Part One

National Nanotechnology Initiatives in Asia, Europe and the US

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Scientific Development and Industrial Application of Nanotechnology in China

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With the recent release of a five-year plan for the strategic development of nanotechnology in China, the People's Republic of China has set the pace in nanotechnology development. This chapter summarizes the current status of nanotechnology in China and policies that have been set in place.

1.1 Policy and Objective of Nanotechnology Development in China

In consultation with the National Development and Program Committee, the Ministry of Education, the Chinese Academy of Sciences and the National Natural Science Foundation Committee (NNSFC), in July 2001 the Ministry of Science and Technology issued a policy plan for a national nanotechnology development strategy for the period 2001 to 2010. This draft plan confirmed the general strategy and objective of nanotechnology development in China.

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1.1.1 General Strategy

According to the policy plan, the Chinese government is committed to continuously improve innovative capability, develop advanced technology, and finally attain industrial applications relevant to China's present status with a focus on national long-term development. With this plan the Chinese government also made clear that it will insist on its set principle that it will support what is beneficial to China, i.e. catching up with international development in general, while finding breakthroughs that can solve key problems in China. In basic research and advanced technology, exploration and innovation are emphasized; In applications, the development of nanomaterials is the main objective for the near future. The development of bionanotechnology and nanomedical technology is a main objective for the medium term, whereas the development of nanoelectronics and nanochips is a long-term objective. The draft emphasizes that developments in identified key areas need to be well coordinated across departments and disciplines, and a well-structured intellectual property portfolio has to be developed.

The tenth five-year plan emphasizes

- enhancing basic and applied research in nanotechnology;
- exploring possible technology applications depending on market requirement and in line with national development objectives, and promoting the industrialization of nanotechnology with a focus on mass production, education and research;
- establishing a nanotechnology centre and progressively forming an innovative national nanotechnology system.

The key tasks for nanotechnology development in China are

- to align R&D with market requirement;
- to accelerate multidisciplinary R&D and communication;
- to pay particular attention to intellectual property rights and to encourage combined fundamental and applied research, and to pay particular attention to intellectual property rights;
- to align innovation policy with nanotechnology development.

1.1.2 Research Objectives within the Tenth Five-Year Plan

Fundamental research into nanotechnology focuses on the basic principles of physical and chemical characteristics at the nanoscale with the purpose of finding new concepts and new theories. Examples are the development of innovative nanochips, new quantum configurations and new quantum domino effects. Further targets are the physical, chemical and biological characterization of materials at the nanoscale, and the characterization of single molecules and their interaction. The knowledge that will be acquired through fundamental research will provide the basis

for the development of advanced scientific theories for the design and manufacturing of new nanostructures, nanomaterials and nanochips based on atomic and molecular technology. The fundamental research is expected to explain phenomena and characteristics at the nanoscale. A further important part of the tenth five-year plan is the establishment of a corresponding nanotechnology database, a national standard for nanoscale, and processes for the industrialization of nanotechnology.

1.2 Application of Nanotechnology

1.2.1 Materials Processing

Nanotechnology is expected to enable environmentally friendly mass production at low cost. It is also expected that nanotechnology will prove to be useful in the development of light and strong materials, biomedical materials, pharmaceutical materials and multifunctional intelligent materials.

1.2.2 Nanochip Fabrication and Integration

Nanotechnology can produce stable and reproducible atomic manipulation plus spontaneous growth; it can deliver super high density memory technology plus integration and encapsulation in nanochip technology. The development of multifunctional nanochips with high integration would offer considerable improvements in speed performance, storage density and power consumption over present systems.

1.2.3 Nanochip Processing Methods

By combining top-down and bottom-up nanoprocessing technology, using microbeam processing and etching technology, and physical, chemical and biological methods of periodic nanopatterning, it is planned to develop nanoelectromechanical systems (NEMS) and optical signal processing systems as well as optoelectric devices.

1.3 Analysis and Characterization of Structure and Function

It is recognized that through scanning tunnelling microscopy and three-dimensional measurements, nanotechnology enables the characterization of single molecules and nanostructures as well as biochemical reactions in cells.

1.3.1 National Safety

Nanotechnology is expected to contribute to China's defence efficiency and capability through development of purpose-designed nanomaterials, functionalized

special-purpose materials, nanosensors, micro-engine technology, micro and nano aircraft, and special-purpose satellites.

1.3.2 Technology Transfer and Applications of Nanomaterials and Nanochips

Technology transfer and the application of nanotechnology is promoted through collaboration and amalgamation with advanced technologies and in combination with traditional technologies. During the tenth five-year plan, attention is focused on the development and application of nanotechnology in new materials, computer and information systems, energy, environment, medical, hygiene, biology, agriculture and traditional industry.

The tenth five-year plan has a particular focus on developing nanomaterials technology, which has a beneficial impact on national economics and safety. The research focus in nanostructure material is on the development of heat-resistant materials of high strength and light mass, which can be applied to space navigation and traffic. With respect to research into nanofunctional materials, it emphasizes on the exploitation, preparation and processing of innovative nanomaterials with application in information technology, communication, medical treatment, public health and environment. The abundant natural resources in China provide a basis for the development of innovative nanostructural and nanofunctional materials.

Further areas are the development of nanocatalysts, detergents and combustion-supporting agents for improving the efficiency of traditional energy sources; developing nanotechnology for air decontamination and water treatment; developing technology that can improve the usage of traditional energy sources by greatly decreasing unwanted combustion products. Research into possible negative environmental effects of nanotechnology are also included as well as programmes to enhance and encourage the application of nanotechnology in basic industries, such as chemical engineering, construction materials and the textile industry, to accelerate evaluation and transformation.

Further attention will be given to the speed-up of cross-disciplinary work and amalgamation of nanotechnology with biotechnology, biomedical engineering and traditional medical technology. The aims are to develop nanotechnology for biological detection, diagnosis, treatment and medication; to prepare highly efficient nanomedicine; to improve disease diagnostics and treatment; to develop technologies for better plant disease resistance, insect pest resistance and flexibility to the environment; and to enhance agricultural yield.

During the tenth five-year plan, the Chinese government will increase support for industrialization of nanotechnology, foster corporations with advanced technology, and build an industrial basis. Close collaboration between government, universities, research organizations and industry will be supported to bring scientists, technologists, administrators, industrialists and financiers together, as well as to integrate

technology, industrial capital and financial capital, and to combine industrial mechanism and risk investment mechanism to accelerate the industrialization of nanotechnology and economic growth through nanotechnology.

1.3.3 Building Basic Nanotechnology Centres and an R&D Base

According to China's internal competition principle, it is planned to select several national laboratories and related research bases from present laboratories and bases and give them strong support so that they may become the key laboratories for nanotechnology development in China. Here are two specific actions:

- Establish a national science research centre for nanotechnology with advanced instrumentation and state-of-the-art equipment to enable it to become the national pilot centre for nanotechnology, the designing and manufacturing centre for nanochip development, and an R&D centre for nanotechnology. The centre will collaborate with other national laboratories to form a larger network in China. The centre will be open and flexible to integrate excellent scientists from all over China, and to encourage a multidisciplinary environment.
- Establish a national engineering research centre for nanotechnology and its applications to accelerate the innovation of nanotechnology and its industrialization. This centre will combine manufacturing, teaching and research, development of intellectual property, and innovative technology and products, to form a good mechanism for R&D and industrialization. The centre is expected to establish a nanotechnology network, build a nanotechnology information desk, and accelerate the sharing of information sources. It is also expected to encourage corporations to participate in nanotechnology development, and to unite government departments to establish laboratories and engineering research centres.

1.4 Main Policy and Measures

1.4.1 Enhance Leadership and Coordination of Nanotechnology R&D

The central government established the Guidance and Coordination Committee of National Nanotechnology to oversee the national nanotechnology development and to guide and coordinate nanotechnology tasks. The committee consists of the National Plan Committee, the National Economic and Trading Committee, the Ministry of Education, Science and Technology Committee, the National Defense Committee, the Ministry of Finance, the Chinese Academy of Science, the Chinese Academy of Engineering, the National Scientific Foundation Committee and the Ministry of Liberation Army General Supply. The committee secretariat was appointed by the Ministry of Science and Technology.

1.4.2 Implementation of National Nanotechnology Initiatives

According to the task in the compendium, respective resources are to be amalgamaed in an effort to implement national nanotechnology initiatives as outlined in the tenth five-year plan, and to deploy and coordinate the development of nanotechnology nationally. Initiatives are overseen by the National Nanotechnology Committee, supported by the National Scientific Foundation Committee, the National Program for Basic Study and Development, the National Research Plan for Advanced Technology, the National Technology Plan for Solving Key Problems, and the Project of Innovating Knowledge and Education Development Plan Facing the 21st Century. The initiatives are then brought into effect by the respective government organizations and development agencies. Sufficient funding will be made available to support initiatives, human resources and management.

The Chinese government is committed to fostering nanotechnology development, to expediting the construction of national nanotechnology centres and bases, to furthering organization and implementation of basic studies into nanotechnology and innovative advanced technology, and to promoting and fostering individuals with excellent abilities. Respective departments and local governments are directed to confirm objectives and tasks on the basis of the task compendium, to support the implementation of national nanotechnology initiatives.

1.4.3 Encourage All Participants and Create Environmentally Beneficial Nanotechnology

As a first step within the larger initiatives, the National Science Research Center for Nanotechnology and the National Engineering Research Center for Nanotechnology and Application are being built in close collaboration with local government. A link between technology, commercialization and economic growth will help to encourage corporations to participate in the development of nanotechnology in the near future. The Chinese are whole-heartedly committed to supporting technology transfer of nanotechnology development and its industrialization through the frameworks of the National Torch Plan, the New Products Plan, the Technology Innovation Fund for Medium and Small Corporations, the Development Plan of Industries with Advanced Technologies, the Developing Economic Plan Based on Advanced Technology and the Technique Reconstruction Plan.

1.4.4 Foster Scientific Specialists and Technologists in Nanotechnology

As part of the initiatives, scientific specialists and technologists will be supported and international experts will be attracted to meet the demand of specialist researchers in all focus areas. The long-term support of human resources in nanotechnology is addressed by popularizing nanotechnology knowledge in primary and secondary schools to ensure that nanotechnology becomes widely understood. In addition, new nanotechnology disciplines will be created in schools plus new

nanotechnology-related courses in physics, chemistry, biology, mechanics, economics and computer sciences.

1.5 Status of Nanotechnology Research in China

Since the Compendium of National Nanotechnology was carried out, the Chinese government has focused on the study of nanomaterials and nanotechnology. National initiatives and local government initiatives invested funds through the National Technology Plan to Tackle Key Problems, programmes 863 and 973, to enable the development of competitive Chinese nanotechnology research publications of a large number of research achievements, and the development of intellectual property, which attracted wide international attention.

1.6 Distribution of Research Potential

1.6.1 Geographic Distribution

There are two main R&D centres for nanomaterials and nanotechnology in China, the northern centre and the southern centre.

The Northern Nanotechnology Research Center is located in Beijing and it includes the Nanotechnology Center and the Institutes of Chemistry, Physics, Metallurgy and Semiconductors within the Chinese Academy of Science, the Beijing Institute of Construction Materials Research, the Beijing Steel Chief Research Institute, Beijing University, Tsinghua University, Beijing Science and Technology University, Beijing Chemical Engineering University, Beijing Science and Engineering University, Beijing Normal University, Tianjing University, Nankai University and Jilin University.

The Southern Nanotechnology Research Center is located in Shanghai and it includes the Shanghai Jiaotong University, Huadong Science and Engineering University, Fudan University, Huadong Normal University, Tongji University, Chinese Science and Technology University, Zhejiang University, Nanjing University, Shandong University, the Institutes of Solid Physics, Metallurgy, Silicates, and Nuclear Science, and the Shanghai Technological Physics Institute within the Chinese Academy of Science.

Apart from these two main R&D centres, nanotechnology and nanomaterials research is also concentrated in the cities of Xian and Lanzhou in the north-west, Chengdu in the south-west and Wuhan in the south.

The geographic distribution of nanotechnology development indicates that the research potential in nanotechnology is spread all over China, but is mainly focused on the areas of Huadong and Huabei, which account for 80% of the overall distribution (Figure 1.1). The survey also indicates that the distribution of research potential seems to be concentrated very locally, but in fact it is spread over a much larger area. For example, the southern R&D centre is mainly located in Shanghai, but also spreads around the cities of Hefei, Nanjing, etc.

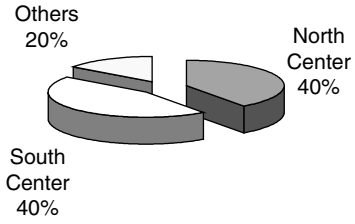

Figure 1.1 Geographic distribution

1.6.2 Human Resources Distribution

The research personnel undertaking nanomaterials and nanotechnology research are mainly located in universities and the Chinese Academy of Science (CAS), which account for over 90% of the overall research potential. There are also research personnel in industries pursuing nanotechnology development, but they account for only 5% and they focus on applications and processing of nanomaterials (Figure 1.2).

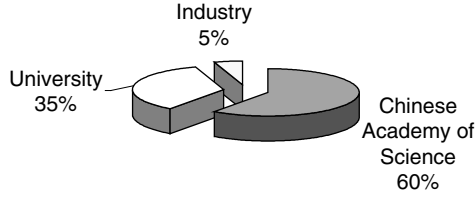

Figure 1.2 Organizational distribution

1.6.3 Personnel Structure

There are more than 4500 scientists in China undertaking R&D of nanomaterials and nanotechnology. Among those research workers, there are about 500 older scientists, 1800 middle-aged scientists and 2200 young scientists. They usually have good qualifications; more than 30% have a PhD technical position or higher, over 40% have a master's degree or mid-level technical position (Figures 1.3 and 1.4).

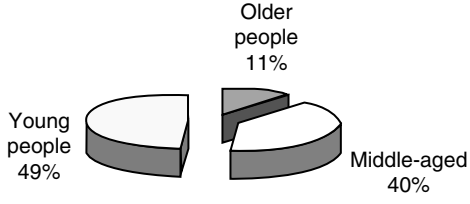

Figure 1.3 Age distribution

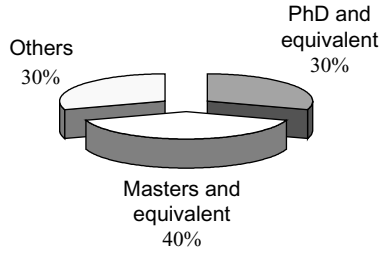

Figure 1.4 Qualifications

1.7 Important Groups and Main Achievements

1.7.1 Research Fields

The main research and development areas in nanoscience and nanotechnology in China are materials, chemistry, physics, information technology and life science. Nanomaterials is one of the most prominentl areas, representing over 50% of all present R&D efforts (Figure 1.5).

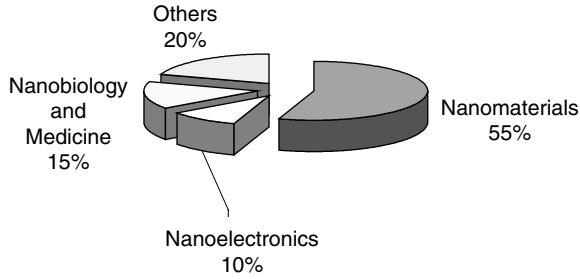

Figure 1.5 Research fields and distribution

1.7.2 Key Achievements in Nanotechnology

Most of the key achievements in nanoscience in China have been reported by the Chinese Academy of Science (CAS) and universities. Private companies plus CAS and university spin-outs are mainly engaged in applications of nanotechnology (e.g. optimizing surface characteristics) and the processing and manufacturing of nanomaterials. Hence most original R&D in nanotechnology in China is still done by CAS and key universities.

The most prominent achievements in Nanotechnology in China are

- oriented synthesis of large-area nanotube arrays;
- synthezising nano nitrogenized gallium using a benzene solvent;
- nanotube arrays on silicon substrates;
- one-dimensional nanowires and nanocables;

- nanodiamond powder using catalytic thermal decomposition;
- first discovery of a rich copper phase;
- functionalized organic nanomaterials.

1.7.3 Key Institutions in Nanotechnology

- Institute of Physics of CAS
- Institute of Solid Physics of CAS
- Shenyang Institute of Metal Research of CAS
- Institute of Chemistry of CAS
- Institute of Technological Physics of CAS
- Shanghai Institute of Silicate of CAS
- Benijing University
- Tsinghua University
- Fudan University
- Shanghai Jiaotong University
- Huadong Technology University
- Huadong Normal University
- Nanjing University
- Sichuan University

1.7.4 Sources of Nanotechnology Funding

Sources of nanotechnology funding are programmes 863 and 973, the National Technology Gong Guan Program and the Natural Science Foundation. There is some funding by industry as applied R&D.

A survey on recent nanotechnology funding (Figure 1.6) indicates that public and private funding for nanotechnology has increased steadily over past years, most of it

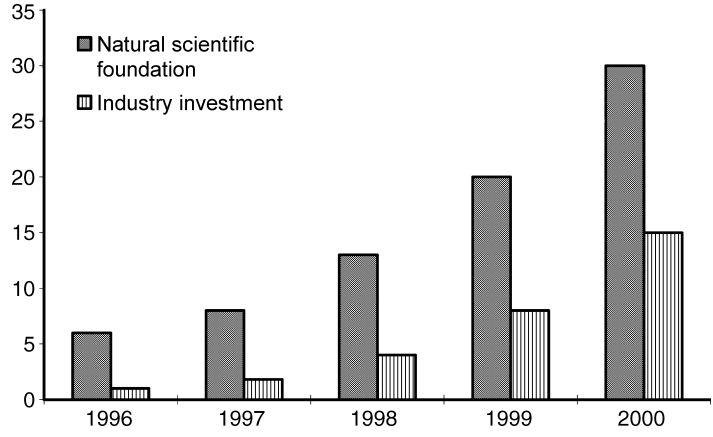

Figure 1.6 Normalized natural scientific foundation and industry investment: base reference of 1 unit is the industry investment in 1996

coming from the public sector. The survey also indicates that industry is paying increasingly more attention to nanotechnology. In 1996 industry investment in nanotechnology was only 15% of National Natural Science Foundation of China (NNSFC) investment but by 2000 it had increased to 50%. One can expect industry investment to outpace government investment some time before 2010.

During 1999 and 2000 there were at least 536 applications to government agencies for nanotechnology funding across six broad disciplines (Figure 1.7). A total of 80 million yuan was allocated to successful grant applications. About 50% of the applications were nanomaterials related, which reflects the general focus on nanomaterials at CAS and Chinese universities. Figure 1.8 shows the number of nanotechnology projects that actually received funding.

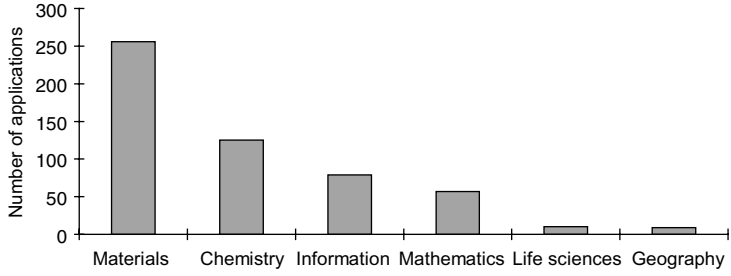

Figure 1.7 Nanotechnology funding applications over the period 1999–2000

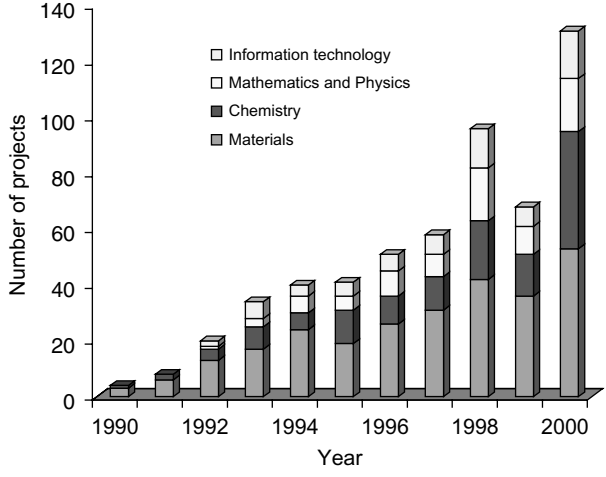

Figure 1.8 Number of nanotechnology projects actually funded

1.7.5 Related Governmental Organizations

To promote development of nanotechnology, national and local government set up corresponding organizations: the Guidance and Harmonization Committee of National Nanotechnology, the National Industrialization Base of Nanotechnology in Tianjing, the Shanghai Industrialization Base of Nanotechnology, the Jiangsu Application and Engineering Center for Nanomaterials, the Shandong Engineering Center of Nanotechnology, the National Industrialization Base of Biological and Medical Nanomaterials in Sichuan, the Jiangsu Engineering Center of Nanotechnology and the Shenyang Industry Park of Nanotechnology.

1.8 Status of Private Nanotechnology Companies in China

1.8.1 Geographic Distribution

Since 1995 some enterprisers have started to go into nanomaterials and nanotechnology. Up to May 2001 there were 323 private nanotechnology corporations in China, 3 billion yuan was devoted to them and three industry areas of nanomaterials and nanotechnology were formed based on Beijing (including Beijing, Tianjing and the north-east), Shanghai (including Shanghai, Zhejiang, Shandong, Jiangsu and Anhui) and Shenzhen (including Shenzhen, Guangzhou and Fujian). Figure 1.9 shows the distribution of private nanomaterials companies in China.

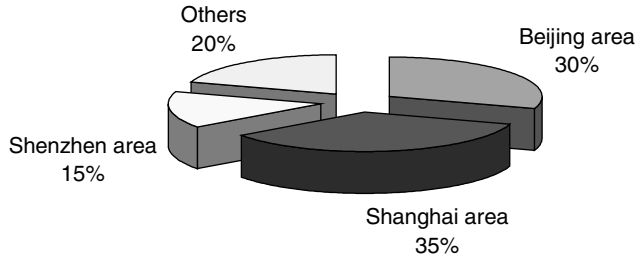

Figure 1.9 Distribution of private nanomaterials companies in China

Nanomaterials companies can be classified as application companies and manufacturing companies. There are about 200 application companies, 95% of them located in Beijing, Shanghai, Zhejiang, Jiangsu, Guangdong, Shandong and Anhui (Figure 1.10). There are about 30 manufacturing companies, about 15% of all nanotechnology companies in China, mainly locating in Shanghai, Zhejiang, Jiangsu, Guangdong and Shandong (Figure 1.11).

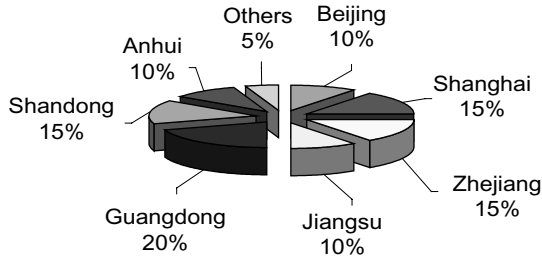

Figure 1.10 Geographic distribution of nanomaterials companies

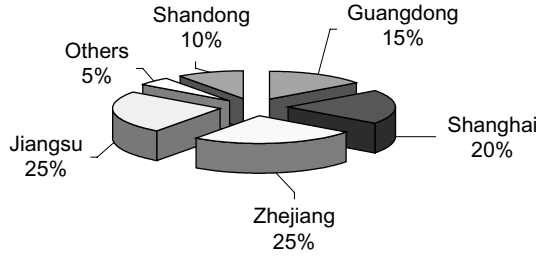

Figure 1.11 Geographic distribution of nanomaterials manufacturing companies

1.8.2 Statistics on Nanotechnology Companies

Figures 1.12 to 1.15 show the statistics (233 companies) on the foundation, ownership and staff numbers of Chinese nanomaterials companies; Figure 1.16 shows the statistics on total assets. At present there are 233 nanomaterials and nanotechnology companies, about half of them were founded after 1995 (Figure 1.12). The distribution of these companies is shown in Figure 1.13 (based on the characteristics), Figure 1.14 (based on the population) and Figure 1.15 (based on the research staff).

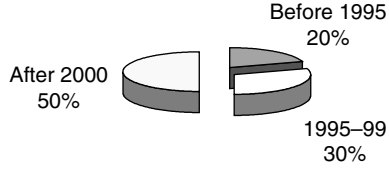

Figure 1.12 Date of foundation for nanomaterials companies in China

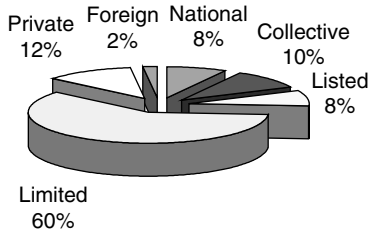

Figure 1.13 Ownership of nanomaterials companies

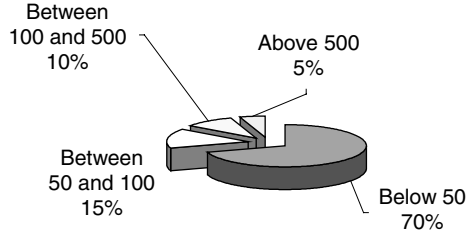

Figure 1.14 Staff numbers of nanomaterials companies

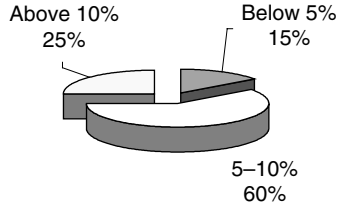

Figure 1.15 Research staff numbers of nanomaterials companies

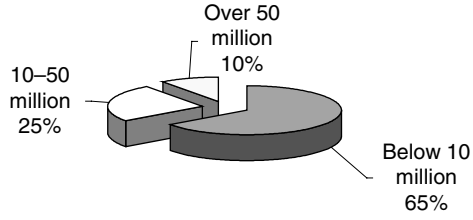

Figure 1.16 Total assets of nanotechnology companies

1.9 Industry Focus and Product Variety

1.9.1 Industry Focus and Product Maturity

Efforts to develop nanomaterials, nanoelectronics and nanomedicine vary across basic research, technology development, industrial manufacturing and market exploitation. The difference in effort is most prominent between basic research and market exploitation (Table 1.1). It is planned to narrow the gap between these two extremes.

Table 1.1 Maturity of key nanotechnology

	Basic study	Technology development	Industrial study	Market exploitation
Nanomaterials	○	○	○	○
Nanoelectronics	○	○	none	none
Nanomedicine	○	○	○	○

Nanotechnology product maturity has been categorized into products which are in pilot testing, batch production and bulk production. Figure 1.17 clearly shows a typical pattern of an emerging technology at an early stage. It is planned to even out this pattern in the near future.

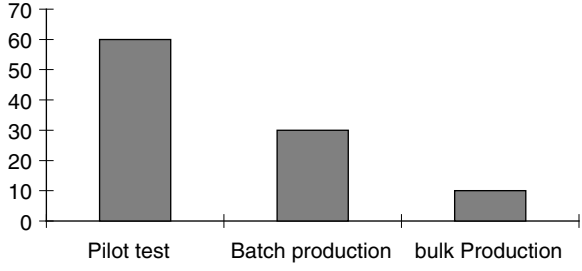

Figure 1.17 Maturity of nanoproducts

1.9.2 Variety and Applications of Nanoproducts

At present there are more than 30 product lines of nanomaterials in China, mostly nano-oxides, nanometal powders and nanocomplex powders. Nanomaterials are mainly designed for use in textiles, plastics, porcelains, lubricants and rubbers (Figure 1.18).

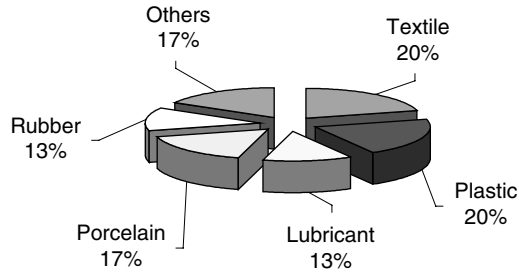

Figure 1.18 Current application areas for nanomaterials

1.10 Funding and Profit Output

Figure 1.19 shows funding and profit output for the whole country. It indicates that the introduced funding gradually increases in recent years, but the profit output increases more slowly than the introduced funding. Furthermore, it is possible that some output values are overestimated as the predicted output value has a direct relationship with the funding amount. A survey of 69 Chinese companies engaged in nanotechnology development showed that the majority of companies (60.8) have a capitalization of less than 30 million yuan. The survey included 13 companies from the Jinghu area, 5 from the South China area, 23 from the Huadong area, 10 from the Huabei area, and 14 from the Middle West area (Table 1.2).

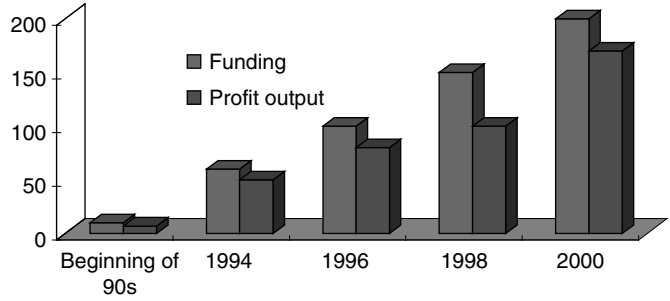

Figure 1.19 Funding input and profit output (million yuan)

Most of the companies with over 100 million yuan capital are those that use nanotechnology to reconstruct their traditional industries, for example, Zhuzhou Horniness Alloy Company (founded in 1954, total capital 1.086 billion yuan, net capital 0.408 billion yuan) and Jiangsu Shenji Corporation (founded in 1979, total capital 0.341 billion yuan, net capital 0.131 billion yuan). There are also some

Table 1.2 Capitalization of nanotechnology companies

Capital (10^6 yuan)	Jingho		South		Huadong		Dongbei		Huabei		Midwest		Totals			
	T	N	T	N	T	N	T	N	T	N	T	N	TC	%	NC	%
>100	0		0		3	1	1	1	1	1	1	1	6	8.7	4	6.8
50–100	2	1	1	1	2	1	0		3	2	1	1	9	13.0	6	10.2
30–50	2		0		7	3	0		2	1	1	1	12	17.4	5	8.5
10–30	2	3	3	2	4	5	1		0	1	3	2	13	18.8	13	22.0
5–10	2		0		3	3	2	2	1	3	6	6	14	20.3	14	23.7
<5	5	6	1	2	4	5	0		3	2	2	2	15	21.7	17	28.8
Total	**13**	10	**5**	5	**23**	18	**4**	3	**10**	10	**14**	13	**69**	100	59	100

Notes: T = number of companies (total capital), N = number of commpanies (net capital), TC = total capital, NC = net capital

nanotechnology companies founded in recent years, e.g. Nei Meng Gu Meng Xi Advanced New Materials (listed company, founded in 1999, total capital 0.606 billion yuan, net capital 0.216 billion yuan) and Hei Long Jiang Zhong Chao Nanotechnology (listed company, total capital 0.104 billion yuan).

There are quite a few small companies with less than 5 million yuan capital, which take up 20% of all companies. Most of them were founded over the past two years. They either develop a technology or a product in collaboration with research institutes. Examples of such collaborations are the Shanghai Aijian Nanotechnology Development Corporation (founded in 2000, total capital 1.94 million yuan, net capital is 1.11 million yuan), which collaborates with the Atomic Energy Institute of the Chinese Academy of Science; the Beijing Eryuan Century Technology Corporation (founded in 2001, total capital 2.1 million yuan, net capital 2.1 million yuan), which collaborates with the Institute of Chemistry; and the Changsha Zhongda Tena Technology Corporation (founded in 2001, total capital 0.483 million yuan, net capital 0.473 million yuan), which collaborates with the Powder Metallurgy Institute of Zhongnan University. Other small companies received funding support through the Innovation Funding scheme such as the Beijing Luborui Lubrication Technology Corporation (total capital 1 million yuan), which received 0.55 million yuan through the fourth Zhongbo Industry Technology Innovation Fund in 2000.

Most surveyed nanotechnology companies (two-thirds out of 69) preferred not to report data on their total and net capital and/or their previous revenue and net profit. However, when asked about future net income expectations, many companies reported an optimistic outlook. Although some of the data in Table 1.3 is still overestimated, these figures at least reflect a general trend in growth of nanotechnology companies.

From Table 1.3 it can be concluded that during 2000 and 2001 most nanotechnology companies gained less than 50 million yuan, i.e. 51.85% of the total number of companies in 1999 and 42.22% in 2000. Some companies reported very small

Table 1.3 Financial performance of nanotechnology companies

Capital (million yuan)	1999		2000		2001	
	Number of companies (income)	Number of companies (net profit)	Number of companies (income)	Number of companies (net profit)	Number of companies (income)	Number of companies (net profit)
Over 100	4		5		4	
50–100	2		3		4	
30–50			1	2	6	2
10–30	5	4	11	2	10	4
5–10	2	1	6		5	4
1–5	8	4	12	11	13	18
Less than 1	6	10	6	13		14
Debt		5	1	5		
Total	**27**	**21**	**45**	**33**	**42**	**42**

profits of less than 1 million yuan, i.e. 47.62% in 1999, and 39.39% in 2000. In 1999 23.81% of the surveyed companies reported debts, and in 2000 only 15.15% reported a negative profit.

Most of the companies with over 10 million yuan profit in 1999 and 2000 are working in traditional industries, such as Taian Kangping Floss Textile Corporation, Jiangsu Sujing Corporation, Jiangsu Changtai Chemical Engineering Corporation, Xiamen Tungsten (listed company) and Zhuzhou Horniness Alloy Company. The reported profits did not, however, come from the introduction of nanotechnology products. Two corporations which produce calcium carbonate nanopowder (Guangping Chemical Engineering Corporation and Nei Meng Gu Meng Xi Advanced New Material Corporation) used this technology to reconstruct their traditional business into a nanomaterials-focused business.

Data: Ministry of Science & Technology, P.R. China