Study of R&D Progress of CNTs in Japan: Viewpoints of Nanotechnology Boom and Risk Perception

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Abstract

The Japanese government was given a big impact by the Clinton's speech and started to give a large fund to R&D of nanotechnology. The carbon nanotubes(CNTs) found by Iijima was located in the core of the nanotechnology in Japan. In this study, the progress of R&D of the CNTs in Japan was investigated from the viewpoints of the nanotechnology boom and risk perception and the recent stagnation of the R&D was discussed.

Keywords: Carbon nanotubes (CNTs), Nanotechnology, Rsik perception, Standardization, R&D

Introduction

The President Clinton's public speech on the National Nanotechnology Initiative (NNI) in Jan. 2000 gave a big impact to the Japanese government because the industrial development had remained sluggish in Japan for an extended period. Following USA, the Japanese government was committed to providing strong support for nanotechnology research based on the Second Science and Technology Basic Plan(2001-2005)(STBP). In this study, the progress of the R&D of the CNTs put in the core of nanotechnology at the beginning was analyzed based upon the articles and the US patents of the CNTs and was discussed from the viewpoints of nanotechnology boom and risk perception of the CNTs .

How did nanotechnology start in Japan?

It was difficult for Japanese citizens to understand the content of the Clinton's speech reported through televisions, but they had an impression that the USA government was willing to lead the developed countries by the newly emerging technology of the 21st century. Following USA, the budget for R&D on nanotechnology was provided to expect technological innovations in future. The Council for Science and Technology Policy(CSTP) exemplified the fields such as nano-devices & materials for IT systems, materials for the environment & energy-saving, biotechnology,*et al*. (1). The CSTP attempted to promote interdisciplinary, interorganizational and intenational collaboration of researchers because it was accepted in Europe and America that nanotechnology has aimed originally for systematic approaches to create revolutionary new products and technologies by control of matter at the nano-scale (2).

On the other hand, nanotechnology means mainly the nano-scale engineering in Japan and it was called as a hyperfine processing technology. Any controversies on the concept of nanotechnology have been scarcely occurred at least inside the academic societies of Japan.

The CNTs was located in the core of nanotechnology of Japan

Nanotechnology has been welcomed as the forerunner of the third industrial revolution in Japan. Iijima S found the CNTs by observation with an electron microscope in 1991. The CNTs scientisits started to study as the Japan-born nanotechnology and some projects of the CNTs have been started up in the 2nd Plan (STBP) with great expectation of innovation in the electronics and energy fields.

The mass media played up the future possibilities of the CNTs, which the scientists advertised by using metaphors, resulting in the boom of the nanotechnology. Figure 1 shows the

hit numbers for the CNTs in the Asahi Newspaper of a general newspaper and the Nikkei Newspaper of an economic newspaper. The peak was observed around 2002. The research science of the CNTs has been activated since 1992, as shown in Fig.2 which shows the change of article numbers for the CNTs with year, according to Web of Science. Figure 3 shows the progress of the patents on the CNTs applied for the USA patent office. The article numbers of the CNTs were increased favorably until 2002, following USA, and the patent numbers increased particularly from 1998 to 2001. That is, the research science and the R&D for the CNTs seemed to move forward. The sport goods such as golf patters were highlighted in the market, in which it was advertised that the nanotechnology hardened more the materials by mixing the CNTs.

The CNT boom was declined.

The boom of nanotechnology was passing and the mass media came to paid scarcely attention to the CNTs after 2004 because a variety of products expected in the fields such as the energy-saving and nano-devices, arosed hardly on the market. While the article numbers and patent numbers for the CNTs in USA increased steeply after 2000 and the rise of the article numbers in China was marked after 2001, those of Japan tended to be stationary after 2001, as shown in Fig.2 and Fig.3[*1]. The quality of the articles of the CNTs was examined by dividing three periods, as shown in Table 1. Here, the number of articles among the top-hundred citation numbers was considered to correspond to the quality of the research science. The quality of the articles of USA was prominent compared with those of Japan and China from 1992 to 2006. Accordingly, it was clear that that of Japan was declined with time.Table 2 shows the quality of the articles in three fields of transistor, storage of hydrogen, and nano-wire by using the CNTs. In Japan, the research science seemed to be specialized to transistors which Japanese electronics companies have developed since the Second World War. This was consistent with our investigations of the USA patents. On the other hand, the scientists of USA and China have tried to develop actively storage of hydrogen and nano-wire.

Our interviews to the top-scientists of the CNTs in Japanese academy circle indicated that they was concentrating in the application of the CNTs under heavy pressure, as the Japanese government wanted the results from the short-term viewpoint, but they wished really to engage in basic study of the CNTs. According to NBCI which is one of Japanese nanotechnology industry associations, the mass production of the pure CNTs and the manufacture of the single-walled CNTs were proceed favourably by chemical companies.

How were the possible risks of the CNTs accepted in Japan?

With the highlight of possible benefits that nanotechnology promises, possible risks have been drawn attention. Such recent debates within the UK have been articulated by the Royal Society and Royal Academy of Engineering, which were commissioned by the UK Government in June 2003 and published in July 2004(3). Accordingly, the Japanese government came to think that efforts for societal implications of nanotechnology were important to push the R&D of nanotechnology. Several workshops on implications of nanotechnology for human health, environments and society were hold with misgiving of larger asbestos damage and the research project on risk assessment of nanomaterials was started by National Institute for Environmental Study. However, according to NBCI, the manufactur of CNTs in Japan have scarcely been affected by possible risks of nanopartcles.

As nanotechnology shifted from science stage to engineering stage and nanomaterials grew up from the laboratory to market, the necessity of standardization has come to be recognized strongly. Corresponding to the 229th technical committee for nanotechnology in May 2005, the Mirror Committee in Japan was launched in August 2005 and the 2nd meeting of TC229 in June 2005 in Tokyo. This is manifestation of the strong will of the Japanese industry. To propose the draft of measurement and characterization of nanocarbon for ISO/TC229 and Japanese Industrial Standards (JIS), the nanocarbon manufacture companies, nanocarbon users, academia, the related administration launched "NanoCarbon Standardization Committee" in August 2006. In fact, such strong will of the manufacture companies moved the Japanese government to the standardization. However, it is unclear at that present time whether the standardization pushes the R&D of the CNTs or not.

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Conclusion

The stagnation of research science and R&D for the CNT after the boom was observed in Japan, though the budget of the nanotechnology tended to increase from 85 billion yen to 97 billion yen (2001-2005), corresponding nearly to that of USA. The recent sluggish tendency seemed to reflect the following situation. In USA, the original essence of nanotechnology has been accepted to be the ability to work at the atomic, molecular and macromolecular levels in order to create materials, devices and systems with fundamentally new properties and functions(2). However, the researchers and the Japanese government have noticed not this essence, but nano-size engineering. Consequently, interdisciplinary and interorganizational collaborations of researchers have not been yet constructed.

[*1]: The numbers in 2003 will increase hereafter with increase of registrations.

Refernces

(1)T.Kishi, J. Nanoparticle Research,6, 547-554(2004)

(2)M.C.Roco, J. Nanoparticle Research 3: 5-11, 2001.

(3)Nanotechnology, edited by G.Hunt and M. Metha, Earthscan,2006.

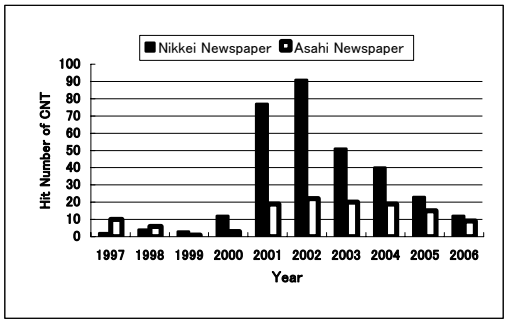

Fig.1 Change of hit numbers of CNT in Asahi and Nikkei newspapers

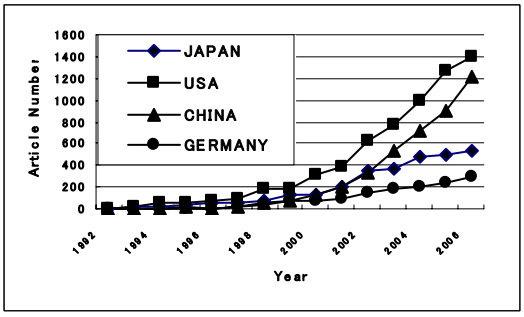

Fig.2 Plots of numbers of articles for CNT against published year

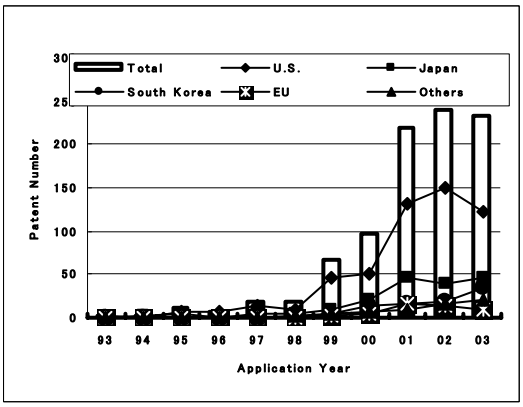

Fig. 3 Progress of patents on CNT applied for US patent office

Table 1 The numbers of the articles among the top-hundred citations of the CNT

	1992-1996	1997-2001	2002-2006
Japan	33	15	6
USA	51	31	72
China	2	3	8

Table 2 The numbers of the articles among the top-hundred citations of the transitor, nanowire, and storage of hydrogen with the CNT

Transistor and CNT		
	1997–2001	2002–2006
Japan	8	14
USA	21	61
China	0	2
Nanowire and CNT		
	1997–2001	2002–2006
Japan	8	6
USA	30	55
China	29	33
Storage of Hydrogen and CNT		
	1997–2001	2002–2006
Japan	21	16
USA	41	38
China	9	13

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