEAMWORK

126 research staffs
3 executives
78 support staffs



1 Work on nanotechnology for life and health

Research and development on innovative medical diagnostics using targeting new molecules, drug delivery and cosmetics from Thai natural resources with major goals to enhance human and animal health.



2 Work on specific nanomaterials and advanced nanotechnology

Research and development on molecular engineering of responsive materials and aspect expands across nanostructure & functional assembly for innovative design, synthesis and assembly of functional nanomaterials for applications in (bio) chemical sensing/imaging and optoelectronics.



3 Work on Agriculture and Environment

Research and development on innovative food, agriculture and environment with the application of nano-technology to modify materials, structures and surfaces for strengthening economics and social cooperation, and promote environmental sustainability.



4 Work on development of nano-materials and nano-system engineering

Research and development on synthesis chemistry, fabrication techniques characterization techniques, scaled-up engineering and theoretical calculations to achieve improved design, and utilization of nanomaterials for energy and environment applications.

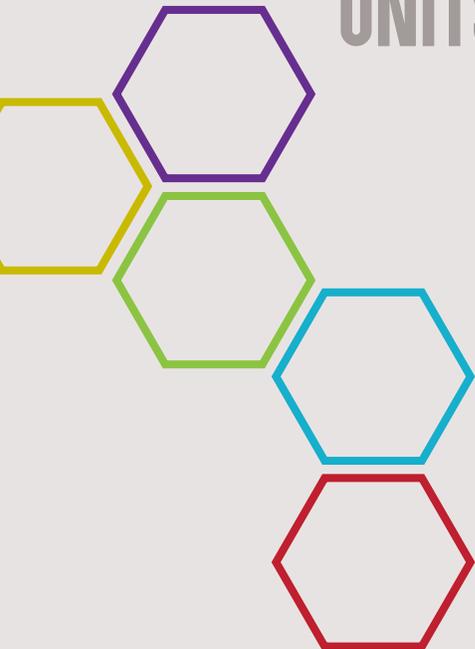


5 Work on nanometrology and engineering analysis

Research and development in the field of nano-metrology, nano-safety, nanoscale testing service, including nano-characterization of nano-product properties, and engineering-prototype development by using modern and advanced nanotechnology instruments with high quality services certified with both national and international standards.

5 STRATEGIC CLUSTERS

LABORATORIES & RESEARCH UNITS



Nano-Life and Health Research Unit

Research and development goal is to enhance human and animal health. This cluster consists of 3 research programs: Nano-Molecular Target Discovery focuses on the design and development of molecules for targeting purposes with main applications in medical diagnostics. Nano Delivery System emphasizes the use of nanotechnology for encapsulation, controlled release and target delivery of drugs, biopharmaceutical agents including bioactive compounds, in order to improve the effectiveness for prevention and treatment. Nano-cosmeceutical focuses on the delivery system in novel cosmeceuticals from Thai natural resources.

Nano Delivery System Laboratory

emphasizes the use of nanotechnology for target delivery and controlled release of drugs, biopharmaceutical agents including bioactive compounds, in order to improve the effectiveness for prevention and treatment.

Nanomolecular Target Discovery Laboratory

focuses on the design and development of molecules for targeting purposes with main applications in medicine. Current research topics include cervical cancer, infectious diseases, and diabetes.

Nano-Cosmeceuticals Laboratory

focuses on the implication of nanotechnology and delivery system in novel cosmeceutical products, especially from Thai natural products. Research area is to develop nanoencapsulation systems for natural extracts for increasing their stability and for controlled release.



Nanomaterials and Nanosystems Engineering Research Unit

Research and development on synthesis chemistry, fabrication techniques characterization techniques, scaled-up engineering and theoretical calculations to achieve improved design, and utilization of nanomaterials for energy and environment applications.

Nanoscale Simulation Laboratory

aims to design and predict the properties of functional nanomaterials, and to create a unique understanding of the physicochemical processes at nanoscale.

Nanomaterials for Energy and Catalysis Laboratory

pursues research and development on nanomaterial synthesis and utilization in Catalytic Processes for production of Biorefineries, Biofuels, High Value-added Green Chemicals and Materials via Nanotechnology with high performance integrated systems and advanced characterization techniques.

Integrated Nanosystem Laboratory

mission is to foster interdisciplinary integrations of low-dimensional nanostructured elements into functional systems and devices. We also investigate novel fabrication techniques that can incorporate the nanoscale building blocks to achieve improved performances or new functionalities.



Nano-Agriculture and Environment Research Unit

Research and development on innovative food, agriculture and environment with the application of nanotechnology to modify materials, structures and surfaces for strengthening economics and social cooperation, and promote environmental sustainability. These include high value-added products, to minimize the usage of natural resource and toxic chemicals as well as to reduce the emission of waste and pollutants throughout the entire production and consumption processes.

Hybrid Nanostructure and Nanocomposite Laboratory

focuses on the research and development of hybrid nanomaterials which emphasizes on the combination of functionalities employing knowledge and skill in organic/inorganic chemistry, material science, and even bioscience.

Nano Agro & Food Innovation Laboratory

aims to develop innovative food and agricultural products by applying appropriate nanoscience and multi-disciplinary approaches to enhance national competitiveness and strengthening food security.

Nanoengineered Soft Materials for Green Environment Laboratory

The convergence and interaction of soft materials and nanomaterials in order to regulate the deformations and instabilities in a designed and controlled manner for extraordinary new applications and functionalities.

Nanometrology & Characterizations and Engineering Unit

Research and development in the field of nano-metrology, nano-safety, nanoscale testing service, including nano-characterization of nano product properties, and engineering-prototype development. We also provide the research and development projects available to industrial sectors by using modern and advanced nanotechnology instruments. Our high quality services are also certified with both national and international standards.

Nano Safety and Risk Assessment Laboratory

conducts the researches to address possible adverse effects of materials on human health and the environment. The methodology for safety investigation are thoroughly implemented case-by-case, using the available guidelines and standards, as well as alternative scientific procedures for the best practice.

Nano Characterization Laboratory

focuses its research and measurement service activities on nanoscale physico-chemical characterizations and standardization.

Engineering and Manufacturing Laboratory

focuses on enabling scaled-up and reliable processes which compatible with mass-manufacturing by using our expertise based on our engineering skills and specific technologies. We provide the participation in design and engineering for R&D project planning according to ISO9001 standard, and also facilitate pre-pilot scale infrastructure for support R&D prototypes to industries.

Functional Nanomaterials and Nanofrontier Research Unit

Research and development on molecular engineering (synthesis, functionalization and encapsulation) of responsive materials. The second aspect expands across nanostructure & functional assembly for innovative design, synthesis and assembly of functional nanomaterials for applications in (bio) chemical sensing/imaging and optoelectronics. These developed nanomaterials that have special features and which focuses on specific application areas such as textile and household products, including the use of natural resources to improve quality of life.

Functional Nanomaterials and Interfaces Laboratory

strives for excellence in molecular engineering (synthesis, functionalization and encapsulation) of responsive materials, activated by physical, chemical and biological stimuli. Currently, our research focuses are on printing, sensing and controlled-released technologies toward smart life and smart living.

Nano Functional Textile Laboratory

creates and brings values to the upstream by incorporating nanomaterials into fibers for multifunctionalities. We are also driving downstream by developing multifunctional nanocoating for various types of fabrics.

Nanostructures and Functional Assembly Laboratory

focuses on innovative design, synthesis and assembly of functional nanomaterials for application in (bio) chemical sensing/imaging and optoelectronics. We control chemical and structural characteristics via integrated fabrication and functionalization techniques to explore new material construct.



RESEARCH HIGHLIGHTS

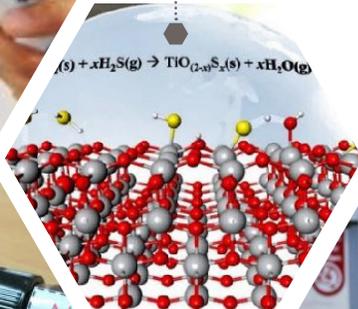
Targeted drug delivery system



White-light colposcope for cervical cancer diagnosis



Computer simulation model



Self-emulsifying delivery system of sweet basil and oregano oil



Enhanced sensibility lateral flow system

Aptasensor for diabetes mellitus detection & monitoring



Nano Cosmeceutical products



Electronic-sensory system

Nano-catalysts



Defendant

Controlled release fertilizer



- Nano-Life and Health Research Unit
- Nanomaterials and Nanosystems Engineering Research Unit
- Nano-Agriculture and Environment Research Unit
- Nanometrology & Characterizations and Engineering Unit
- Functional Nanomaterials and Nanofrontier Research Unit

Solar operating system for water purification



Ripeness label sticker for fruits



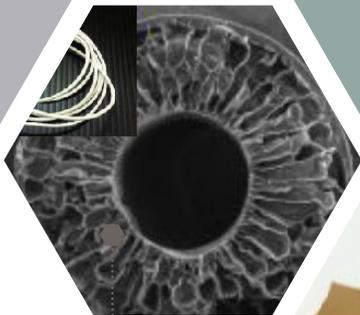
Single-step multiple coating technology for textiles



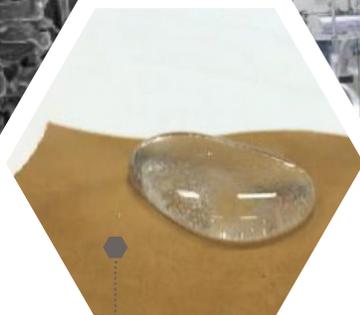
Existing flexible solar cell



Nanofiltration hollow fiber membranes



Transparent super hydrophobic surface



Cosmetic pilot plant (GMP)



in vitro models for determining toxicological effects



Cosmetic pilot plant (GMP)



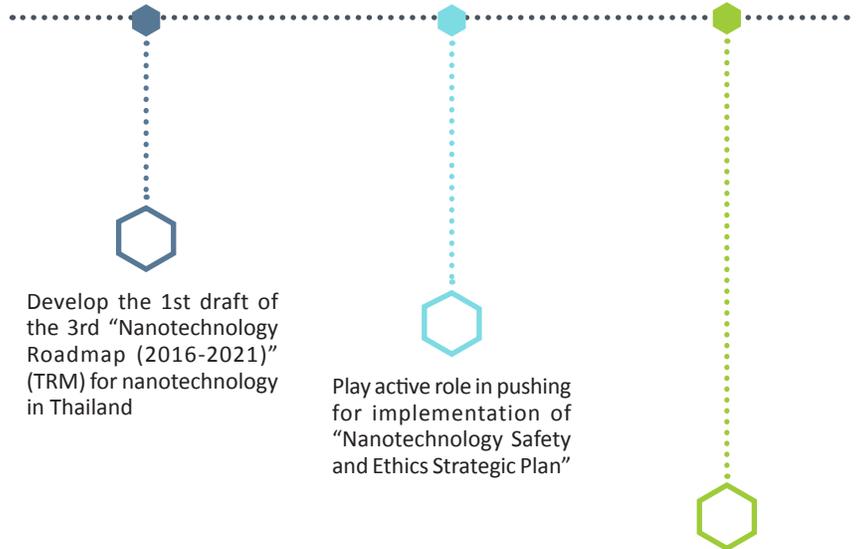
- Nano-Life and Health Research Unit
- Nanomaterials and Nanosystems Engineering Research Unit
- Nano-Agriculture and Environment Research Unit
- Nanometrology & Characterizations and Engineering Unit
- Functional Nanomaterials and Nanofrontier Research Unit

48 contract-research projects with industries

Supporting **9** centers of excellence in Thailand

Create economic impacts of about **2,017.12** million Baht

Set up the Marketing Strategic Plan Unit to explore the market potential of nanotechnology and products



Develop the 1st draft of the 3rd "Nanotechnology Roadmap (2016-2021)" (TRM) for nanotechnology in Thailand

Play active role in pushing for implementation of "Nanotechnology Safety and Ethics Strategic Plan"

Work with the National Science Technology and Innovation Policy Office, as the secretariat of "the National Nanotechnology Policy Framework (2012-2021)"

NANOTEC 2017

NANOTEC Flagship program able to increase research interaction with partners both public and private sector eg.



Toyota Motors



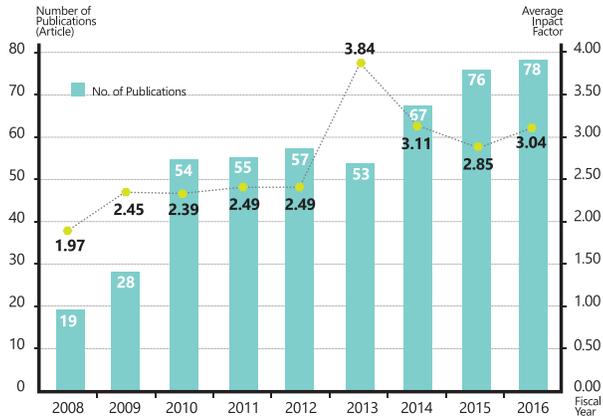
Chao Phya Abhaibhubejhr Hospital



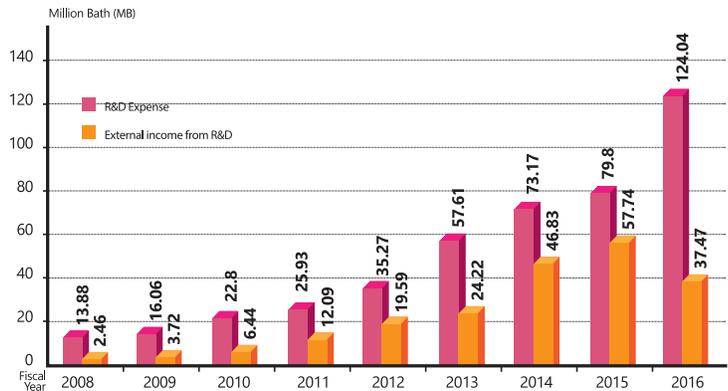
Betagro

NANOTEC PERFORMANCE

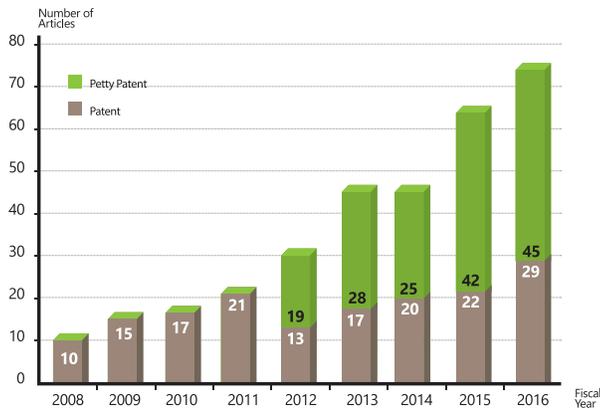
International Publications



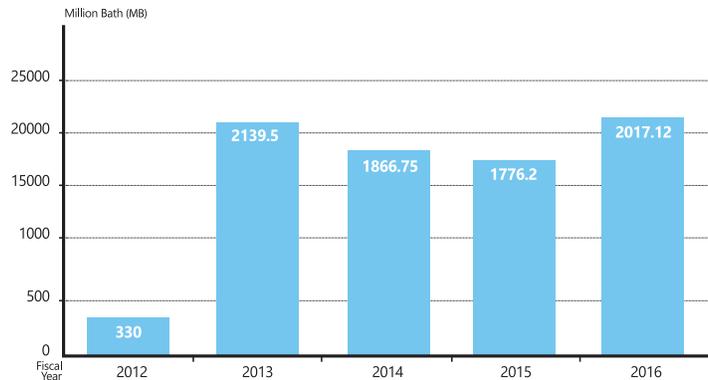
Research Expense vs External Income Form R&D



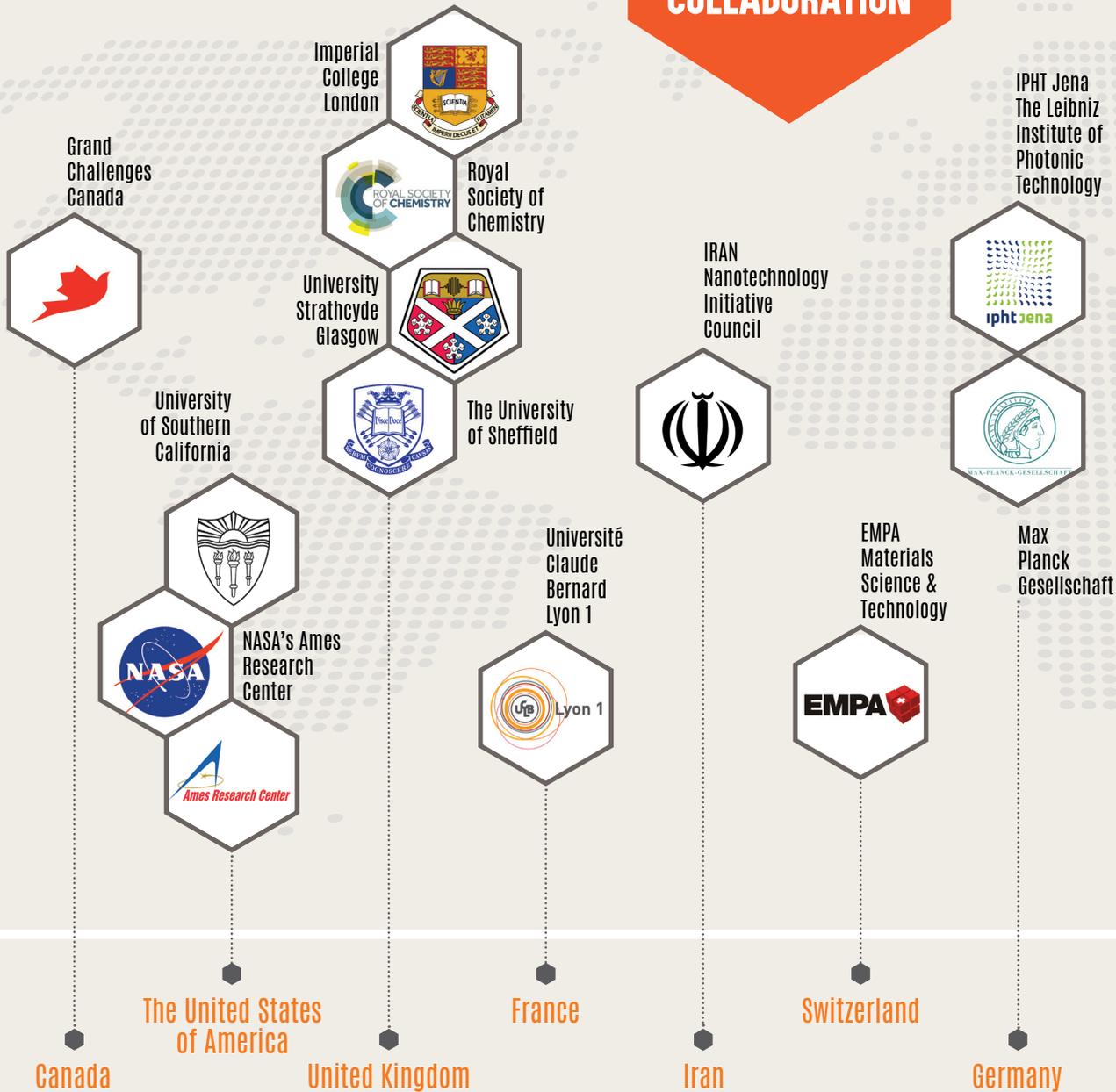
Intellectual Property

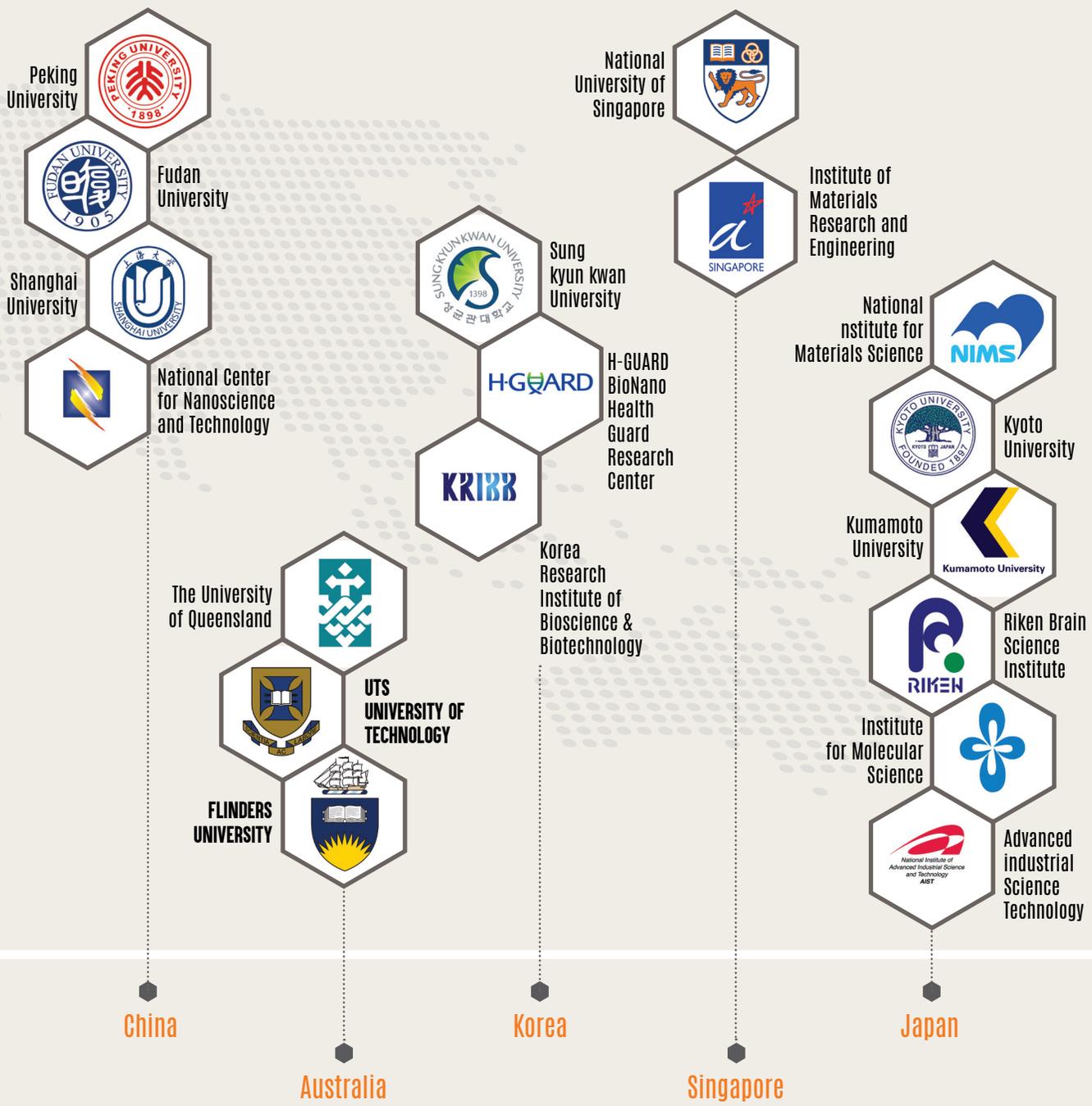


Create Economic and Social Impact



NANOTEC INTERNATIONAL COLLABORATION





China

Australia

Korea

Singapore

Japan

NANOTEC 



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