Overview of Nanotechnology in Korea

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Nanotech. Milestones in Korea

- The 1st 10 years NT Master Plan (July, 01) & the 2nd Plan (Dec., 05)
- R&D of Nanotechnology
  - Ultra fine structure Program: 1st NT project in Korea (96)
  - Creative Research Inititives (97) and NRLs (99)
  - Frontier Research Programs
  - ► Tera-level nanodevices (July, 00), Nanostructured materials (July, 02), Nanomechatronics (July, 02)
  - Nanocore, Nanobasic, and Nanoexplorative technologies (Oct., 02)
  - NT fusion technologies (July, 03)
  - 2 NCRC: Nanoelectronics (Dec. 03) and Nanomedicine (Dec. 04)
- Infrastructure for Nanotechnology
  - National Nanotechnology Centers for Industry (July, 01)
  - Nanotechnology Research Association (02)
  - National NanoFab. Center (July, 02)
  - Application Specific NanoFab. Center (May, 03)
  - Nanotechnology Information Cooperation Network (July, 03)
  - Nanotechnology Research Society (Jan., 04)
  - Center for Industrialization of NT Components (Jan., 04)
  - 3 National Nanotechnology Cluster Centers (July. 04)
- Nanotech. Development Promotion Bill (Dec., 02) and Act (June, 03)

Background and Necessities of making the 2nd 10 Years NT Master Plan in Korea

- Nanotechnology, along with IT, BT and ET, is becoming the core technology which will take the lead of industrial revolution of 21st century.
  - 62 countries(US, Japan, Europe etc.) have established a master plan of nanotechnology.
- 5 years have past since the establishment of the 1st NT master plan('01.7, National Science & Technology council)
  - 'Nanotech. Development Promotion Bill (Dec., 02) and Act (June, 03)
- Necessary to review and check the past R&D results, infra and system and then to establish a new master plan which reflects the trend of technology and industry.

Review of the 1st 10 years NT Master Plan ('01 ~ '05)

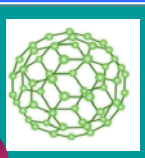
	2001	2005
Investment	105.2B Won	277.2B Won (2.7 Times)
NO. of NT Researcher	1,015	3,900('04) (3.8 Times)
NO. of NT Company	78 (Venture:33)	214 (Venture: 126)
NO. of NT Department	3	33 (11 Times)
NO. of Paper(SCI)	408 (8th in the World)	1,128 ('04) (2.8 Times, 5th)
NO of Patent (Foreign)	-	979건 ('90 ~ '03) (5th)
Level of Competitiveness	25%	66%

National Competitiveness of NT in Korea

- Level of Competitiveness in 2001: 25%, but now: 66%

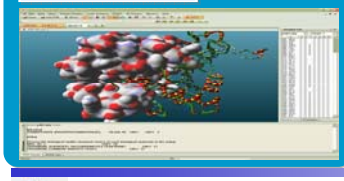
Devices:77%

Materials:66%

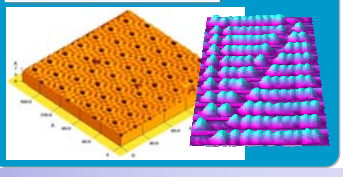


Total: 66%

Nano-Bio:56%



Process/Tool:65%



R&D Programs since the 1st NT Master Plan

Frontier

- Tera-level nanodevices('00. 4), Nanomaterials('02. 5)
- Nanomechtronics('02. 5)

NRL /Creative /SRC/ERC /NCRC

- NRL : 50 Labs including Nanoelectronics Lab.
- Creative : 19 Groups including Nano storage Group
- SRC : 6 Centers including Quantum Devices Center
- ERC : 5 Centers including Spin Property Center
- NCRC : 2 Centers including NanoSystem Center

Fusion & the Other

- 7 Centers including IT-NT Fusion Center
- The other 2372 Projects in Progress

Representative Research Results since the 1st NT Plan

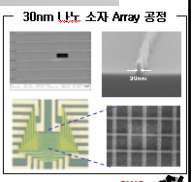
Devices
- World's first tera-level flash memory cell
- Photonic crystal laser , the size of millionth of meter

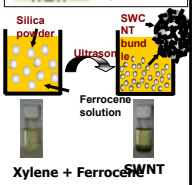
Materials
- World's 1st synthesis of CNT at RT
- World's highest degree of purity of nanotube semiconductor

Nano-Bio
- Chips for medical examination of hepatitis or cancer
- Nano-bio sensors for cell use

Process/Tool
- 100nm level soft lithography technology
- Manipulation of block co-polymer for semiconductor device

Products
- 16 Giga NAND flash memory
- Sterilizing air conditioner /washing machine using nanosilver





Establishment of Fab. since the 1st Master Plan

- Lack of NT related fab. facility before the 1st NT master plan
- have laid integrated facilities and supporting facilities with the support of MOST and MOCIE
  - Integrated facility : 2 Nano fab., 3 NT cluster centers
  - Supporting facility : 3 NT centers for industry, 1 center for industrialization of NT components
  - Fab. facilities established considering the region and the function but lack some of specialty(nano-biotechnology)

The 1st 10 Years NT Master Plan('01~'15)

Objectives

- Establishment of nanotechnology infrastructure within 5 years and entry into the world top 5 nations in this field by 2010
  - Planning to obtain at least 10 cutting-edge nanotechnologies
  - Producing 13,000 nanotechnology experts by 2010
- Setting-up of 3 grand goals for the realization
  - Research & Development : Selection and concentration
  - Manpower: Short and long term plan to meet the demand for universities, government labs and industries
  - Facilities: Construction of public fabrication facilities for universities, government labs and industries

Vision of the 2nd 10 Years NT Master Plan

- Maintaining sustainable growth potential with nanotechnology (product)
  - Entry into the world top 3 nations in this field by 2015
- Connecting and combining existing technologies with NT
  - Pre-occupying new market through the fusion of IT, BT, ET and other technologies with NT that leads the synergy.
    - Semiconductor, display, car and textile market
    - Robot and ubiquitous market
    - Nano food, medical market
    - Fuel and solar cell market
- Improvement of human being life with nanotechnology
  - Realization of safe, wealthy and environmentally friendly society
    - Eliminating cancer and improving medical diagnosis and treatment

Goal of the 2nd 10 Years NT Master Plan

- Setting-up of 4 grand goals for the realization
  - – R&D, education and infrastructure, industrial competitiveness and social needs

❑ R&D
: having 30 or more technologies superior to other nations (Nano Flash memory device, CNT Synthesis at RT)

❑ Education and public infrastructure
: Introduction of education system to cultivate NT manpower and continuing construction and supplement of public fabrication facilities for universities, government labs and industries

❑ Strengthening industrial competitiveness by promoting commercialization
: maintaining 20% share of world market

❑ Coping with social needs like effects of NT on environment, health and safety

Direction for the implementation of the 2nd NT Plan

: Research and Development-1

❑ Based on the SWOT analysis considering competitiveness, market size and possibility of commercialization, new areas of research were drawn.
  – These areas are divided into periods of short and long term and will be carried out by the ministry, concerned

❑ Existing projects that are in progress must be expanded , reduced, and even terminated according to the principle of investment through SWOT analysis.

Direction for the implementation of the 2nd NT Plan

: Research and Development-2

Strategy: Carrying out R&D by the relevant ministry after the division of technologies into short, middle & long Term

- Short (within 5~10years): Application (1~2B Won)
  - ► NanoCMOS, Nanoparticles Manufacturing and Application
- Middle/long (within 10~15years): Future Application (2~10B Won)
  - ► Nanodevice System, Cancer NT
- Base Technology: To nurture scientists/infrastructure (0.3 ~2B Won)
  - ► ERC, SRC, Creative, NRL, NCRC etc.
- Pre-competitive Technology: (0.03 ~0.2B Won)
  - ► To foster young scientists and obtain many,new ideas by bottom-up
- Nurturing Ventures: (0.1 ~0.2B Won/1st phase)
  - ► Development of creative ideas into products within 3 ~4 years

Direction for the implementation of the 2nd NT Plan

: Research Facilities

- Active operation of public facilities
  - Preventing duplication of equipments in fabs. / effective supervision(evaluation for each phase)
  - Building best process services and its system to increase users
- Supplement of public facilities regarding the estimated demand and supply
  - Decentralization of facilities and focus on the specific function
- Function as a hub for ventures and small size companies
  - Facilitating commercialization of their technology and supporting the establishment of ventures
- Build-up of training courses to nurture workforces in short period of time

Direction for the implementation of the 2nd NT Plan
: Fostering Manpower-1

- Middle and Long Term
  - Set-up and operation of regional NT educational institutes
    - Development of textbooks for educational courses
  - Supporting existing NT departments and multi-disciplinary programs
  - Supporting young and top-class NT researchers
  - Luring top scientists that are either foreigner or Korean abroad into Korea and supporting them

Direction for the implementation of the 2nd NT Plan
: Fostering Manpower-2

- Short Term
  - Operation of intensive NT training program for undergraduate/ graduate students and engineers in industry
  - Operation of short retraining program for elementary, middle and high school teachers.
  - Supporting special activities for elementary, middle and high schools as well as educational program for the public
    - Development and distribution of educational contents (CD etc.)
    - Operation of mobile exhibition center of NT for the public and students
  - Program to foster workforces for industry
    - Activation of retraining program for NT researchers in industries
    - Operation of regional NT education center in some technical high schools and technical colleges to foster engineer

Direction for the implementation of the 2nd NT Plan
: Improving System to Promote NT-1

- **Introduction of standardization and certification for NT products**
  - Formation and operation of standardization committee
    - Supervision authority given to MOCIE
    - Designation of certification center for NT products
- **Development of national information system for NT**
  - Collecting & analyzing NT information and constructing database system
- **NT assessment for sustainable development & societal implications**
  - Including NT in 'technology assessment'
  - Enactment and amendment of related laws and regulations
- **Promotion of international cooperation**
  - Applying selection and focus policy considering country and technology

Direction for the implementation of the 2nd NT Plan
: Improving System to Promote NT-2

- **Complement & amendment of system to promote NT industrialization**
  - Formation of NT industrialization committee (if needed)
  - Designation of NT industrialization promotion center or reorganization of similar agencies
  - Establishment of basis to foster NT industrialization
- **Finding leading nano-ventures to be grown and providing the system in order to foster ventures**
  - Designation of NT ventures with potential, financial /systematic support
- **System build-up for research and development organization**
  - Designation of NT research Institute
    - Becoming the national core research institute on mid-long term base
    - Continuous and systematic execution of national NT R&D
    - Function as a base in switching research results to practical use

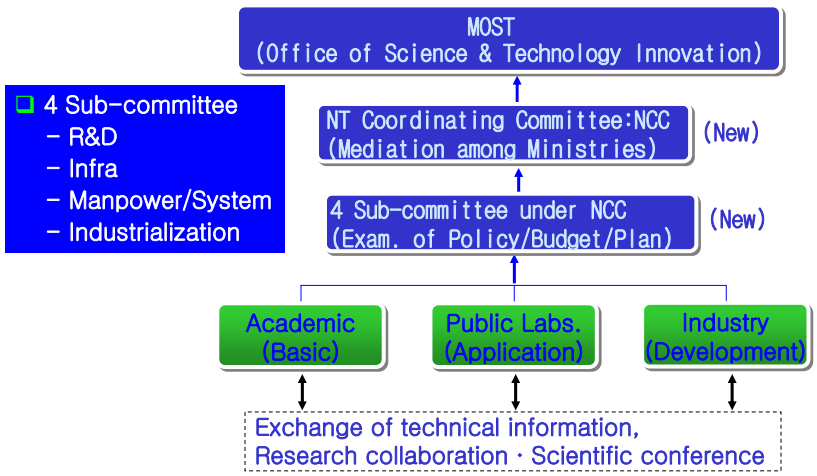
Strategy of the 2nd NT Plan for Each Phase

1st Phase (2006~2010)	2nd Phase (2011~2015)
Finding and expansion of comparatively competitive area Starting industrial application of the research results Development of technology right before commercializing	Finding and conducting research on system-level NT Acceleration of commercialization of the 1st phase results System build-up in international cooperation for a world leader role

- Applying the concept of moving target for R&D considering technology trends for each year and phase
- All the plan managed by national NT coordinating committee in order to prevent the duplication of national resources

System Establishment to Drive the 2nd NT Plan

- Establishment of system for policy tuning among Ministries



Investment Plan from 2006 to 2015

- Active supporting within the limit of national finance plan considering a great influence of NT on future national competitiveness
- Active invitation of private sector capital to promote the commercialization of NT products

◈ Estimated Investment Plan including Private Sector

(unit : B Won)

Classification	R&D	Facility	Manpower and System	Total
1st Phase ('06~'10)	1,432.7	537	66.1	2,035.8
2nd Phase ('11~'15)	1,962.1	758.2	99	2,819.3
Total	3,394.8	1,295.2	165.1	4,855.1

✱ Concrete investment scale decided by national budget plan

NSF Support for International Collaboration

- Part of new proposals to NSF disciplinary programs
- Supplements to existing NSF grants
- New proposals to Office of International Science and Engineering

Office of International Science and Engineering (OISE)

Key elements for OISE funding:

- Collaborative and synergistic
- Catalytic
- Junior researchers & students

OISE Regional Clusters

- Africa, Near East, South Asia
- Americas
- East Asia and Pacific
- Europe
- Global Initiatives

Proposals to OISE

- Planning Visits
- Workshops
- Postdoctoral Researchers
- Students
- Partnerships

Planning Visits

- Short trips by US researchers
- Assess foreign expertise, facilities, equipment, data, experimental protocols, etc.
- Plan for collaborative research

Workshops

- Co-organized by US & foreign investigator
- Held in US or foreign country
- NSF supports U.S. participants
- Identify areas of joint research
- Stimulate future collaborative proposals
- Include students and junior researchers

Support for Postdoctoral Researchers

- Participation in NSF disciplinary awards
- Disciplinary Postdoctoral Fellowships
- Participation in OISE planning visits or workshops
- International Research Fellowships

International Research Fellowships

- Work outside the U.S. for 9–24 months
- Re-entry support within 24-month tenure
- US citizens or permanent residents not past 3 years from their Ph.D.
- Applications for work in developing countries are especially encouraged
- Annual deadline: 2nd Tuesday in October

Support for Graduate Students

- Participation in NSF disciplinary awards
- Integrative Graduate Education and Research Traineeship (IGERT) Program
- Graduate Research Fellowships
- Participation in OISE planning visits or workshops
- Dissertation Enhancement Awards
- International Research Experiences for Students
- East Asia and Pacific Summer Institutes

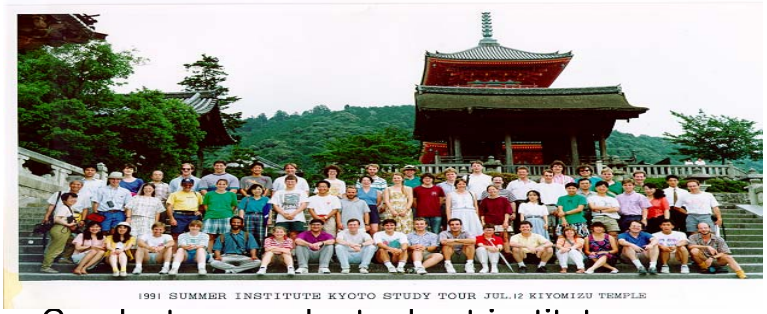
East Asia and Pacific Summer Institutes for U.S. Graduate Students (EAPSI)

Become an internationally experienced researcher. Spend eight weeks conducting research and experiencing life in: Australia, China, Japan, Korea or Taiwan





East Asia and Pacific Summer Institutes for US Graduate Students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- Conduct research at a host institute
- Language study and cultural orientation
- Professional visits
- Eight weeks June–August in Japan, Korea, Taiwan, China or Australia

EAPSI Sponsoring Organizations

- National Science Foundation
- National Institutes of Health (Japan only)
- Japan Society for the Promotion of Science
- Korea Science and Engineering Foundation
- National Science Council of Taiwan
- Chinese Ministry of Science and Technology
- Chinese Academy of Sciences
- National Natural Science Foundation of China
- Australian Academy of Science

EAPSI Host Institutions

Depending on the program:

- University
- Government
- Industry

Support for Undergraduate Students

- Participation in NSF disciplinary awards
- Research Experiences for Undergraduates (REU)
- Participation in OISE planning visits or workshops
- International Research Experiences for Students

International Research Experiences for Students

- Can include graduate and undergraduate students
- Supports small groups of students in a particular field
- Awards of up to $50,000 per year for up to 3 years

Partnerships for International Research and Education

- Advance research and education objectives
- Establish innovative models for international collaborations
- Develop a globally –engaged science and engineering workforce