Current Status

DEVELOPMENT OF NANOTECHNOLOGY IN INDONESIA

Expert Group Meeting
“Networking of R&D Institutions in the Asia-Pacific to strengthen capacity of R&D Management and Innovation in the field of Nanotechnology”
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OUTLINE

- Potency of Indonesia
- Brief story about nanotech in Indonesia
- Nanotech activities in Indonesia
  - Strategy and policy
  - Program and funding
  - R & D
- Pictures of Human resources and infrastructures
- Application of nanotechnology in national industry
- Some research results in nanoparticles and their potency for commercialization
- Standardization and internationalization program
- Summary
Indonesia

- Potential
  - 3rd most populated country in Asia and 4th in the world with ± 250 million population → Potential market
  - Land area of 1,919,440 km² with 17,508 islands
  - Natural resources: minerals and wide variety of flora and fauna (biodiversity) → Potential raw materials for Nanoproduct
  - Thus, nanotechnology development must be directed to manage and add Indonesian natural resources value significantly for fulfilling all domestic needs while competing global product to increase nation competitiveness.
Nanotechnology development in Indonesia in brief

- ~2004: Several research centers and Universities have started nanotechnology researches mainly conducted by young researchers who just came back from abroad.
- 2004~2005: The State Ministry of Research and Technology started to identify research on nanotechnology.
- April 2005: Indonesian Society for Nano or Masyarakat Nano Indonesia (MNI) was established. In order to accelerate development of nanotechnology R&D in Indonesia, MNI has created programs such as workshops, national and international conferences, nanotechnology road show, establishing MOU with universities to collaborate with researches and educate students, also creating information center for nanotechnology via website.
- 2005~2008: The State Ministry of Research and Technology gave financial support for nanotechnology R&D and then research on Nanotechnology has become significant issue at research centers and universities in Indonesia.
- 2008~2010: Ministry of Industry in collaboration with MNI made nanotechnology roadmap for supporting National industry
- 2010-2011: Ministry of Agriculture has started giving research grant for nano and proposes nano-center for foods application.
- 2012~ Nanotechnology is expected to become national issue
Paradigm shift of Nanotechnology in Indonesia

- Limited interest
- Limited information
- Limited R&D
- NT: Science fiction

- NT to Research trend
- NT to Expect in the future

- Start up company
- National Issue

<2005 Before MNI

2005-2008 Transition

2008-2011 Industrial Roadmap

>2012 Nano era in industry begins
Nano activities in Indonesia

Nanotechnology development in Indonesia is getting more active, where many institutions from several ministries have been involved seriously.

- **Pioneers**
  - Ministry of Research and Technology
  - Ministry of Industry
  - Ministry of National Education

- **Followers**
  - Ministry of Agriculture
  - Ministry of Health
  - Ministry of Energy and Mineral Resources

- **Coming soon**
  - Ministry of Marine and Fishery
  - Ministry of Environment
  - Ministry of Justice and Human Right
New Policy/New Program/Initiative/Funding for nanotech in each ministry (1)

- Ministry of Research and Technology (since 2005)
  - Research grant for development and implementation of nanotechnology for supporting national industry (2005-2011)

- Ministry of Industry (since 2008)
  - Agency for Industrial Research and Development decree (No.06/BPPI.2/SK/1/2010 regarding Nanotechnology Roadmap for supporting national industry)
    - Roadmap for Textile & Ceramics industries (2008), Food and Chemical industries (2009), Polymer Industry (2010)
    - Assessment of incentive program for national industry which apply nanotechnology (2010)
    - Research grant for development and implementation nanotechnology for supporting industry (2008-2010)
New Policy/New Program/Initiative/Funding for nanotech in each ministry (2)

- Ministry of agriculture: Indonesia Agency for Agricultural Research and Development (IAARD) (since 2010)
  - Research consortium on nanotechnology application for fertilizer (2010-2011)
  - Development of Nanotechnology for Foods and Agriculture in Indonesian
  - Propose a nanotechnology laboratory for foods and agriculture in fiscal year 2012 with total amount: 5,4 Million USD (3,1 Million USD for Laboratory Equipments and 2,3 Million USD for Infrastructure/Building).

- Ministry of Health
  - Agency for Drug and Food Assessment: Hearing on nanotechnology Product Regulation (Nov 2010)

- Ministry of Energy and Mineral Resources
  - Research grant for nanotechnology development based on mineral resources (since 2007)

- Etc
Update on Nanotech policy (Funding, new initiatives, strategy areas etc) in Indonesian Institute of Sciences (LIPI)

- Initiating consortium for nanotechnology involving 9 research centers, 4 private industries and 2 professional organizations.
Update on Nanotech policy (Funding, new initiatives, strategy areas etc). Cont’..

- Nanotech policy at several universities
  - University of Indonesia began building center of excellence for nano with budget from private sector (US $ 500,000).
  - Bandung Institute of Technology in collaboration with JICA for Nano-Science development Project (US$ 20 million).
  - Sepuluh November Institute of Technology (ITS) proposes Center of excellence including nano-center.
  - University of Gajah Mada: allocated budget for nanotechnology infrastructure (TEM etc)
  - University of Airlangga allocated budget for nanotechnology infrastructure (TEM etc)
Nanotechnology development roadmap to support national industry based on market pull–technology push approaches.

Source: Ministry of Industry, 2008
HUMAN RESOURCES IN NANOTECHNOLOGY
(TOTAL 620 RESEARCHER, FY 2009)

Source: KRT 2009

46% Universities

47% Research institutes (LPND)

2.4% Privates / industries

4.5% Research agency in each Ministry

R&D activities at industries or private sector are still only small portion (less than 3%)
Young researcher (around 40 years) covered most of the research activities.

Source: KRT 2009

- < 30 years (23.8%)
- 31-40 years (34.6%)
- 41-50 years (33.6%)
- 51-60 years (7.1%)
- > 61 years (1%)
More than 62% of human resources have master and PhD degree.
Main nanotechnology research centers in Indonesia.

- Eijkman Institute
- ISTA
- Jakarta National University (UNJ)
- Atmajaya Catholic University
- Gunadarma University
- University of Indonesia (UI)

- Indonesian Institute of Sciences (LIPI)
  - National Nuclear Energy Agency For Indonesia (BATAN)
  - Agency for Assessment & Application Of Technology (BPPT)
  - National Aeronautics & Space (LAPAN)

- Sepuluh November Institute Of Technology (ITS)
- Surabaya University (UBAYA)
- Airlangga University (UNAIR)

- Andalas University
- Science & Technology Research Centre (PUSPITEK)
  - Indonesian Institute of Sciences (LIPI)
  - Indonesian Society for Nanotechnology (MNI)
- Mochtar Riady Centre (MRC)

- Bandung Institute of Technology (ITB)
- Bandung State of Polytechnic

- Gajah Mada University (UGM)
- Yogyakarta Muhammadiyah University (UMY)
- Soedirman University
Most of researchers (Nano-based research subject) are centralized at Java Island, especially at Jakarta and Bandung area.
CLASSIFICATION OF RESEARCH

46% Basic research
5% Capacity Enhancement for production system
2% Diffusion of technology
45% Applied research

Type of research on Nanotechnology in Indonesia (2005-2009)

Source: KRT 2009
Infrastructure (instrumentation for R&D on nanotechnology) is centralized at Jakarta and Bandung area.
Fields of nano-R&D in Indonesia

- **Nanomaterial** → Development of nanotechnology to improve the value of natural resources for supporting national industry.
- **Nano-Biotechnology** → Make benefit of nano-biotechnology to increase food and agriculture yield.
- **Pharmacy and Health** → Enhancing quality of Indonesian drugs based on local biodeversity.
- **Energy** → Using nanotechnology to fulfill and conserve national energy
- **Nano-Devices**
Research Highlights/Breakthrough

- Pilot plant for ZnO nanoparticle and Vitamin A-encapsulated in chitosan nanoparticles for cosmetic products.
- Development of Herbal nanoparticles (curcuma, ginger, pegagan, purwaceng, mangosteen, sambiloto etc) for medicine and food supplements.
- Nanoparticles for fertilizer (SiO2, MgO, CuO, CaCO3, ZnO, MnO etc).
- R & D of nanoparticle TiO2 from local iron sand for ceramic application, self cleaning coating etc.
- R & D of nanosensor and solar cell (nano particle SnO, ZnO, TiO2, gold etc).
- R & D of nanoparticle silver and ZnO for antibacterial and their application for packaging, ceramic, polymer, etc.
- Nano catalyst for fuel cell etc.
ZnO Nanoparticle produced by Arc Plasma (Teknoplaz)
Size: 70 ~ 250 nm

Product samples
✓ No irritation
✓ Naturally
✓ Easy to use

Indonesian institute of Sciences in collaboration with Nanotech company (Grant ristek: 2011).

Cosmetic with nano ZnO
Dental Cement with nano ZnO
Pet bottle with nano ZnO
NANO/MICRO-ENCAPSULATION RESEARCH

- **Encapsulation of herbal extract**
  - Spray drying
  - Ginger extract
  - Chitosan nanocapsules

- **Encapsulation of vitamins**
  - Spray drying
  - Vitamin A
  - dextrin/acacia gum nc

- **Encapsulation of trace elements**
  - Spray drying
  - Potassium iodide
  - Dextrin nc

- **Encapsulation of anticancer agents**
  - Ionotropic gelation
  - Ferrous sulphate
  - Alginate mc

- **Encapsulation of insulin**
  - Alginate matrix
  - Chitosan layer
  - for formulation of oral insulin

TFM CENTER, BPPT
Development of nanoparticle A Vitamin encapsulated by chitosan for anti-aging cosmetic

Photo of chitosan encapsulated A Vitamin by ionotropic gelation (left), spray drying (middle), and spray coagulation (right)

Core materials: A Vitamin
Wall material: chitosan

TFM CENTER, BPPT
High energy ball mill with elliptical three dimension (HEM 3ED) has been commercialized in Indonesia and exported to Malaysia.
CALCIUM CARBONATE BY PHYSICAL METHOD

HEM (High Energy Milling)

International Conference on Advanced Material and Practical Nanotechnology, 2009
Nanocomposite

HDPE
High density polyethylene

LDPE
Low density polyethylene
biodegradability

Before degradation

2 weeks

4 weeks

8 weeks
HYDROGEL NANO-COMPOSITE

Hydrogel polymer + Clay nanoparticle → Hydrogel nanocomposite
CONTROL RELEASE FERTILIZER

Hydrogel nano-composite

Water and fertilizer release can be controlled efficiently from the hydrogel nano-composite according to plant growth.
Chitosan based polymer surfactant for nano-emulsion


Preparation of Nano-emulsion Using Spontaneous Emulsification

2009

<table>
<thead>
<tr>
<th>Oil type</th>
<th>Formulation A (Matrixyl®)</th>
<th>Formulation B (CeraSkin® P)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Particle size (nm)</td>
<td>Polydiversity index</td>
</tr>
<tr>
<td>Avocado oil</td>
<td>166 ± 42</td>
<td>0.217</td>
</tr>
<tr>
<td>Almond oil</td>
<td>232 ± 55</td>
<td>0.148</td>
</tr>
<tr>
<td>Jojoba oil</td>
<td>341 ± 81</td>
<td>0.019</td>
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<tr>
<td>Mineral oil</td>
<td>212 ± 53</td>
<td>0.194</td>
</tr>
<tr>
<td>Squalene</td>
<td>184 ± 46</td>
<td>0.203</td>
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</tbody>
</table>

Joint collaboration with PT Martina Berto
Antimicrobial Effect of Nylon Fiber Immersed with Nano-Silver

<table>
<thead>
<tr>
<th>Sample</th>
<th>Bacteria</th>
<th>Number of bacterial colonies (CFU)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$10^{-1}$ ml</td>
</tr>
<tr>
<td>Nylon</td>
<td></td>
<td>Countless</td>
</tr>
<tr>
<td>Silver-coated nylon with $S.\ aureus$ immersion time 30 s</td>
<td></td>
<td>Countless</td>
</tr>
<tr>
<td>Silver-coated nylon with immersion time 10 min</td>
<td></td>
<td>Countless</td>
</tr>
<tr>
<td>Silver-coated nylon with immersion time 24 h</td>
<td></td>
<td>Countless</td>
</tr>
</tbody>
</table>

Most of the products of the R&D activities on nanotechnology in Indonesia are national and international publications. Research institutes provide larger number of patent, products and prototype than universities.

Source: KRT 2009
Commercialization Initiatives/Programs/ Highlights

- Ministry of Industry in collaboration with Ministry of Research and Technology and Indonesian Society for Nano initiated ASMINOTEK (Strategic Alliances for Micro and Nanotechnology) in 2010.
- Ritech Expo: R & D and application of nanotech exhibition held by Ministry of Research and Technology and Ministry of Industry, August 2010, jakarta.
Although many industries applied nanotechnology in their products, human resources for nano-based R&D are still few. This is because, the industries using import technology in their production. Moreover, the nano-products are only small portion in the production line.
There is no specific regulation for nanotechnology application in Indonesia. The existing regulation is PP no. 74/2001 about hazardous materials handling (definitions of hazardous materials, transportation mechanism, saving, disposal and etc.).

There are only roadmaps of technological development of nanotechnology-based industries by RISTEK and Ministry of Industry working closely with Indonesian Society for Nano (Masyarakat Nano Indonesia-MNI).
Standardization and EHS Highlights in collaboration with MNI

- Agency for National Standardization has established working team for nanotechnology standardization
- Agency for Drug and Food Assessment begins considering nanotechnology application in drug and food fields
- Succofindo (an institution for product certification) also begins considering nanotechnology enabled products
## LIST OF SNI ADOPTING

<table>
<thead>
<tr>
<th>No</th>
<th>Code</th>
<th>Adopted from</th>
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<tbody>
<tr>
<td>1</td>
<td>SNI ISO/TR 12885</td>
<td>ISO/TR 12885:2008, Nanotechnologies -- Health and safety practices in occupational settings relevant to nanotechnologies</td>
</tr>
<tr>
<td>3</td>
<td>SNI ISO 29701</td>
<td>ISO 29701:2010, Nanotechnologies -- Endotoxin test on nanomaterial samples for in vitro systems -- Limulus amebocyte lysate (LAL) test</td>
</tr>
<tr>
<td>7</td>
<td>ISO/TR 11360</td>
<td>ISO/TR 11360:2010, Nanotechnologies -- Methodology for the classification and categorization of nanomaterials</td>
</tr>
</tbody>
</table>
Several universities have involved in nanotechnology socialization through general stadium, seminar, etc in collaboration with Indonesia Society for Nano

New subject of Nanotechnology in several universities

Indonesian Society for Nano activities
  - Intensive training for nanoparticle synthesis and characterization
  - Regular seminar and workshop on nanotechnology
  - Initiation of nanoclub for university student since 2009
Internationalization Highlights

- Agenda of several universities to become world class university through international publication, collaboration, etc.

- LIPI in the field of Advanced Material and Nanotechnology will initiate “Nano LIPI go International” program to accelerate high quality of research results through international collaboration research, publications, staff exchange program, PhD student etc.

- Several international events and contribution
  - Quality on International Research QIR, University of Indonesia (2011)
  - ANF 2011 Tehran, Iran
  - SEA-EU-NET workshop: “Nanoproducts and risk management in nanotechnology the experience of European and South-East Asian countries“, 22 Oct 2011, Warsaw, Polandia
  - ASIAN AND PACIFIC CENTRE FOR TRANSFER OF TECHNOLOGY (APCTT-ESCAP) Expert Group Meeting "Networking of R&D Institutions in the Asia-Pacific to strengthen capacity of R&D Management and Innovation in the field of Nanotechnology” 07-08 December 2011, Bangkok, Thailand
  - etc
Interest in Nanotechnology is increasing in recent years, particularly from industry and government because of the benefit and opportunity of nanotechnology application.

Nanotechnology development must be directed to manage and add Indonesian natural resources value significantly for fulfilling all domestic needs while competing global product to increase nation competitiveness.

It still needs effort to construct the nanotechnology regulation in Indonesia because of the lack of information and public awareness.

Networking development especially with foreign institution is required to accelerate nanotechnology implementation in safe manner in Indonesia.
MNI has awarded to researcher, research center, government, industry and mass media for their pioneer contribution to develop nanotech in Indonesia, Jakarta, Nov 2009.

Thank you!
Introduction to

Indonesian Society for Nano

Many Indonesian young scientists came from aboard in nanotechnology fields but had limited facilities, staffs and budgets.

It was established in April 2005 and Composed of more than 250 young researchers from many national research institutions (government institutions, universities, private sectors) in interdisciplinary of nanotechnology.

www.nano.or.id
MNI’s activities

- To build public awareness for nanotechnology in Indonesia for improving national prosperity, independency, and glory.
- To confront nanotechnology researchers, users, industries, and decision makers in order to exchange valuable information.
- To provide a forum and networking for communication and idea exchange in the field of nanotechnology.
- To identify and make data base for current research of nanotechnology in Indonesia.
- To provide information center for nanotechnology: nano.or.id.
- To coordinate for collaboration research between research institution and private industries.
- To do international contribution through international collaboration research, training of the staff, expert exchange program, organizing international seminar etc.