

Thailand: Nanotechnology for Natural Disaster Mitigation

Over the past decade we have seen an increase in the intensity of natural disasters worldwide. Through the media, and for some of us, through first-hand experience, we have witnessed the awesome force of nature. We have had natural disasters created by the tsunamis in Asia and Japan, the earthquakes in Pakistan, Haiti and China, as well as hurricane Katrina and others in North and Central America. The recent flooding in many parts of South East Asia including Thailand is caused by heavy monsoon rain which has caused unprecedented devastation and great loss of life which have been etched in our minds due to their magnitude.

Countries that have experienced natural disasters have relied on the use of technology to help minimize the hardship endured. The recent flooding in Thailand in 2011 has proved that nanotechnology can play a role in natural disaster mitigation as can be seen in the use of nano related products which has been researched by NANOTEC and its partners and used as relief and recovery kit items for distribution to flood victims. The use of nanotechnology as one of natural disaster mitigation tools has received positive feedback from end-users which helps to reinforce the need for Thailand to continue its nanotechnology development program which is geared towards social and economic development.

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1. STRATEGIC LOCATION

Thailand's strategic location at the heart of Asia makes it ideal for business to capture a huge market. The fast growing Southeast Asian region, to which Thailand belongs, is home to more than 580 million consumers. Add to that, Thailand's friendly trade relations and expanding free trade agreements with such strong economies as China, India, Australia, and New Zealand and voila what you have is three billion consumers.

According to a study by the Standard Chartered Bank, Asia will likely dominate the global economy in the next five years and capture more than half of the world's gross domestic product by 2030. This is due to sound economic fundamentals and the unfortunate debt crises experience of the advanced economies in the West.

2. STRONG ECONOMIC ESSENTIALS

With 65 million consumers Thailand itself is a big market. Thailand will continue growing given strong economic fundamentals in several sectors.

Thailand is a major exporter of food and food product, natural rubber, cassava, and rice. It is the world's largest hard disk drive producers with over one third of the world's market, and is well on the way to be among the world's top ten auto manufacturing countries. Thailand is also rank 18th on the world's largest tourist receipts list and the world's 19th largest in purchasing power.

Thailand's Gross Domestic Product (GDP) for 2009 was USD 536 billion. The main sector contributing to the GDP is agricultural sector 9%, manufacturing 39%, and services 52%. The GDP per capita in 2009 was USD 8,100.

3. EXCELLENT INFRASTRUCTURE

Thailand has developed the country's infrastructure to world class standards, which supports the growth of key economic sectors and has led to the development of comprehensive industrial clusters. Modern industrial estates, state-of-the-art transportation, communication facilities, and logistics system help achieve cost-effective business operations.

Thailand Science Park (TSP) is the key infrastructure to support research and development, and technology intensive business. The first science and technology park was established in 2002 with the aim of promoting innovation development and R&D activities in the private sector. TSP is situated close to the Asian Institute of Technology, Thammasat University, Sirindhorn International Institute of Technology, as well as housing the National Science and Technology Development Agency's (NSTDA) four national research centers; National Center for Genetic Engineering and Biotechnology (BIOTEC), National Metal and Material Technology Center (MTEC), National Electronics and Computer Technology Center (NECTEC), and National Nanotechnology Center (NANOTEC). The proximity provides the opportunity for corporate tenants to gain access to highly skilled personnel including 1,600 full-time NSTDA researchers.

Phase 1 of TSP is fully occupied by the national research centers and over 60 corporate tenants. Around 30 percent of the corporate tenants are overseas companies from Japan, the United States, Germany, and France.

To meet rapid demand, the NSTDA in 2008 started the construction of TSP Phase II also known as Innovation Cluster II (INC II). INC II is expected to be operational by third quarter 2011. INC 2 is built around the concept of "Work-Life Integration". It is designed to create a conducive environment for technology companies, in which their talented people can live, work and play. INC 2 aims to adapt to the ever-changing needs of today's knowledge workers.

INC 2 provides its R&D-oriented tenants with a comprehensive suite of business facilities and a superb working environment. The modular design of the four towers of INC 2 makes it easy to accommodate the different needs of R&D intensive companies. INC 2 has:

- Designated areas for laboratories requiring vibration control and special preparation
- Specific areas at the base of the four towers suitable for setting up equipment requiring floor loading allowance
- Link-ways between the 4 towers to foster interaction and networking among the tenants
- Direct access to the state-of-the-art Thailand Science Park Convention Center comprising of 14 meeting rooms, an auditorium and 2,000 sq.m. exhibition area

It is believed that the expansion of INC II will accelerate the pace of new innovation development and strengthen collaborations among government sector, private sector, and research institutions.

For R&D support facilities, tenants at TSP can tap upon NSTDA's laboratory testing and analytical services through its various laboratories and research units. Support services available at TS include:

Technology & Technical Services

- Contract Research and Joint Research
- Testing and Analytical Service
- Technology Information Service
- Technology Licensing Service (In-licensing & Out-licensing)

Financial Services

- Application for Research Funding
- Application for Soft Loans
- Joint Investments

Human Resource Services

- Training and Seminars on specific Business and Technology Topics
- HR Recruitment
- Specialist Database

Business Support Services

- Intellectual Property Service
- Technology Licensing Office
- Business Matching Service
- Visa & Work Permit Assistance
- Privileges & Incentives Coordination Service

4. INVESTMENT INCENTIVES AND PRIVILEGES

The Thailand Board of Investment (BOI) a government agency under the Ministry of Industry whose purpose is to encourage and promote investment in Thailand is working closely with TSP to assist investors both local and overseas looking to setup operation in Thailand. BOI assistance initiatives include:

1. Enhancing Competitiveness and Investment facilitation by
 - 1.1 offering an attractive and competitive package of tax and non tax incentives
 - 1.2 imposing no foreign equity restrictions on manufacturing activities or on some activities
 - 1.3 providing assistance in the provision of visa and work permits to facilitate entry and subsequent operation for a foreign-owned business
 - 1.4 waiving restrictions on land ownership by foreign entities
2. Giving business support services such as comprehensive information and advice on establishing operations in Thailand, arranging site visits, identifying potential suppliers, subcontractors, joint-venture partners, providing useful contacts with key public and private organizations, and coordinating between the foreign business community and other public agencies.

Recently, BOI announced it has revised investment promotion scheme to also cover production of nano materials or products from nano materials. The aim of this initiative is to encourage more use of high-technology in Thailand's nano manufacturing. This type of business will be categorised as a top priority business which brings greater benefits to the country and boost Thailand's positioning as an attractive investment destination.

5. R&D

According to a market research report published by Electronics.ca Publications it is estimated that the global nanotechnology market in 2010 range from about \$15.7 billion (the figure used in this report) to \$1 trillion. By 2015, the market may be worth more than \$2.4 trillion, according to different analysts. These differences reflect not only different analytical methods and assumptions, but also different definitions of the nanotechnology market (e.g., whether to include decades-old technologies such as carbon black rubber reinforcers and photographic silver, or whether to base the market value on nanotechnology inputs alone, as opposed to the total value of products that incorporate nanotechnology).

Thailand has an incentive to cash in on nanotechnology couple with the dramatic economic growth of neighbours. This progress prompted Thailand to develop the capability to identify, promote and invigorate niche industries and products for sustainable development and national competitiveness in the global market. Science and technology (S&T) development was adopted as one of the indispensable key strategies for Thailand to make her economy and society more robust and competitive. Both the government and experts are focusing on science, technology and innovation development to make it more competitive on global markets, especially with the approach of a single Asean market by 2015. Nanotechnology development is expected to stimulate Thailand to leapfrog in key areas of S&T.

National Nanotechnology Center (NANOTEC) established in 2003 by the National Science and Technology Development Agency (NSTDA) as one of four national research centres under its jurisdiction. With an annual budget of 11 million USD, NANOTEC is the key research funding agency for nanotechnology. NANOTEC is investing in nanotechnology as a means of differentiating and adding value so that domestic products can compete effectively.

NANOTEC has the dual role of serving as a national R&D centre and as a funding agency to support universities and other research institutes. It has established strong links with other institutes in Thailand and with more than 400 nanotechnology researchers, as well as with leading nanotechnology centres overseas.

Currently, NANOTEC consists of 10 central laboratories located at the Thailand Science Park:

- Nano Delivery System;
- Nanomolecular Target Discovery;
- Nano-cosmeceuticals;
- Nano Safety and Risk Assessment;
- Nanomolecular Sensor;
- Organic Nanomaterials;
- Hybrid Nanostructure and Nanocomposites;
- Nanomaterials for Energy and Catalysis;
- Nanoscale Simulation;
- Testing and Service.

One of the major goals of NANOTEC is to be a “solution provider in nanotechnology”, therefore a high percentage of the nanotechnology research is focused on industrial applications:

- textiles – antimicrobial fabric, self-cleaning and water repellent fabric;
- cosmeceuticals – nano-emulsions, controlled release nano-capsules;
- food – e-nose sensors for quality control processes.

Since its inception, NANOTEC has provided more than 15,000 testing services to industries and researchers annually. Furthermore, nano safety initiatives are being developed in compliance with international standards and global networks via SAICM, OECD and UNITAR.

NANOTEC has identified 7 flagship programs which it considers are in response to both national and NSTDA priorities. The flagship programs are:

1. Clean water

Product target: Water filtration system providing clean and clear water in the areas contaminated with heavy metals and/or agriculture fertilizers. Capacity is 1,000 liter/day for usage in rural areas around the country.

2. Control-released fertilizer

Product target: Control-released fertilizer that responds to plant's life cycle Plant target: Sugarcane, rice, and orchid

3. Vector control system (mosquito)

Product target: Insecticide-impregnated mosquito net and mosquito repellent lotion

4. Nano Aroma

Product target: Essential oil for aromatherapy with long lasting fragrances and effects

5. Nano-Mark

Product target: Nano Mark (with potential safety tag for nanoparticle-containing products)

6. Smart Soil

Product target: Carbonaceous soil or biochar from water hyacinth or biomass, to be used as soil conditioners

7. Nano-biosensors

Product target: UV indicator, heavy metal identification, and bacteria band for bacterial detection

In nanobiotechnology and the life sciences, NANOTEC is conducting research on nano-delivery systems, nanomolecular sensors, and nano-cosmeceuticals. For delivery systems, NANOTEC is developing platforms for drug delivery based on nano-encapsulation and molecular complexation techniques for the controlled release and target delivery of bioactive compounds. Nano-carriers studies include core-shell nanoparticles, self-assembly nanoparticles, polymer conjugates, nanoemulsion and molecular inclusion complexes. In addition, novel targeting moieties such as peptides, magnetic, and antibodies are being explored.

In nanomolecular target discovery, the design and development of antibody fragments for targeting infectious diseases and cancer are being investigated. The emphasis is on therapeutic antibody-based nanomolecules and molecular diagnostic tests.

National Science, Technology and Innovation Policy Office (STI) is drafting the National Research and Development Master Plan with the aim of nurturing more local scientists and promoting collaboration research projects between government and private sector groups. Thus, prompting the increase investment in science, technology and innovation to compete in the global market, especially with the approach of the single ASEAN market in 2015.

6. NETWORKING

NANOTEC strive to be visible in global nanotechnology research arena and has establishes a number of formal and informal research collaborations with local and international partners.

To increase research dynamics, NANOTEC is also collaborating with 8 leading Centers of Excellence (COE) in Nanotechnology established in key universities such as Chulalongkorn University, Mahidol University, Kasetsart University, Asian Institute of Technology, King Mongkut Institute of Technology Ladkrabang, Khon Kaen University, Chiang Mai University and Prince of Songkla University. Research output from these COEs has received worldwide recognition and further increase partnership activities.

Both NANOTEC and NSTDA are active participants in regional and global activities. Several bilateral and multilateral partnerships have been successfully concluded. Here are some sample collaborative partnerships:

- EU FP7 on Nanoscience,
- Nanomaterials and New Production Technology (NMP) - national contact point
- Asia Nano Forum (ANF)
- ASEAN Committee on Science and Technology (COST)
- National focal point for the ASEAN Sub-Committee on Science and Technology Infrastructure and Resource Development (SCRID)
- National Institute of Advanced Industrial Science and Technology (AIST), Japan
- Taiwan Textile Research Institute (TTRI), Taiwan
- Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V., Germany
- University of Queensland, Australia
- Laboratory of Materials-Biology Interactions EMPA Swiss Laboratories for Material Testing and Research, Switzerland
- National Institute for Materials Science(NIMS), Japan
- Korea Research Institute of Biosciences and Biotechnology, KRIBB

7. NANOTECHNOLOGY INDUSTRY IN THAILAND

Nano Products presently in the market includes; nanocomposite food packaging, nanoclay membranes for water treatment, nano-cosmetics (curcuminiod nano-liposome face cream), nano-shirts, nano-silver detergent, etc. NanoProducts in the pipeline include; nanoalumina-doped ceramics-based artificial, gemstones, nanochitosan-based slow-release drug vehicles, nanoparticle OLEDs (Organic Light Emitting Diodes), nanodye-sensitized solar cells, etc.

It is estimated that by the year 2013, Thailand will have more than 50 nanotechnology companies and more than 300 nanotechnology patents. Revenue generated by nanotechnology products will reach USD 300 million.

8. NANOTECHNOLOGY RELATED COMPANIES

SIAMRAK CO., LTD	(Fragrance Pot Pourri)
LION CORPORATION (THAILAND) LTD	(Petrochemical and Plastic, Health & Beauty)
IDEA SQUARE LABORATORIES CO.,LTD	(Household products)
SSP INTERNATIONAL TEXTILE	(Textile)
NONAMI SCIENCE (THAILAND) CO., LTD.	(ceramics, material of photocatalyst by titanium dioxide(TiO2) that coverd apataite)
ASAHI-THAI ALLOY CO.,LTD	(Building materials)
SUPREME PRODUCTS CO., LTD	(medical equipment)
YOTHAKA INTERNATIONAL CO., LTD	(furniture)
FUJITSU (THAILAND) CO., LTD	(Information technology)
THAI PLASTIC AND CHEMICALS PUBLIC COMPANY LIMITED	(polyvinyl chloride polymer (PVC))
MIC-CELL CO., LTD	(Insulation sheet)
THAI FISH SAUCE FACTORY (SQUID BRAND) CO., LTD	(food product)
CHAO PHYA ABHAIBHUBEJHR HOSPITAL FOUNDATION	(healthcare)
SANOFI-AVENTIS (THAILAND) LTD	(healthcare)
THE SUPPORT ART AND CRAFTS INTERNATIONAL CENTER OF THAILAND (PUBLIC ORGANIZATION)	(art & craft)
SIAM RESEARCH AND INNOVATION CO., LTD	(R&D service)
GROUPMECH CORPORATION LTD	(construction)
E.S.P PLASTICS LIMITED PARTNERSHIP	(plastic for household products)
S.H.L PARAWOOD CO., LTD	(furniture)
UNILEVER THAI HOLDINGS LIMITED	(consumer product)
BANGKOK BOTANICA CO., LTD	medical product from herbs
BIO DESIGN	Laboratory services
HI-GRIMM RESEARCH & ENVIRONMENT	Environment management