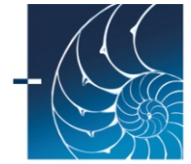


Science-Matrix

A Bibliometric Analysis of Nanotechnology R&D



Dataset

- Scientometric analysis:
 - Scopus Database
 - Coverage of 16,000 journals, 14 millions indexed papers and more than 60 millions references
 - Keyword query in titles, abstracts and author's keywords fields
- Technometric analysis:
 - USPTO Database
 - Coverage of 3.3 million granted patents
 - Keyword query in titles, abstracts and patent classes



Operational definition used to build query

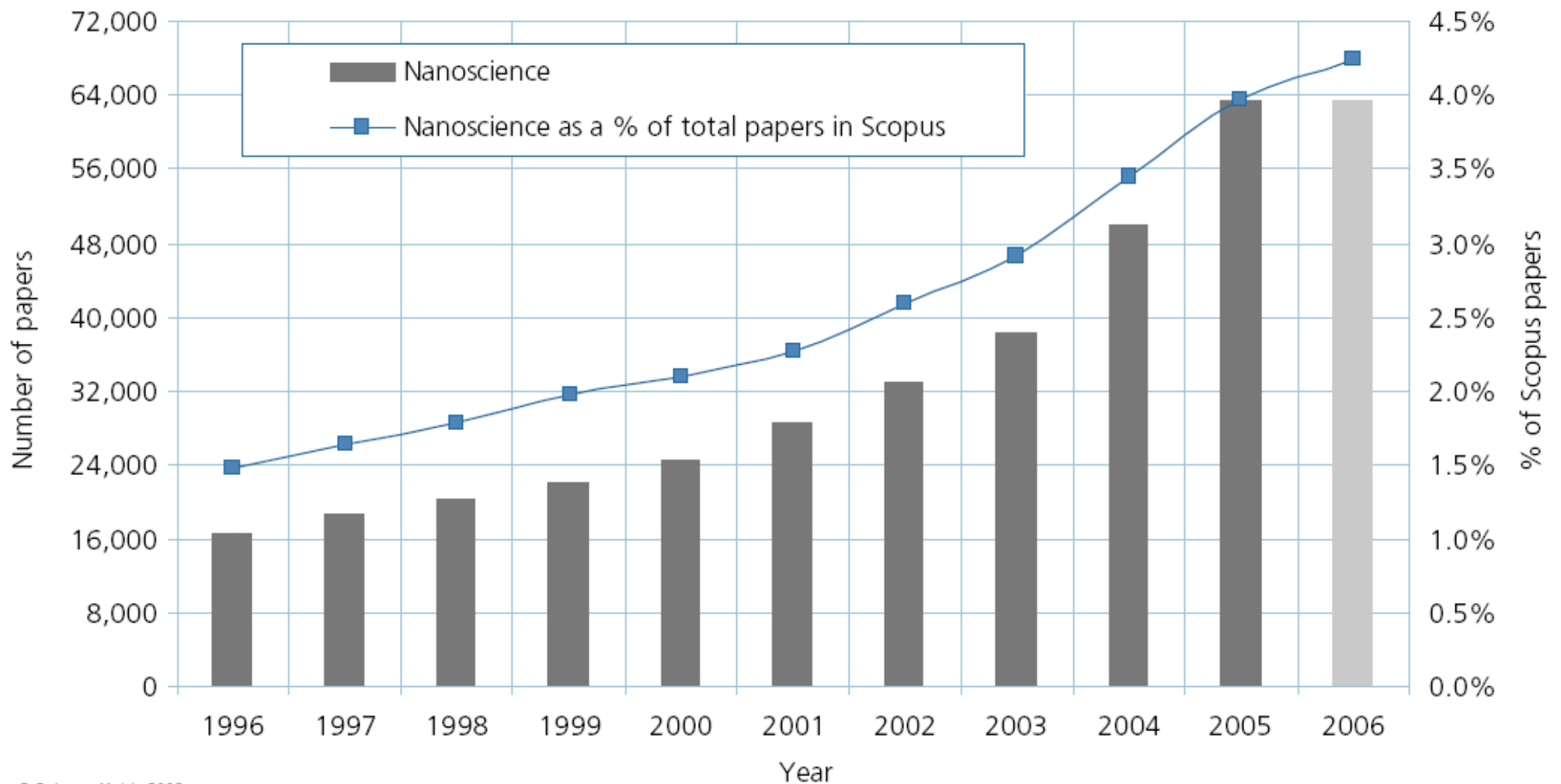
Nanoscale: Devices, processes and phenomena at the atomic, molecular or macromolecular levels, where feature size is between 1 and 100 nanometres, and where differentiating properties and functions are sought. In some cases, the critical-length scale for novel properties and phenomena may be under 1 nm (e.g., manipulation of atoms at ~0.1 nm) or larger than 100 nm (e.g., nanoparticle reinforced polymers have the unique feature at ~200 300 nm of being able to act as local bridges or bonds between the nano particles and the polymer).

Nanoscience: Scientific research at the nanoscale. Provides a fundamental understanding of phenomena and materials at the nanoscale.

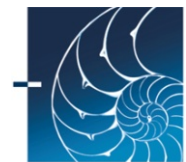
Nanotechnology: Research and commercial activities at the nanoscale. Creates and uses structures, devices, and systems that have novel properties and functions because of their small and/or intermediate size.



Nanoscience publications grew from 16k papers to 64k papers between 1996 and 2006 (1.5% to 4.25% of papers)



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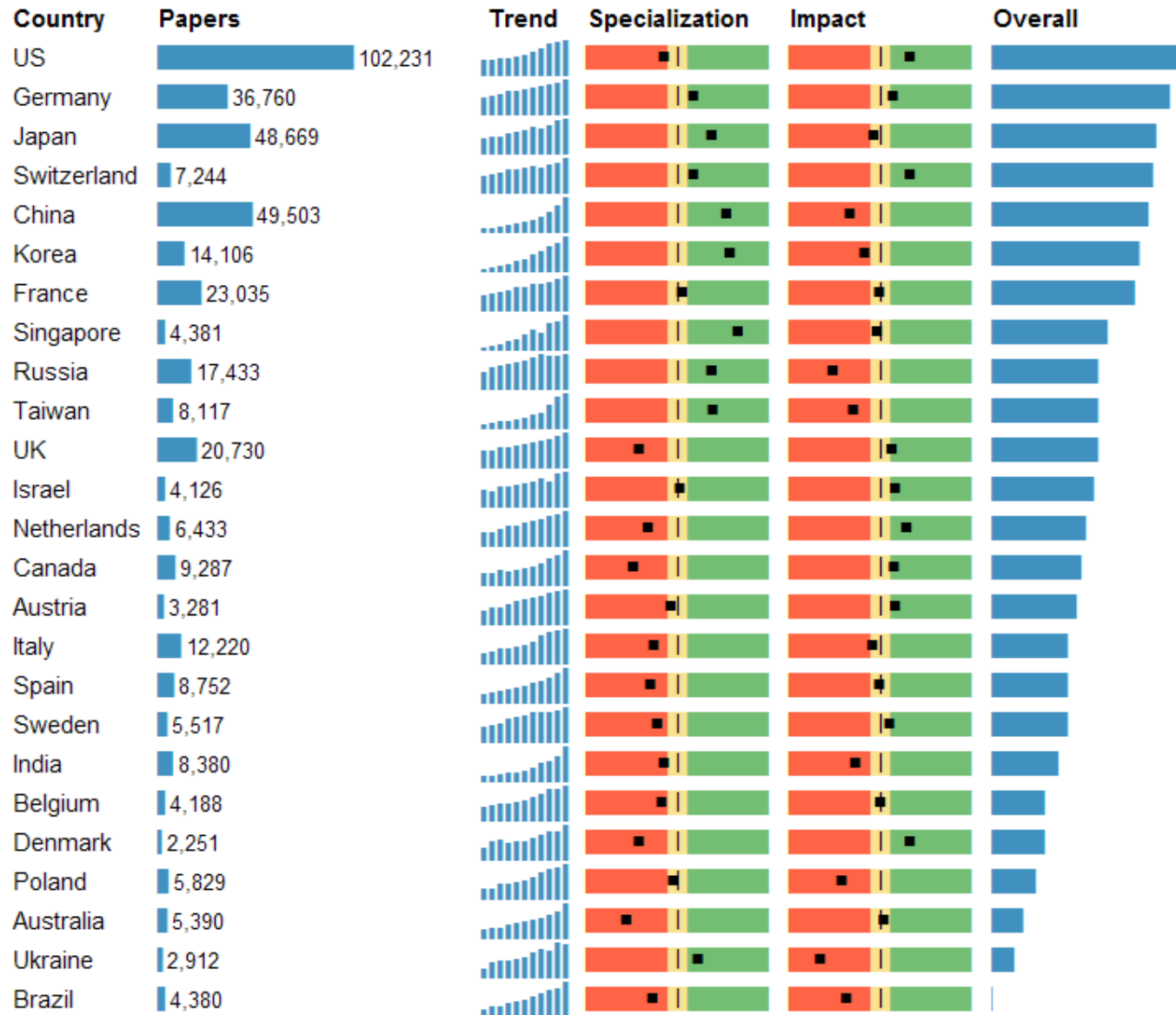
Growth is particularly fast in NEMS, Energy and Environment

Growth rate of the number of papers published in nanoscience domains, 1996-2006

Domain	Papers	Annual Growth	Doubling Time
NEMS	6,609	35.5%	2.3
Energy	11,963	31.1%	2.6
Environment	3,729	25.9%	3.0
Materials	223,836	21.8%	3.5
Medicine & Biology	58,963	20.7%	3.7
Metrology	2,660	15.5%	4.8
Optics & Photonics	104,992	14.5%	5.1
Electronics & Computing	99,879	12.8%	5.8
Nanotechnology	378,996	16.0%	4.7
World	14,086,635	3.9%	18.1

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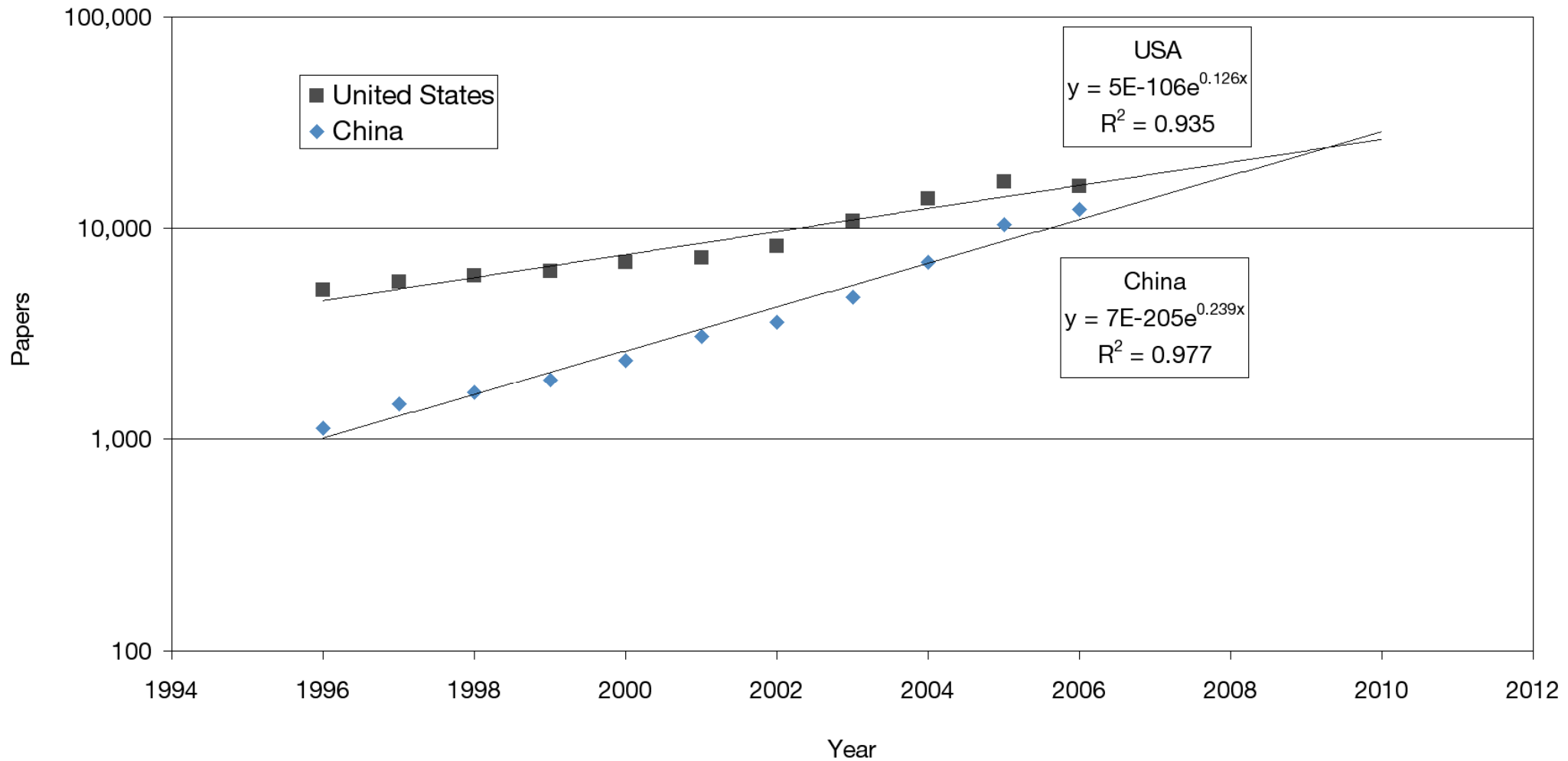
Nanoscience is dominated by the US, China, and Japan but Germany and Switzerland are also important when quality is factored in



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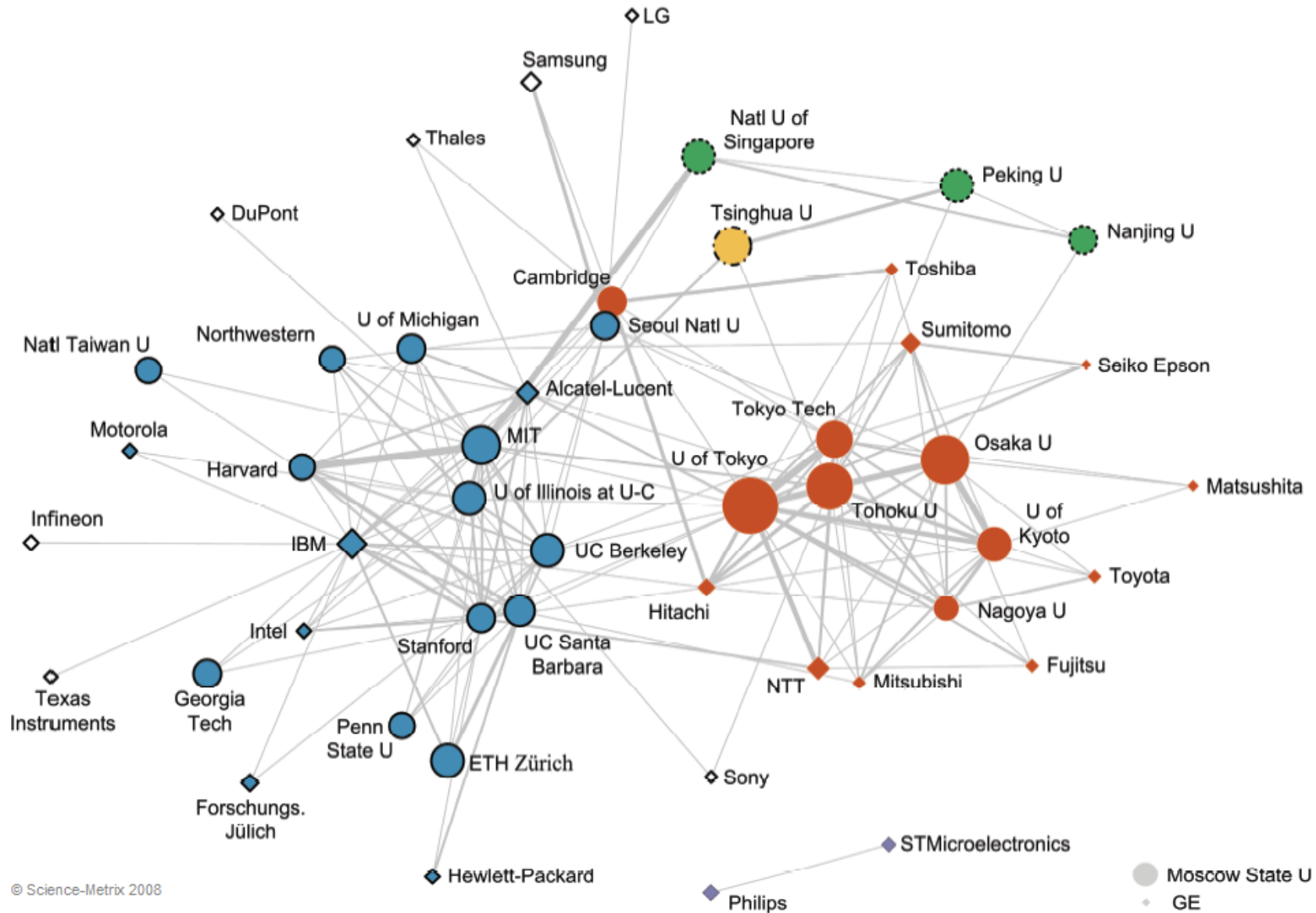


If observed trends persist, China will overtake the US in 2010 in nanoscience publications





Analysis of the collaboration network reveals that the largest nodes are mostly located in the US and Japan





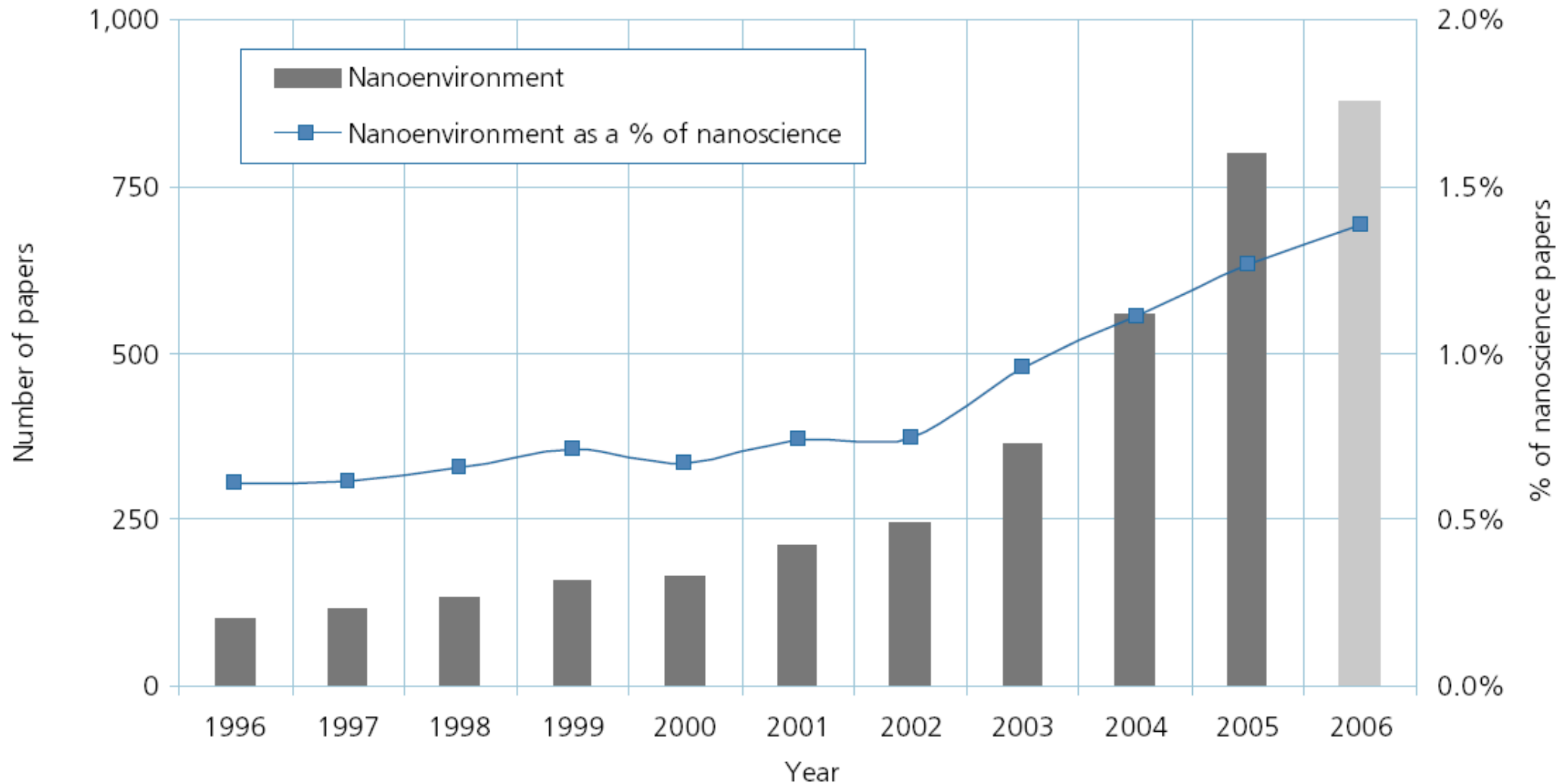
Within nanoscience, Asian universities tend to write a larger proportion of their papers in nanomaterials

University	Country	Papers	Specialization
Rice	US	835	1.33
Hanyang U	Korea	930	1.29
Zhejiang U	China	1,289	1.28
Shanghai Jiao Tong U	China	951	1.26
Natl Tsing Hua U	Taiwan	941	1.25
Nanjing U	China	1,610	1.25
Tsinghua U	China	2,223	1.22
Peking U	China	1,692	1.18
Georgia Tech	US	1,417	1.17
Indian Inst of Tech	India	1,181	1.15
Natl U of Singapore	Singapore	1,625	1.14
Fudan U	China	1,009	1.13
Penn State	US	1,285	1.12
Tohoku U	Japan	2,633	1.11
Jilin U	China	1,110	1.11
UC Davis	US	814	1.11
Moscow State U	Russia	1,307	1.10
Natl Chiao Tung U	Taiwan	783	1.09
U of Tsukuba	Japan	818	1.09
Seoul Natl U	Korea	1,315	1.06
Nanyang Tech U	Singapore	946	1.06
U of Texas Austin	US	1,031	1.04
U Pierre et Marie Curie	France	867	1.01
Northwestern	US	1,059	1.01

Source: Calculated by Science-Metrix using Scopus data

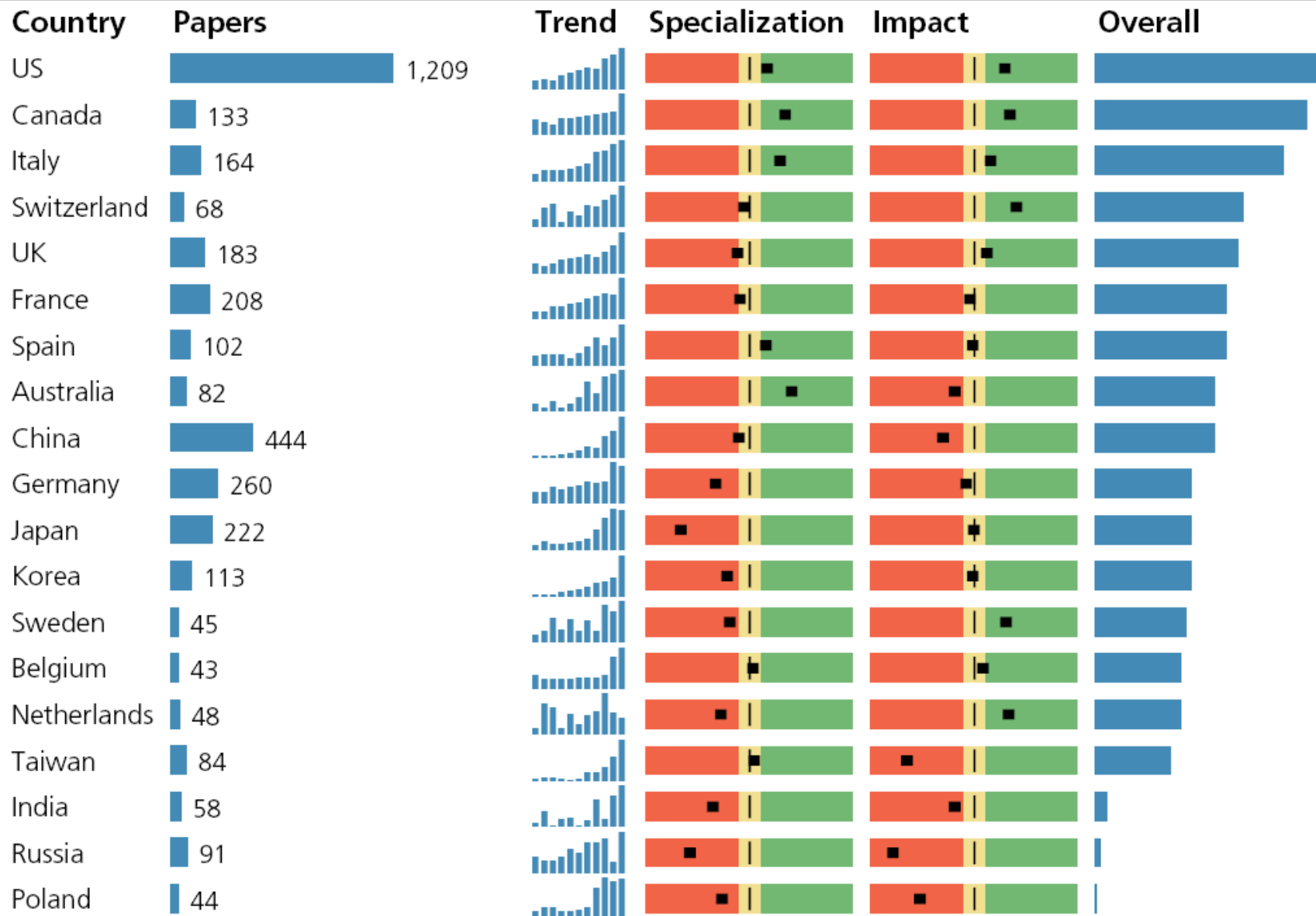


Nanoenvironment is the third fastest growing field within nanoscience



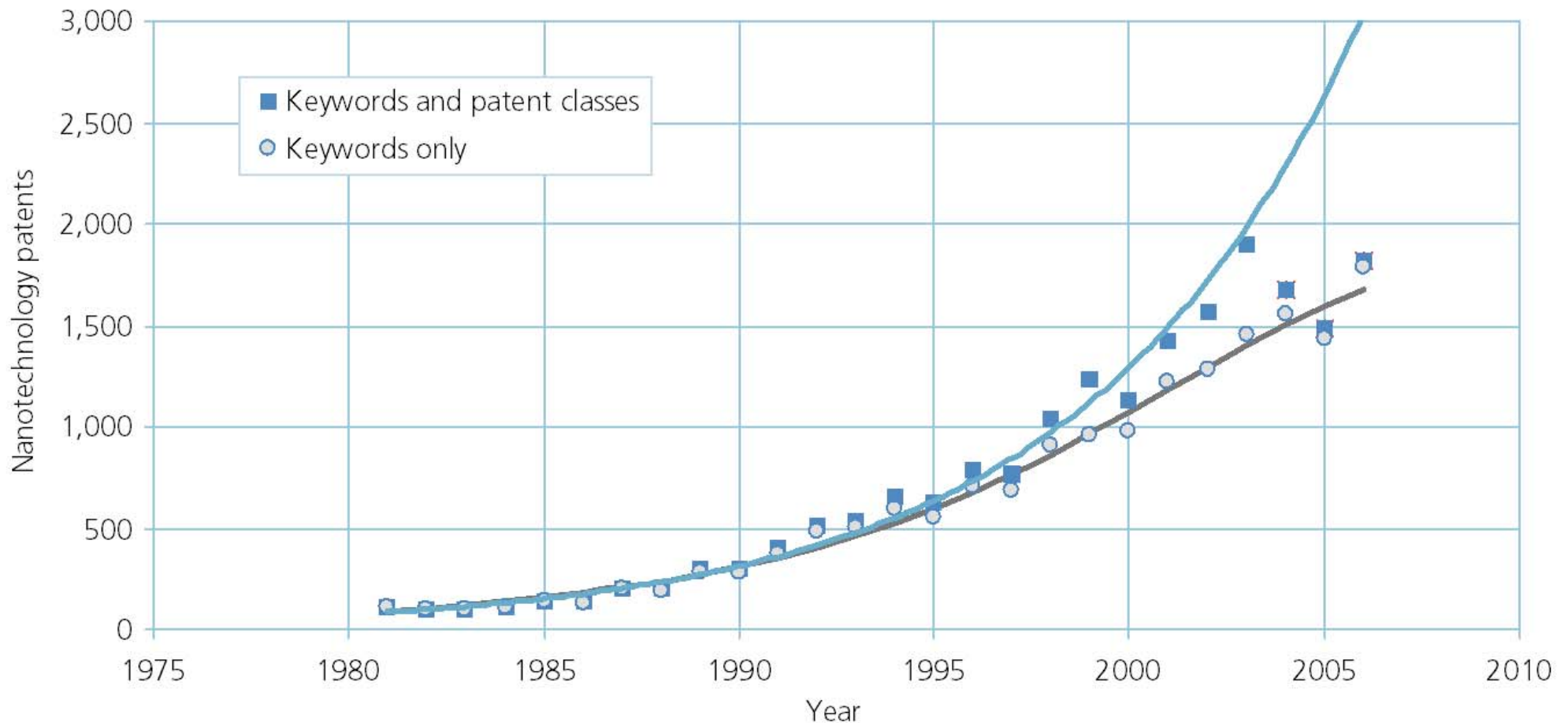


Nanoenvironment is a niche where the players are not the mainstream nanoscience players





Technometric Analysis – US patents granted in nanotechnology

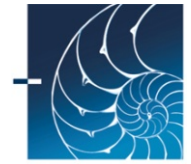




In contrast to scientific output, the # of patents granted is not growing fastest in nanoenergy - but nanoenvironment is quite fast

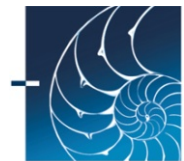
Domain	Granted Patents	Annual Growth	Intermodel Variation (\pm)*	Doubling Period (Years)
Materials	7132	17.0%	1.8	4.4
Electronics & Computing	5502	16.5%	0.8	4.5
NEMS	742	16.4%	1.2	4.6
Environment	143	14.1%	3.3	5.3
Metrology	2372	13.9%	2.4	5.3
Optics & Photonics	5800	13.9%	0.7	5.3
Energy	833	12.9%	0.5	5.7
Medicine & Biology	6950	12.3%	2.0	6.0
Nanotechnology	19,305	12.9%	1.1	5.7
USPTO	2,894,359	4.3%	0.4	16.3

* Note: Variation is in percentage-points.
Source: Calculated by Science-Metrix using USPTO data



Conclusions

- The field of nanoscale R&D has traditionally been dominated by the US
- China is rapidly becoming a central player, not only as a country, but many of its universities are increasingly in the top ranking institutions
- However, Chinese nanotechnology companies are nowhere to be seen
- Nanoenergy and nanoenvironment occupy a marginal place in the field but their growth is quite spectacular
- These fields are not typical – i.e., they are not dominated by the mainstream players at the country and institutional levels



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