Policy Initiatives and Strategies for Promoting Nanotechnology in Korea

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and

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1 Introduction

Historical Perspectives on,

(a) Growth of Korea from 1960-2012
(b) Growth of Nanotechnology Activity in Korea
(c) Summary of Key Achievements during the last 15 years

Prof. Kim, Ki-Bum

EDUCATION:

1976-1980	Seoul National University, B.S. in Metallurgical Engineering
1981-1983	Seoul National University, M.S. in Metallurgical Engineering
1983-1988	Stanford University: Ph.D. in Materials Science and Engineering

PROFESSIONAL EXPERIENCES:

1988-1991	Philips Research Laboratory, Research Scientist
1991-1992	Applied Materials Inc., Research Scientist
1992-present	Professor, Department of Materials Science and Engineering, SNU
1996-1997	Applied Materials Inc., and Stanford Univ., Visiting Professor
2007-2008	IBM T. J. Watson Research Laboratory, Visiting Professor

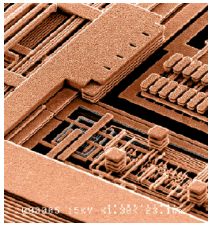
Research History:

Material Science (1983 ~)

Information Tech. (1991 ~)

Nano Tech. (2001 ~)

Convergence Tech. (2007 ~)



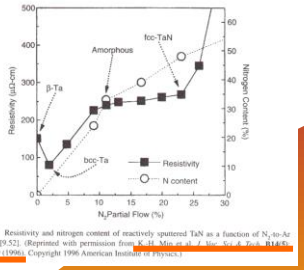
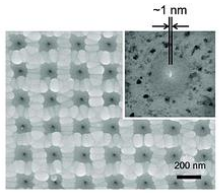
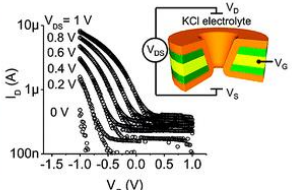


FIG. 9.35 Resistivity and nitrogen content of reactively sputtered TaN as a function of N_2-to-Ar flow ratio [9.52]. (Reprinted with permission from K. H. Min et al. J. Vac. Sci. & Tech. B14(5), 3263-3269 (1996). Copyright 1996 American Institute of Physics.)





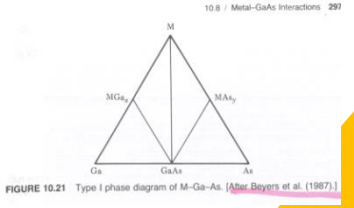
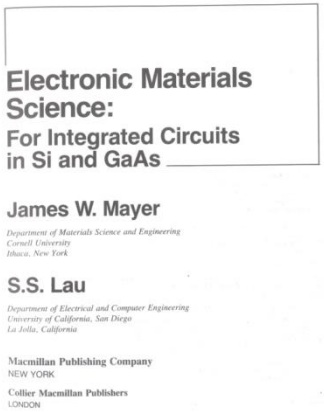
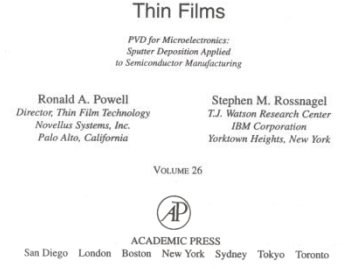
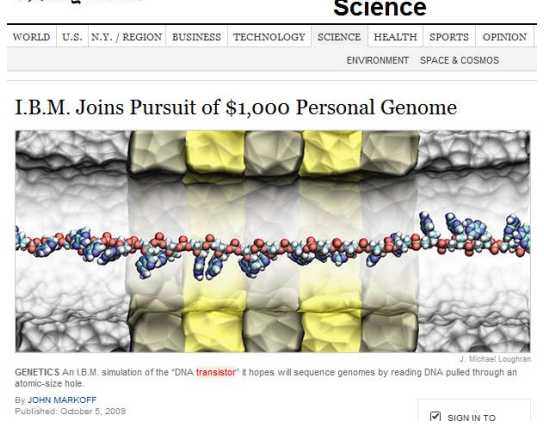


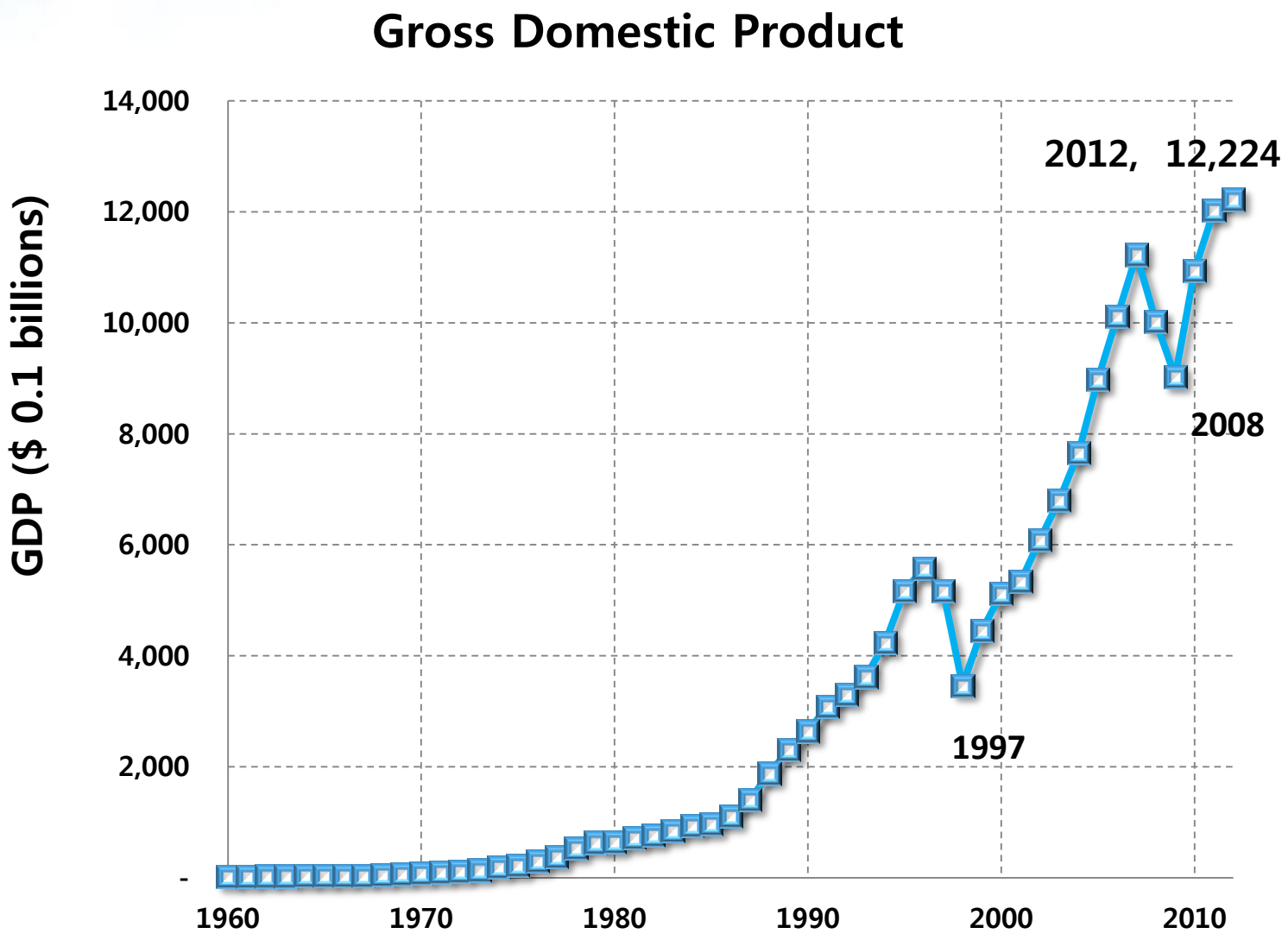
FIGURE 10.21 Type I phase diagram of M–Ga–As. [After Beyers et al. (1987).]







1. History of Korea Growth (1960 – 2012)



STATISTICS KOREA (The Bank of Korea)
http://kosis.kr/

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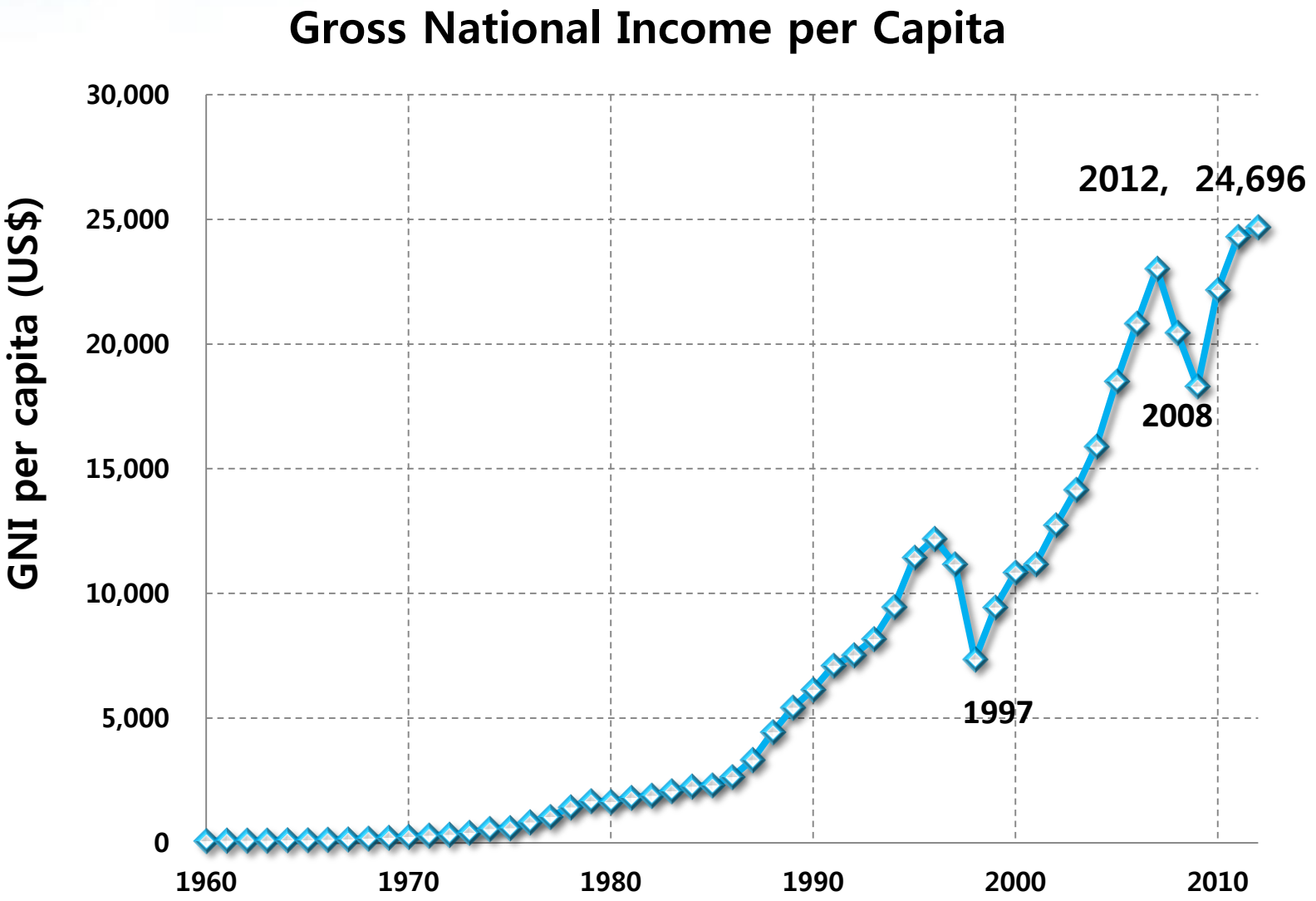

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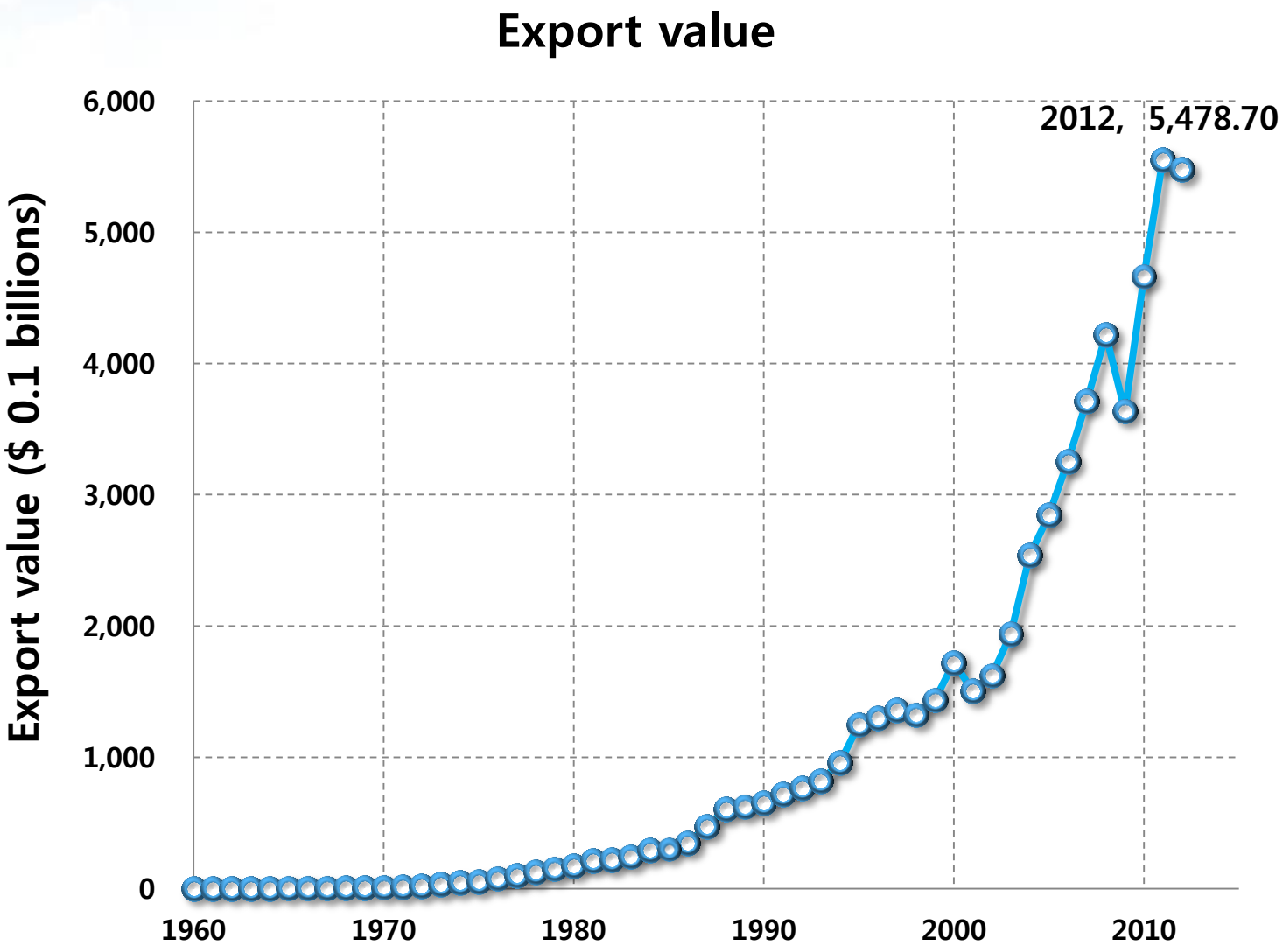

Korea International Trade Association
http://stat.kita.net/

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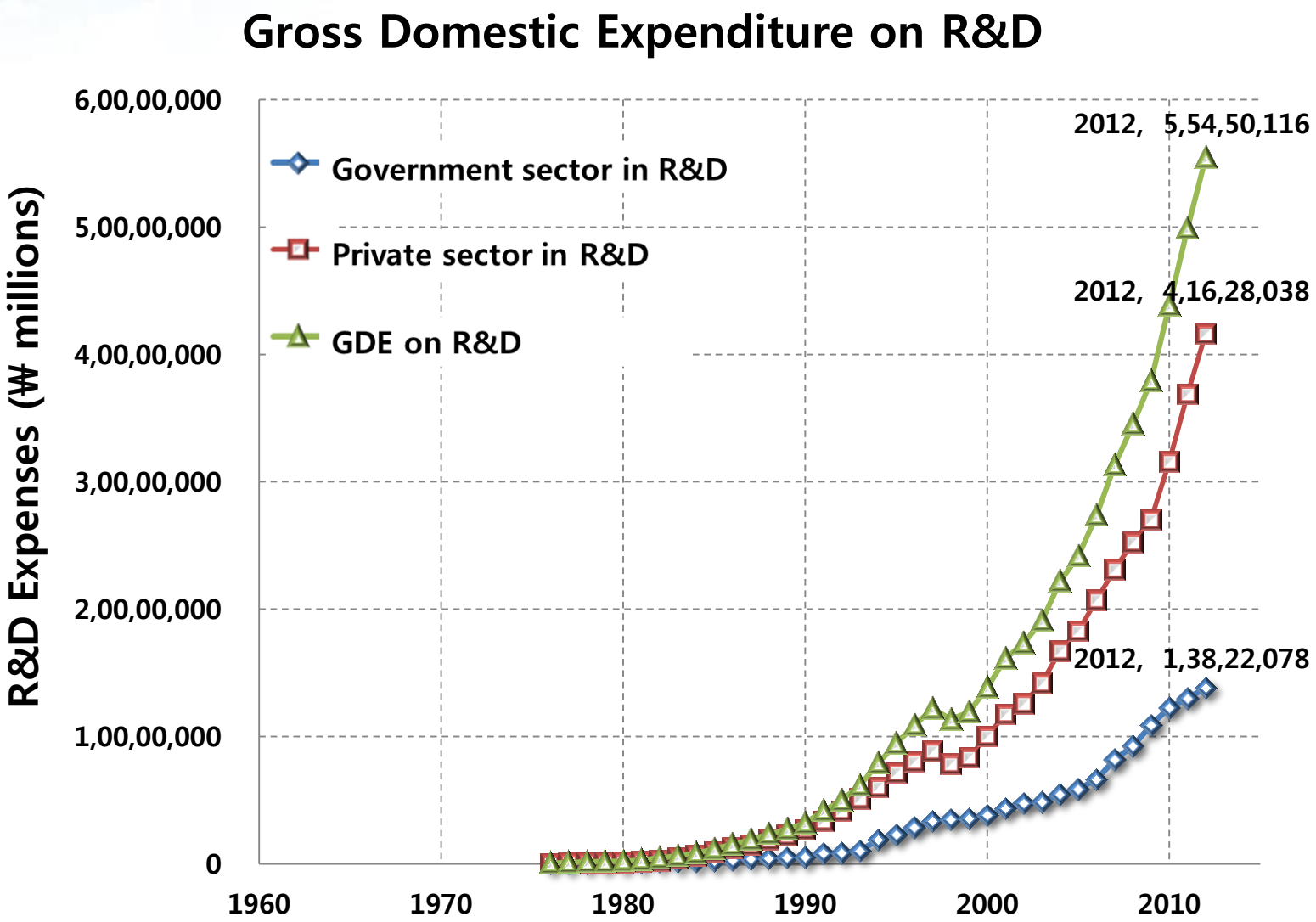

STATISTICS KOREA (Ministry of Science, ICT and Future Planning)
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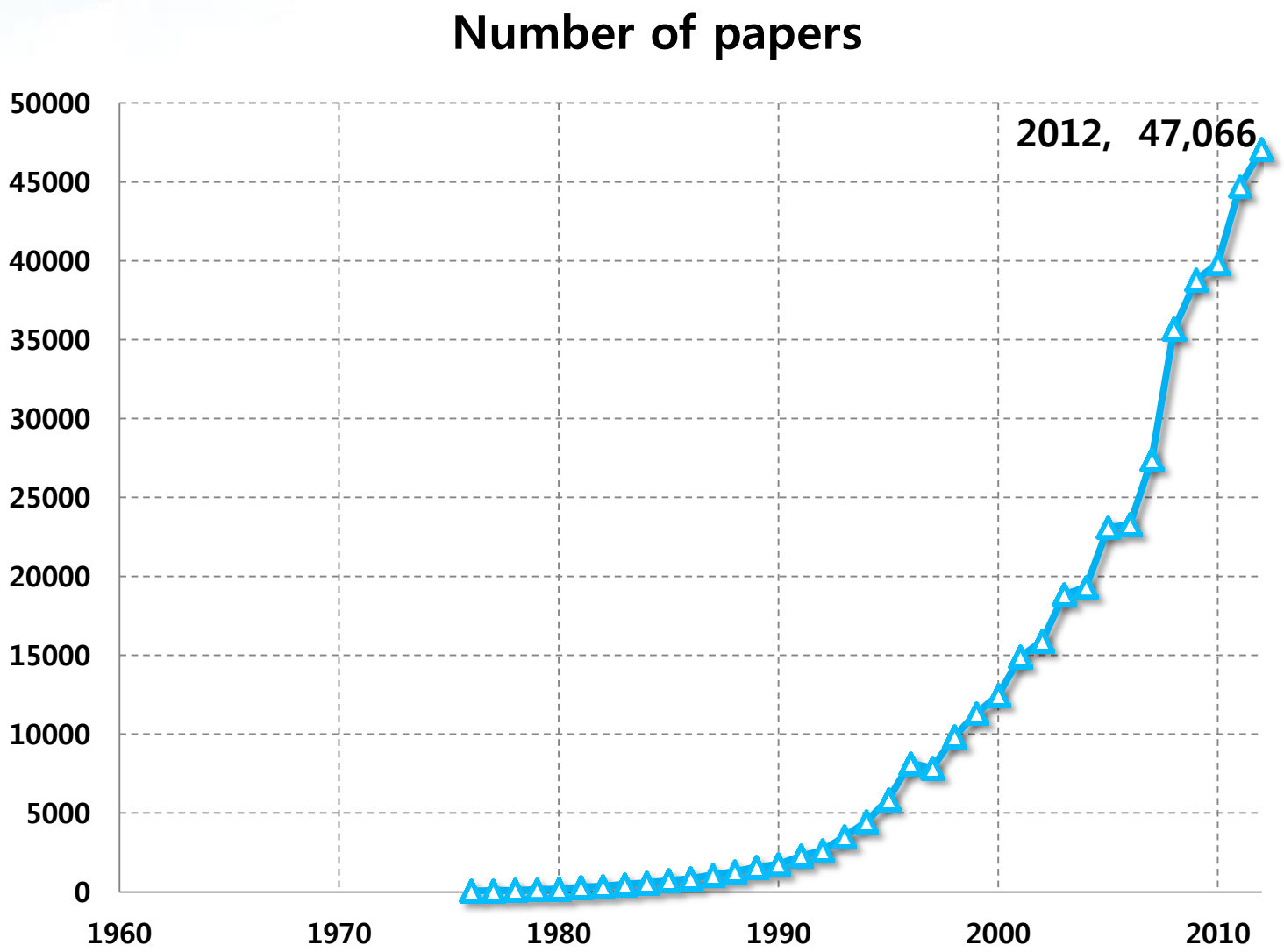

Web of Science
http://apps.webofknowledge.com/

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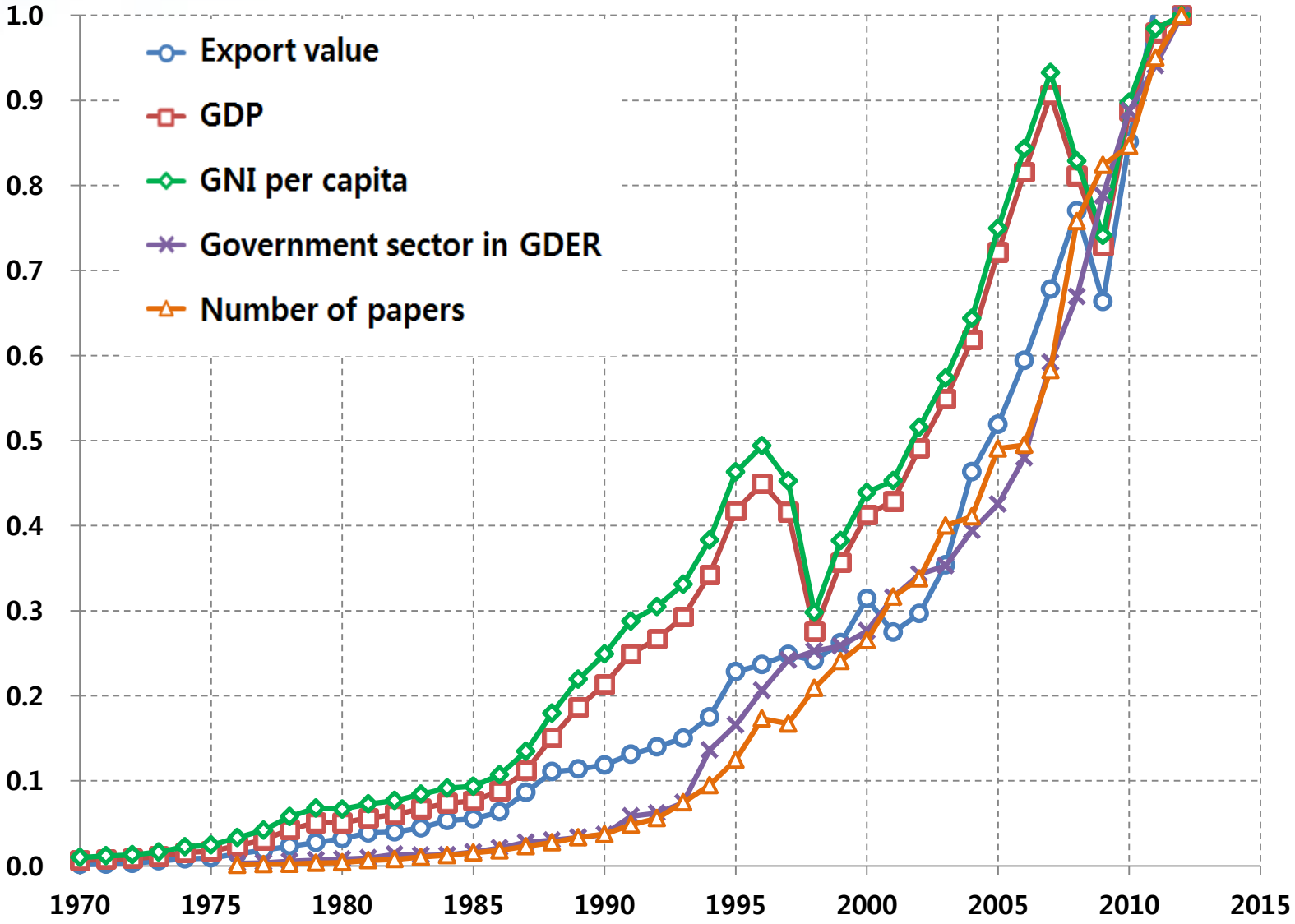

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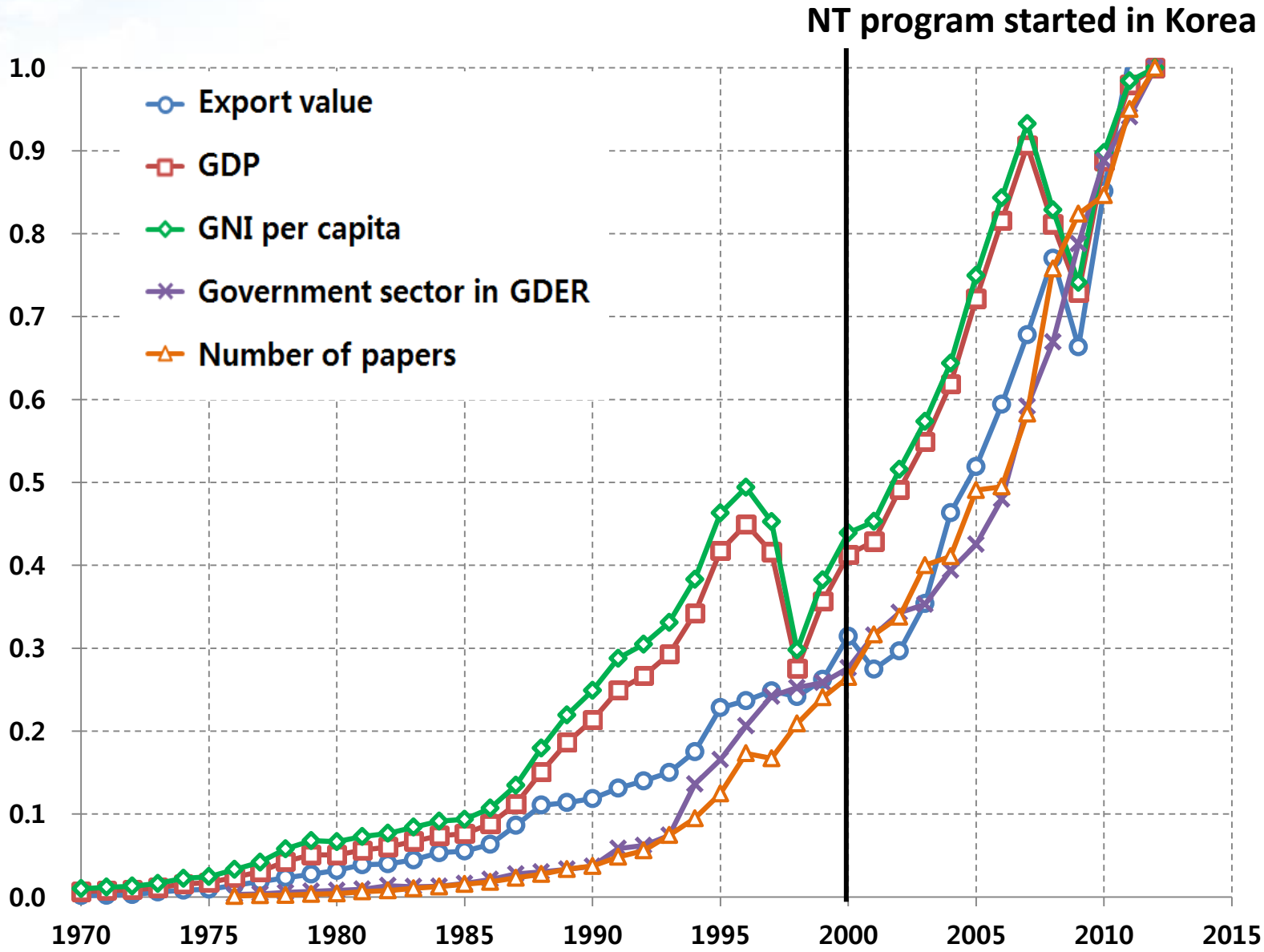
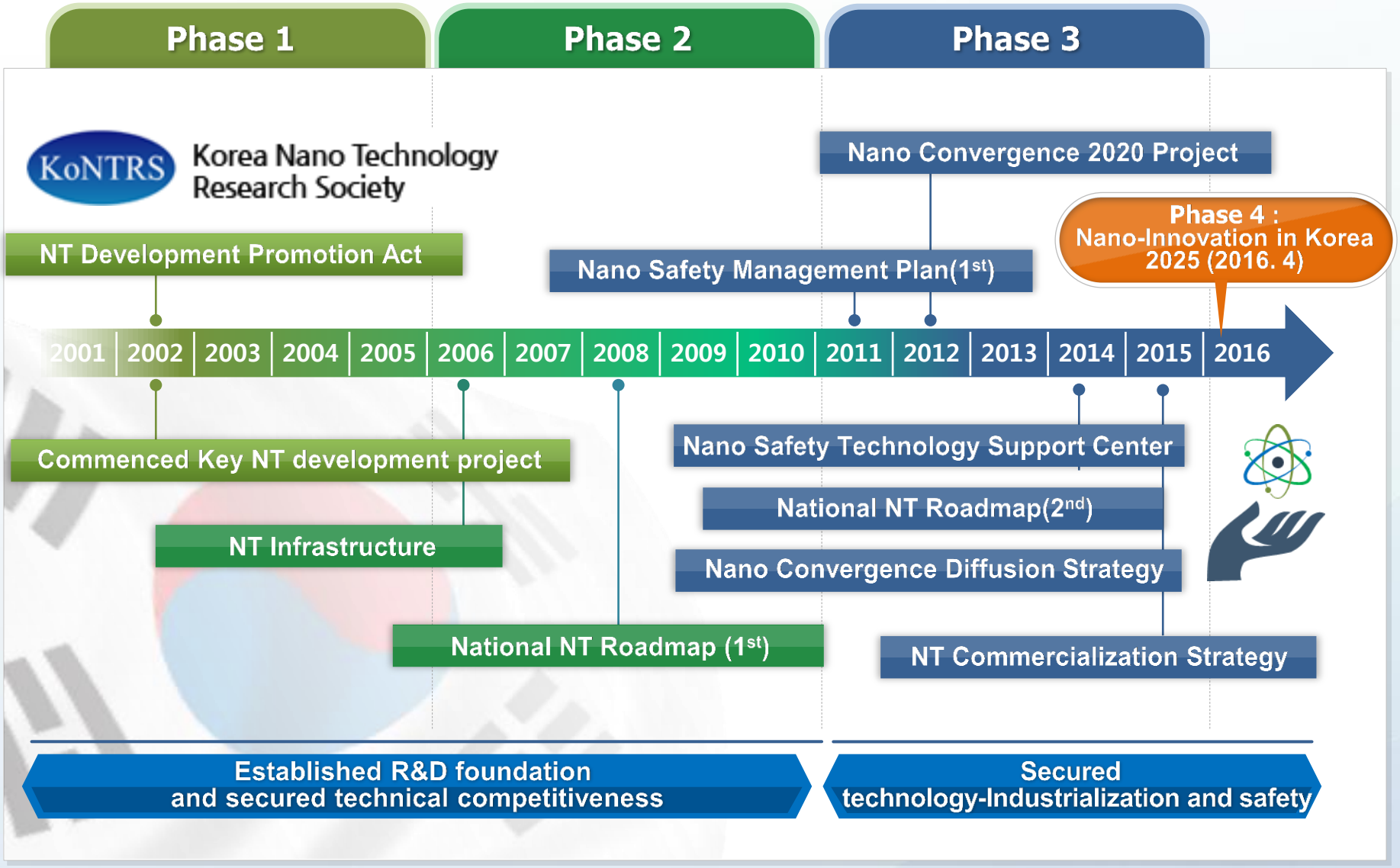


History of NT policies in Korea

Ministry of Science, ICT and Future Planning



KoNTRS Korea Nano Technology Research Society

Established in 2002

Major Activities

- NANO KOREA Symposium — Every year since 2004
- Nano Convergence — Publication of Nano Journal
- National Nano Technology Road Map
- Management of Basic NT Education Program
- e-Nanoschool
- Network Activation — Development of regional policy agenda in connection
- International Cooperation

Progress(Phase 1- 4)

Ministry of Science, ICT and Future Planning

Phase1 (2001~ 2010)

Vision Establishing infrastructure and entering **Top Level of** NT countries

Strategy
Design infrastructure for Fab service
Design National Nanotechnology Research Program
Design National-Level of nanotechnology Education Program

Phase2 (2006~2015)

Vision
1. Developing **New Technology Market** through convergence
2. Realizing a safe and prosperous society

Strategy Establishing the foundation for industrialization

Phase3 (2011~2020)

Vision Building a **Global Nano Powerhouse**

Strategy
1. Developing future technologies 30
2. Advanced HR, Maximize infrastructures application
3. Reinforcing social and ethical responsibility

Phase4 (2016~2025)

Vision Being a **First Class Country** accomplishing sustainable growth through the innovation in NT

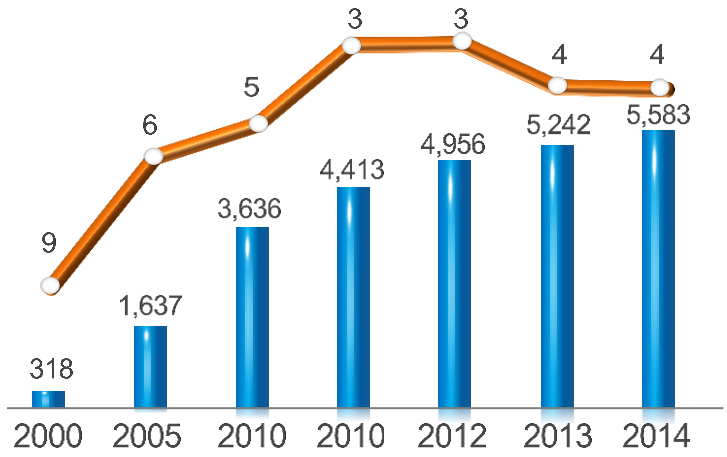
Strategy
1. Diffuse innovation-driven Nano Industrialization
2. Secure advanced NT for future sustainable growth
3. Expand infrastructure of promote innovation through NT

3. Key Achievements during the last 15 years (1/3)

- Secured world-class scientific capabilities
  - No. of NT-related SCI papers: 9th (2000) → 4th (2014)
  - No. of patents registered at USPTO*: 8th (2000) → 3rd (2014)

Papers

- **Significant Growth in the number of NT-related SCI papers**

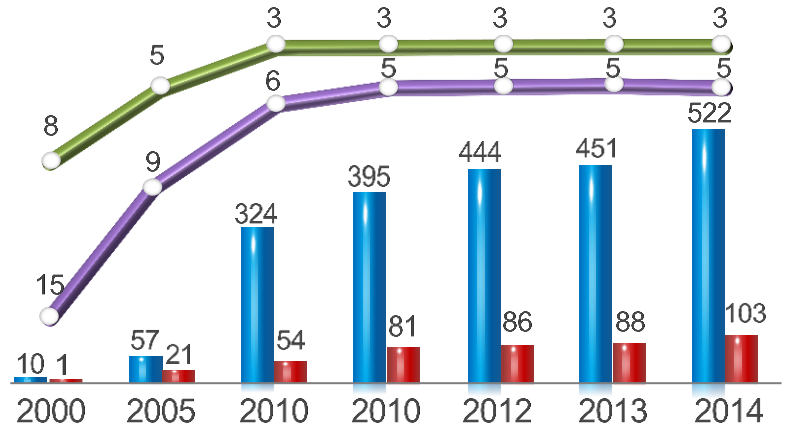


Source: National Nanotechnology Policy Center (NNPC), Nanotechnology Yearbook 2014

Patents

- **Significant Growth in NT related patents registered**

Total 522 in 2014 (15.7% growth from the previous year)



Source: : NNPC, Nanotechnology Yearbook 2014, Nanotechnology Patent Trends (2015)

* USPTO: United States Patent and Trademark office

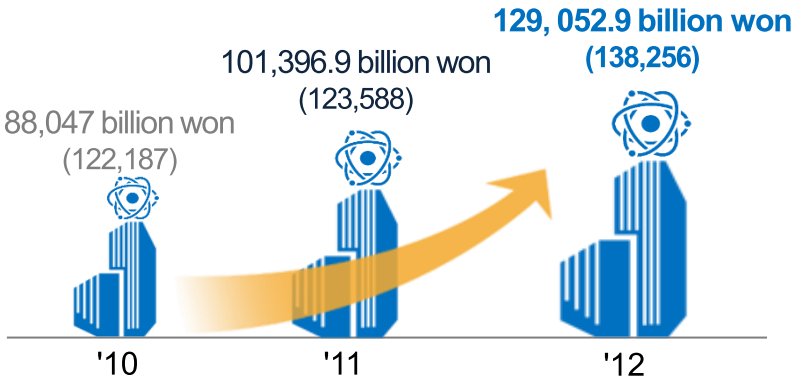
3. Key Achievements during the last 15 years (2/3)

- Korea emerging as a key NT industrial country
  - No. of NT companies: 504 (estimated at around 1,000)
  - Korea is the third after the U.S. and Germany in the diversity of NT products (Woodrow Wilson Center, 2014)

NT Convergence Industrial Companies

- **No. of NT convergence industrial companies**
  - Total 504 in 2012
    [Nano Materials(43.3%), Nano Equipment/Devices (28.6%), Nano Electronics(16.7%), Nano Bio/Medicine(11.5%)]
  - Total 138,000 jobs created in 2012
    (11.9% growth from the previous year)

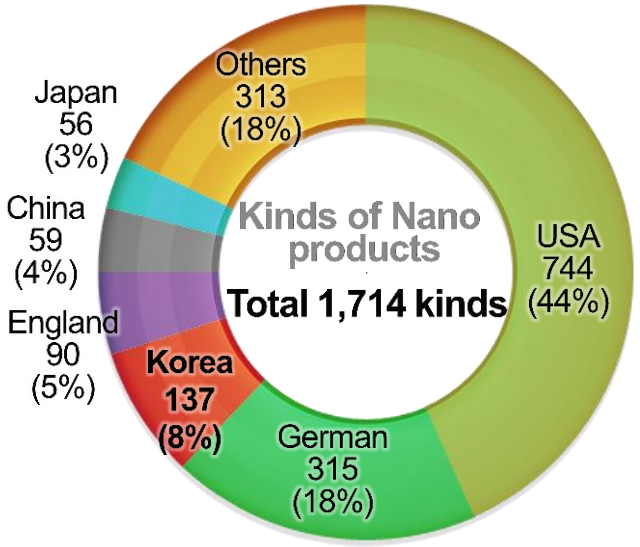
* Sales (No. of employees)



Source: MOTIE, Nano Convergence Industry Survey (2013~2014)

Product in NT

- **Kinds of Nano products worldwide**
  - 1,714 kinds in 2014 (Korea produced 137 types, ranked the 3rd in the world)



Source: Woodrow Wilson Center, Project on Emerging Nanotechnologies (2014.8)

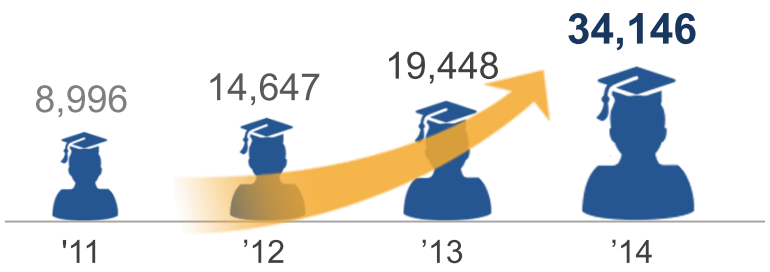
3. Key Achievements during the last 15 years (3/3)

Human resources for research communities and industries

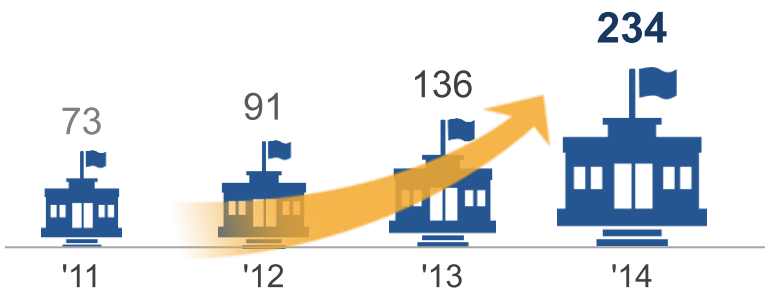
- 8,158 core researchers and 138,256 industrial manpower

Developing human resources in NT

- **No. of college students enrolled in NT related departments**



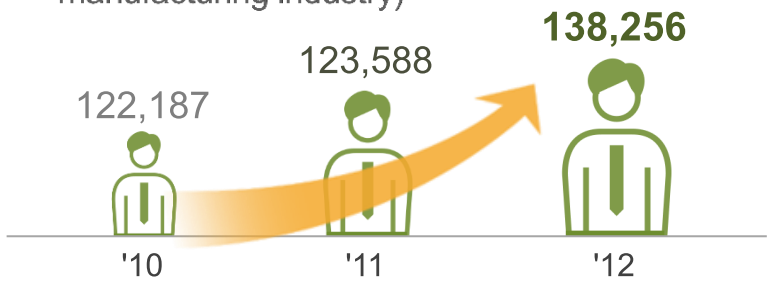
- **No of NT related departments among Korean University**



Researchers/industrial manpower

- **Researchers in NT**
  - Total 8,548 in 2014 (18% annual average growth)

- **Manpower in NT convergence industries**
  - Total 138,256 in 2012 (5% of the whole manufacturing industry)



Source: NNPC NT Organization Survey (2013), MOTIE Nano Convergence industry Survey (2013~2014)

3. Key Achievements during the last 15 years

2 Nano-Innovation of Korea 2025

The 4th National Nanotechnology Initiative Program

I. Background

Ministry of Science, ICT and Future Planning

1 Background for NNI-K

Technical Innovation

▶ Increased Need to NT against Future Environmental Changes

- Excessive information, issues of energy and climate, increase lifespans
  ➡ Increased demand to utilize NT
- Nanotechnology : Source of next gen. technical innovation
  ➡ Overcoming technical limitations of manufacturing industry+ Eco-friendly growth

Revenue per person **in manufacturing** KRW **530** million

over **1.7** times

Revenue per person **in nano convergence industry** KRW **930** million

Leading Technology

▶ Strategy to lead the diffusion of Nano-Convergence

- Joining NT leading country group(investment for past 15 years)
- Electronics ➡ Full fledged utilization of NT(large companies)
  Nano materials, equipment & energy/bio industry ➡ Early stage of growth
- Manufacturing industry needs to spread nano-convergence and enhance investment in leading technologies

Legal Basis

▶ NT Development Promotion Act

- Establishing foundation for researching NT and systematic development and nurturing of nanotechnology
- Enacted every 5 years

I. Background

Ministry of Science, ICT and Future Planning

2 Future Challenges related to Nanotechnology

	1 Expanded information processing and nano electronics	2 Nano-bio technologies For wellbeing-oriented and aging society	3 Climate change and nano energy/environmental technology
ISUUES	Hyper-connected society Big data Intelligence/ unmanned electronics	Healthy Life Better quality of Life	Abnormal Climate changes Water Shortage
SOLUTIONS	Need for high performance elements capable of processing tons of information with speed and low power consumption	**Need to develop technologies for early diagnosis of diseases**, improvement or replacement of **weakened damaged human tissues**	A need to provide eco-friendly energy sources and technology to purify air and water
	Big USD **3.8** billion (2013) Big USD **384** billion (2020 Expectations)	**81.4** AGE (2012) Average lifespan **73** AGE (2012) Healthy life	CO2 **37%** Reduction Goal 2030

II. Local and Global Status and Policy Directions

Ministry of Science, ICT and Future Planning

1 Current status of NT in Korea and Overseas

Global Trends — Establishing Sustainable Environment and Securing Source Technology

- **U.S.** — Nano Signature Initiative
- **E U** — Horizon 2020
- **China** — Made in China 2025

Korea Status — Improved Research Capability of NT and Growth of related Industries

- Pursuit of catch-up strategy in R&D and investment from 2001 resulted in **improved research capability of NT and growth of related industries**

Technology Level

25% (2001) → 81% (2014)

Specialized HR

7,383 (2010) → No. of univ. students(related NT) 34,146 (2015)

Nano Convergence Industry

The Market size of nano-abled products has grown enough to be recognized as a separate industry
→ Experiencing rapid growth

Sales	USD 121 billion '13	* Average yearly growth of 18.5%
Jobs	151,000 people '13	* Average yearly growth of 7.1%
Companies	541 '13	
Investments	USD 24 billion '13	* Average yearly growth of 15%
Revenue per person	USD 0.08 billion '13	* 1.7times of manufacturing industry

NT Industrialization

Most companies are based in the nano materials(46.3%, 24 companies) but are suffering from relatively negligible revenue, and industrialization of nano bio technologies is particularly weak

- Nano electronics — Active application of nano elements for displays, components and memory devices and etc.
- Nano process — Most equipment are imported, **causing weak expansion of nano convergence**
- Nano materials — Largest companies in this field(234), **Most are SMBs with negligible revenue**
- Nano bio — Growth of Bio/healthcare industry expected, **Requirements such as validation and clinical trials as obstacles to commercialization**
- Nano energy/ environment — **Expanded application of NT to overcome barriers of efficiency, especially for secondary batteries**

2 Policy Directions

NT Industrialization diffusion

Create Innovation in the Manufacturing Industry through of NT utilization

- Develop new markets by facilitating commercialization of NT
  - Selecting NT capable of creating new industries
- Establish support systems to reduce burdens of companies in the commercialization process
- Make up critical missing links in the commercialization process
  - Nano bio: Evaluation support for Nano-bio technology validation
  - Nano materials: Linking Support for nano materials and related companies

Leading NT Innovation

Lead the Development of Future NT as a Nano-advanced Country

- Secrue technologies for overcoming limitations to resolve future issues
  - Promote source/applied researches and Challenge Project
  - Strengthen strategic investment in basic research in NT and Build the development promotion-system

Nano Innovation-based expansion

Build the foundation for continued growth of NT and related industries

- Establish international cooperation system, Cultivate core R&D HR and on-site experts
- Nano safety management system, System to support reduced cost and time for NT development

III. Vision and Goals

Ministry of Science, ICT and Future Planning

Vision

Being a First Class Country accomplishing sustainable growth through **the Innovation in NT**

Realization of innovative technology for manufacturing industries

92%
Technology Level (U.S standard 100)

12,000
Core Research HR

Goal (2025)

Global leader in nanotechnology industrialization

12%
Ratio of the sales revenues by nano-abled products

1,000 industries
No. of nano convergence company

3 Major Strategies and 12 Projects

1 Diffuse Innovation-driven Nano Industrialization

① Secure core technologies for Industrialization promotion
② Support technology Commercialization of the company
③ Strengthen infrastructure for the proliferation of nano-convergence
④ Overcome the barriers for commercialization

2 Secure Advanced NT for the Future

⑤ Promote strategic basic research in NT
⑥ Develop 30 core subjects in NT
⑦ Promote 「Nano Challenge」 projects in 4 majors categories of NT
⑧ Rationalize national investment in NT

3 Expand Nano Innovation Infrastructure

⑨ Cultivate on-site type 'Nano specialists'
⑩ Build neo-global cooperation system
⑪ Secure nano-safety management system
⑫ Build information system for innovation support

IV. Expected Improvements

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▶ Relate Nano Technology R&D Results To Industries

- Improving competitiveness of domestic manufacturing by commercializing nano technologies and R&D results
- Creating new growth initiative by intensive facilitation of core strategic technologies

▶ Creating Nano-based New Industries

- Creating new jobs through growth of nano-related companies and facilitating manufacturers
- Improving quality of jobs by adding values to corporate activities

▶ Development of NT for Future Generations

- Establishing sustainable society living with future generations by securing nano-based energy/environmental technologies

Goals designated for 2025

- **12%** Ratio of nano-convergence products
- **5,000 cases** Number of patents approved in U.S.
- **1000 industries** No. of nano-convergence companies
- **250,000 people** No. of people in nano-related industries
- **92%** Technical level
- **12,000 people** Core R&D personnel

Thank you very much

Nano-**I**nnovation in **K**orea 2025