

Putting the Carbon Nanotubes to Use as the Industrial Materials

---Recent Progress in Development of Mass Production Method of Single Wall Carbon Nanotube and Development of Their Application in Japan.

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Single Walled Carbon Nanotube (SWCNT) Mass Production :

Industrial mass production technology is being developed based on highly efficient "Super-Growth" (i.e. water-assisted chemical vapor deposition) method [1] by combining large area with continuous process. On February 2011, a pilot plant of this method which is capable of producing 0.6 kg of SWCNT per day was established (in AIST) with Nihon Zeon Corp. On May 2014, Nihon Zeon Corp. started construction of commercial plant. Improvement of eDIPS (enhanced Direct Injection Pyrolytic Synthesis) method [2] was developed to control diameter of highly crystalline SWCNTs. As a result, the development of super-growth and eDIPS methods for mass production with low cost will promote the development of the industrial use of SWCNTs in the near future.

Development of SWCNT Application:

In 2010, the "Innovative Carbon Nanotubes and Their Applications Project" was begun which aims to develop applications utilizing the excellent properties of carbon nanotubes. We aimed to develop innovative applications of SWCNTs synthesized by Super-Growth method and eDIPS methods, and to build up methods of separating [3] and dispersing SWCNTs. In addition, we assessed the safety and the management of nanotube materials [4]. Moreover, we promoted R&D on ultra-light, super-strength, high-performance materials for application development through establishing a new industry on Carbon Nanotube (CNT) composite materials. In 2014, "Nano-carbon Application Project towards Low-carbon Society" project has been began to make further development of outcomes of "Innovative Carbon Nanotubes and Their Applications Project"

[1] K. Hata, D.Futaba et al., *Science*. 306, pp.1362 (2004)

[2] T. Saito et al., *Journal of Nanoscience and Nanotechnology*, vol.8, pp.6153 (2008)

[3] H. Kataura et al., *Nano Lett.* 9 pp.1497 (2009).

[4] J. Nakanishi et al., *Executive Summaries of Interim Reports on Risk Assessments of Three Manufactured Nanomaterials , Carbon Nanotubes (CNTs)* (issued on October 16, 2009)