

# Nanotechnology Research in China: Performance, Policy, and Prospects

**Zhang Jingjing**  
Georgia Institute of Technology

**Liu Li**  
Tsinghua University/Fraunhofer ISI

**Prime workshop**  
**Mapping the emergence of nanotechnologies and understanding the engine of growth  
and development**  
**Grenoble, Wednesday March, 1st and Friday, March 3rd 2006**  
**MSH Alpes, Maison des Sciences de l'Homme**  
**Campus Universitaire**

# Outline

- China in World Science
- Performance
  - An analysis of Chinese nanotechnology publications for the last 10 years
- Policy
  - An overview of related government S&T policy supporting nanotechnology research
- Prospects
  - Recommendations for sustainable development of nanotechnology research

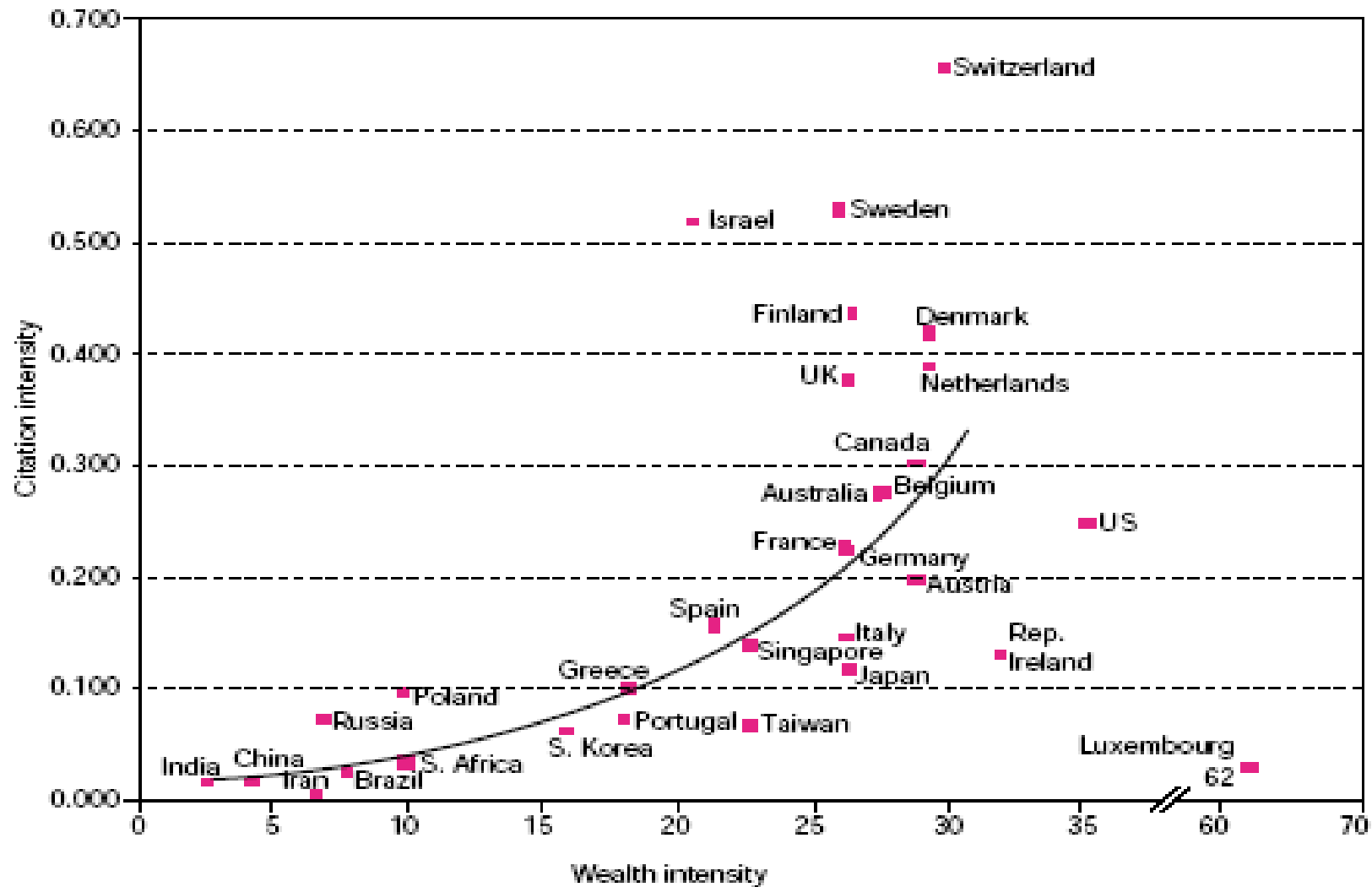
# 1 China in World Science

- the third largest R&D performer behind the United States and Japan(OECD,2005).

GERD/GDP: 0.60% in 1996 to 1.31% in 2003

- the world's second largest number of researchers (862 000), behind the United States. (OECD, 2005)
- The SCI publications rank No.5 (5.4%)
- But,

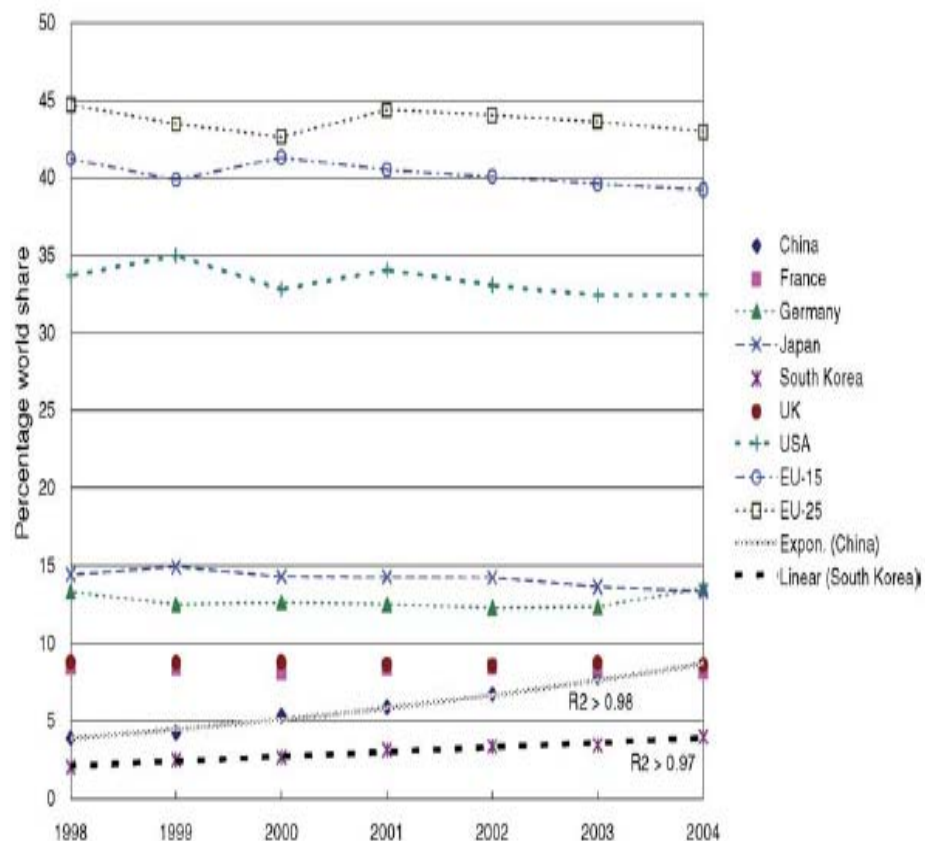
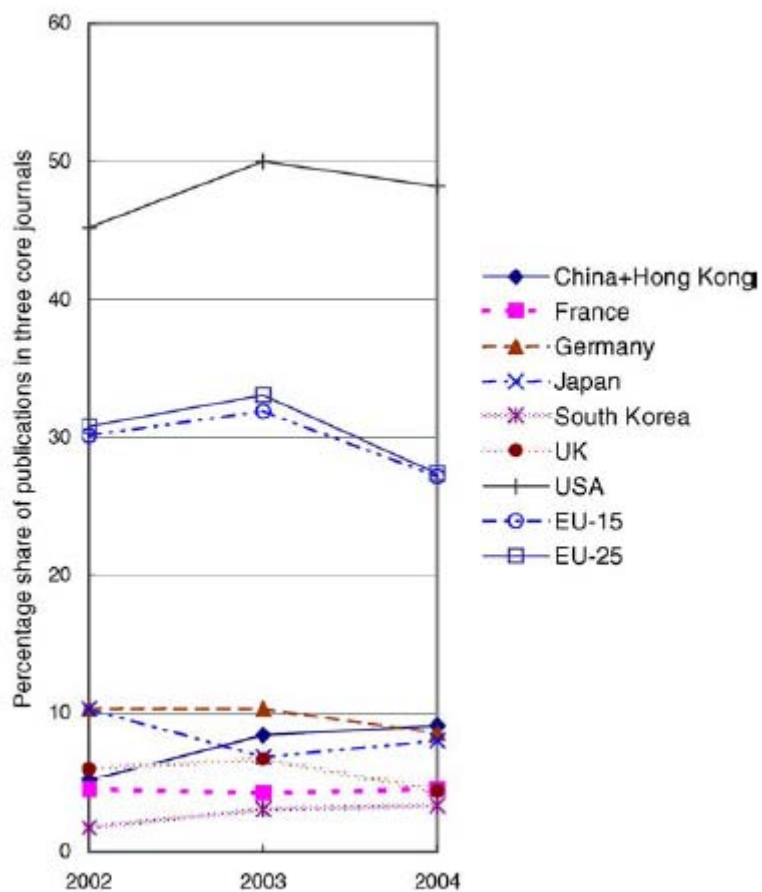
# another picture



## 2 Performance

- Glanzel and Meyer (2003): From 1998-2001, Chinese nanotechnology publications accounted for 9.5% of world total publications, and ranked fourth only behind, the U.S., Japan, and Germany
- Kostoff (2004): for the first 8 months of 2004, China ranked first, 14% higher than the US.
- Zucker and Darby (2005) : China as the second largest producers of publications.
- Zhou & Leydesdorff (2006):

## Share of Publications in three core nano-journals; Percentage of world share of 85 nano-relevant publications



# What are characteristics of Chinese SCI publications on Nanotechnology?

- Methodology:  
Used the search strategy suggested by Glanzel and Meyer (2003), we searched all the nanoscience and technology related publications that have at least one author from China in science citation index (SCI) for the past 10 years (1995-2004).
- Results:  
totally 15643 publications fit the above criterion.  
and the following findings

Table 1 Nanotech Papers by Chinese Authors, 1995-2004

Year	Papers	Citations	Citations/Paper
1995	244	1984	8.13
1996	336	3608	10.74
1997	487	4824	9.91
1998	624	6367	10.20
1999	932	10341	11.10
2000	1197	12675	10.59
2001	1732	13549	7.82
2002	2411	15384	6.38
2003	3498	13622	3.89
2004	4138	6048	1.46

Source: The Chinese nanotechnology publication dataset derived from Science Citation Index by the authors



Table 2: Chinese Nanotech Papers by Language  
1995-2004

Year	Total	Chinese	English	Japanese	Unknown
1995	244	13	231		
1996	336	9	327		
1997	487	18	465	1	3
1998	624	14	121		489
1999	932	135	751		46
2000	1197	115	620		462
2001	1732	305	1425	2	
2002	2411	412	1988	11	
2003	3498	586	2907	5	
2004	4138	581	3551	6	

Source: The Chinese nanotechnology publication dataset derived from Science Citation Index by the authors

Table 3: Top ten research disciplines 1995-2004

Rank	Disciplines	Papers
1	Chemistry, Multidisciplinary	1662
2	Materials Science, Multidisciplinary	1623
3	Chemistry, Physical	963
4	Physics, Condensed Matter	917
5	Physics, Applied	873
6	Physics, Multidisciplinary	788
7	Polymer Science	694
8	Materials Science, Multidisciplinary; Metallurgy & Metallurgical Engineering	618
9	Materials Science, Multidisciplinary; Physics, Applied	530
10	Chemistry, Physical; Materials Science, Multidisciplinary	530

Source: The Chinese nanotechnology publication dataset derived from Science Citation Index by the authors

Table 4: Top 10 most productive organizations

	Organization	Papers	Citations	Citation/ paper
1	Chinese Academy of Science	3081	1873	6.08
2	University of Science & Technology of China	1019	6135	6.02
3	<b>Tsinghua University</b>	972	6181	6.36
4	Nanjing University	710	4162	5.86
5	Peking University	706	6444	9.13
6	Jilin University	454	2136	4.70
7	Zhejiang University	346	1241	3.59
8	Shandong University	329	940	2.86
9	Fudan University	273	1610	5.90
10	Shanghai Jiao Tong University	271	940	3.47

Source: The Chinese nanotechnology publication dataset derived from Science Citation Index by the authors

## Table-5 Top 15 most-cited Authors

Rank	Name	Affiliation	Paper	Citation
1	Xie, Y	Univ Sci & Technol China	66	675
2	Li, YD	Tsing Hua Univ	53	651
3	Qian, YT	Univ Sci & Technol China	137	631
4	Gao, L	Chinese Acad Sci	99	444
5	Li, HL	Lanzhou Univ	52	354
6	Jiang, L	Chinese Acad Sci	19	288
7	Qi, ZN	Chinese Acad Sci	3	275
8	Li, NQ	Peking Univ	6	274
9	Li, Y	Chinese Acad Sci	3	271
10	Jiang, Q	Jilin Univ Technol	14	245
11	Wang, ZL	Georgia Inst Technol	12	238
12	Fan, SS	Tsing Hua Univ	13	231
13	Gu, ZN	Peking Univ	9	223
14	Pan, ZW	Chinese Acad Sci	4	220
15	Wang, EG	Chinese Acad Sci	12	218

Source: The Chinese nanotechnology publication dataset derived from Science Citation Index by the authors

# Table-6 The first 20 Key Words

<b>Ranking</b>	<b>Key Words</b>	<b>No. of Publications</b>
1	carbon nanotubes	324
2	nanoparticles	263
3	X-ray diffraction	255
4	nanostructures	251
5	microstructure	236
6	nanocomposites	231
7	nanostructures	220
8	chemical synthesis	194
9	nanomaterials	164
10	nanocomposite	144
11	nanoparticle	141
12	nanocrystalline	126
13	photoluminescence	123
14	synthesis	123
15	optical properties	120
16	mechanical properties	119
17	sol-gel	113
18	luminescence	106
19	electron microscopy	105

# International Collaborations

Country	No. of co-authored papers
USA	291
Japan	202
Germany	132
Singapore	84
Korea	56
England	54
Canada	41
Australia	35
France	34
Israel	32

Ranking	Names of the co-authors	No. of Co-authored papers	affiliation	Country
1	Gedanken, A	25	Bar Ilan Univ	Israel
2	Wang, ZL	12	Georgia Inst Technol	GA 30332 USA
3	Sun, CQ	9	Nanyang Technol Univ	Singapore
4	Yin, LF	7	Natl Inst Nat Sci	Japan
5	Shaw, TK	6	Univ Western Ontario	Canada
6	Tsumekawa, S	5	Tohoku Univ	Japan
7	Huang, Y	5	Univ Illinois	IL 61801 USA
8	Ha, CS	4	Pusan Natl Univ	South Korea
9	Liao, K	4	Nanyang Technol Univ	Singapore
10	Walton, DM	4	Univ Sussex	England
11	Yu, C	4	Chinese Univ Hong Kong	Hong Kong
12	Ren, SF	4	Illinois State Univ	IL 61790 USA
13	Yu, SH	3	Max Planck Inst Colloids & Interfaces	Germany
14	Li, JL	3	Univ London Queen Mary Coll	England
15	Zhang, XY	3	Univ Stuttgart	Germany

# Nanotechnology research in Tsinghua University

- SCI Papers ranked 3<sup>rd</sup> in China (see Table 4)
- Zhu, Hongwei et al., SCIENCE, MAY 3, 2002
- Jiang Kaili, et al., Nature, Oct. 24, 2002
- Xun Wang, Jing Zhuang, Qing Peng & Yadong Li. "A general strategy for nanocrystal synthesis", Nature, Vol 437, 1 September 2005.
- The artificial nanobone was invented and permission for pilot production was granted.
- Tsinghua-Foxcom Nanotechnology research center

# Performance: a summary

- Fast growth in both quantity and quality
- Formation of independent domestic nanotechnology research community
- Multidisciplinary research
- Dominant roles of universities and public research institution and few contribution from industrial sectors



# 3 Policy

One of the key reasons of this fast growth in nanotechnology research in China is the strong and dedicated government support.

# Funding Sources

- From 1999 to 2002, Funding for Nanotechnology from government organizations increases 7 times
  - MOST: 350M RMB for Basic and applied Research
  - NSFC: 320M RMB for Basic research
  - CAS 150M RMB for Basic and applied Research
  - SDRC 380M RMB for Networks and Promoting Technology Transfer
- Funding from local governments and enterprises 1300 M RMB for commercialization

# Nanotechnology Policy

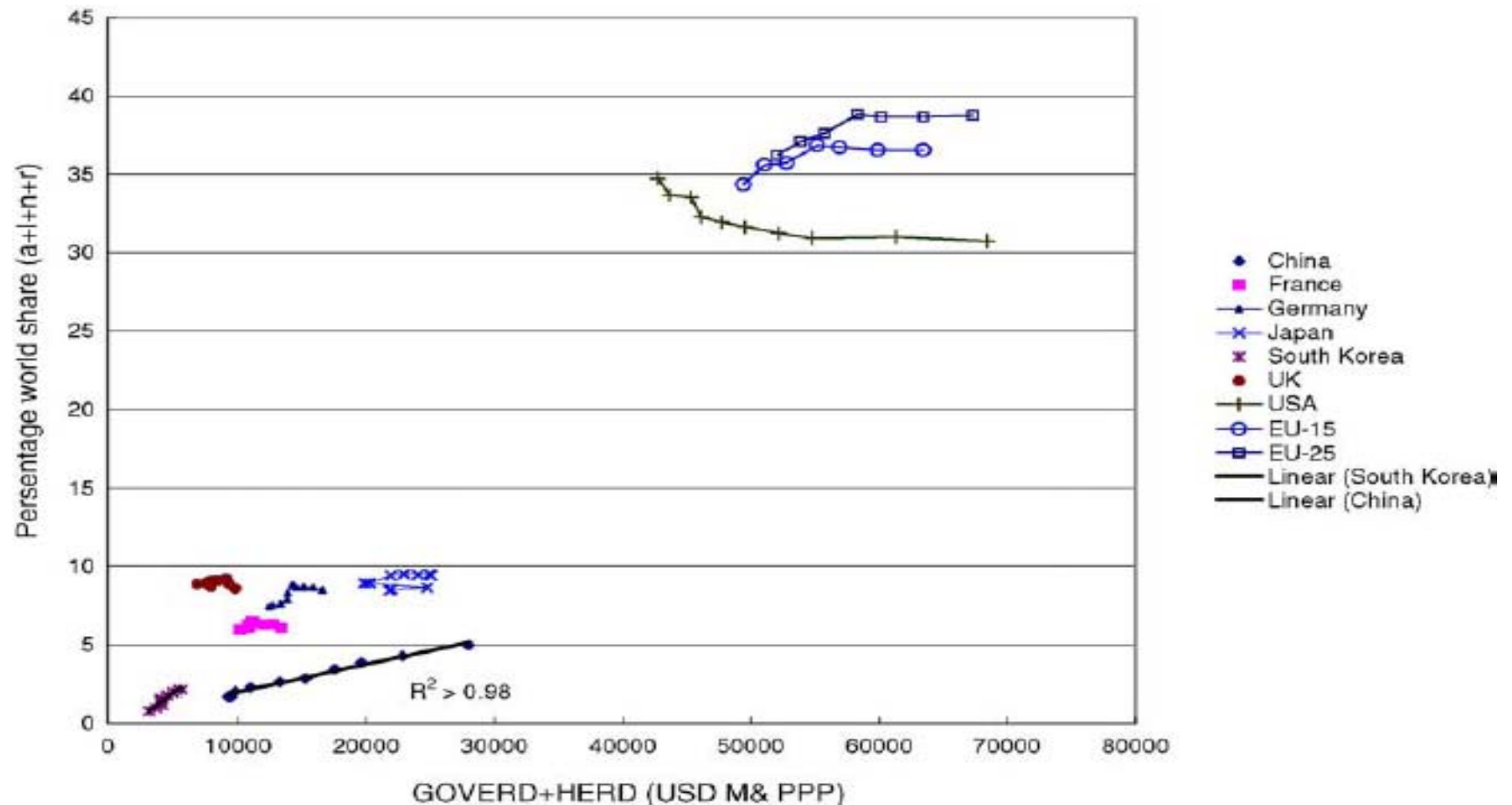
- **the National Steering Committee for Nanoscience and Technology created in 2000 , by MOST, the State Development and Planning Commission, the Ministry of Education, CAS, CAE, and the NSFC.**
- **The "National Guidelines to Nanotech Development" (2001-2010) was issued by the Committee.**
- **The "Development Framework for National Nanotechnology Research" by MOST in 2001.**  
**R&D of Nano in China will focus on**
  - ① **Core Tech. of nanoelectronics and nanobio.**
  - ② **Creation new functional materials and commercialization:**
- **Nanotech as a priority area in the " The 10th Five-Year Plan for S&T" and in "National Mid-Long Term Plan for Science and Technology (2006-2020), and "The 11th Five-Year Plan for S&T "**

# Important Events

- National Center for Nanoscience and Technology (NCNST) (founded 2003 in Beijing)
- National Center for Nanoengineering in Shanghai
- ChinaNANO (Beijing , June 9-11, 2005)

# Prospects

- With the continuing support, China's Nanotechnology research will achieve sustainable success, as a study indicates that China's output shows a linear relation with input.



# More to be done

- To achieve the sustainable success, China needs to
  - provide more qualified scientists and engineers on nanotechnology research and innovation,
  - encourage multidisciplinary researches in universities by reforming the university curriculum system,
  - solve the braindrain problems,
  - stimulate the nanotechnology research in industrial sectors
  - Promote the commercialization of research results.
  - and invest in studies of the possible negative impacts of nanotechnology research and innovation.

**Thank you for your attention!**

Liu Li