

## **Growth, mass production, functions and applications of carbon nanotubes in the era of large scale production**

M. Endo

*Faculty of Engineering, Shinshu University, 4-17-1 Wakasato, Nagano-shi 380-8553, Japan*

The nano-sized one-dimensional carbon nanotubes consisting of rolled graphene layer built from  $sp^2$  units have attracted the imagination of scientists as one-dimensional macromolecules due to their unique physical and chemical properties and expected applications ranging from nanocomposite, nano-electronic device to bio and medical sensor. A large quantity of carbon nanotubes (100 ton/year) is available, because they are industrially produced in a semi-continuous system through a combination of the catalytic chemical vapor deposition method and the subsequent high-temperature thermal treatment in argon [1, 2].

In this talk, we will describe the current status of their bulk synthesis from the viewpoint of industry. Then, high purity and crystalline coaxial tubes will be described [3] because these tubes are thermally and structurally stable, and also contain small-sized tubes (below 2 nm). Among the recent applications of carbon nanotubes, their electronic, structural and bio-medical applications [4] will be described. Finally, the recent hot topic on the safety issue of carbon nanotubes will be discussed based on systematically studied biological responses of carbon nanotubes [5]. We envisage that carbon nanotubes will strengthen their viabilities by commercializing nanotube-related products in numerous fields soon.

- [1] A. Oberlin, M. Endo et al., *J. Crys. Grow.* **32**, 335 (1976).
- [2] M. Endo, *Chem. Tech.* 568 (1988).
- [3] M. Endo et al., *Nature* **433**, 476 (2005).
- [4] M. Endo et al., *Nano Lett.* **5**, 101 (2005).
- [5] S. Koyama, M. Endo et al., *Carbon* **44**, 1079 (2006).