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The Robert R. McCormick School
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Northwestern University
Evanston, IL 60208

THE 2008 DOW LECTURE

in

MATERIALS SCIENCE AND ENGINEERING

Carbon Nanotubes: Synthesis, Modification and Characterizations

Professor Sumio Iijima
Research Center for Advanced Carbon Materials (AIST),
Meijo University and NEC Corporation

Tuesday, January 22, 2008

4:00 PM

Room L211
The McCormick Technological Institute
Northwestern University

Reception, 5:15 PM
Cook Atrium

Sumio Iijima, often cited as the discoverer of carbon nanotubes, has been a professor at Meijo University, Nagoya, Japan since 1999. He was appointed as director of the Research Center for Advanced Carbon Materials at AIST in Japan and also partly works as a Special Research Fellow at NEC. After graduating from Tohoku University, he moved to Arizona State University where he developed high-resolution transmission electron microscopy (HRTEM) (1970-1982), which is a basis of the current TEM method. In 1982 he returned to Japan and worked for 5 years on the Japanese government research project (ERATO) on nano-particles. He joined the NEC fundamental research laboratories in 1987. In 1991 he discovered carbon nanotubes, which have initiated nano-materials science and nanotechnology. The discovery earned him numerous awards, prizes and honorary titles including the 2001 Franklin Medal in physics, the Agilent Europhysics award, the APS McGroddy prize, the Imperial Prize, the Japan Academy Prize and the title of Person of Cultural Merits (2002). In 2007, he was awarded the Aminoff Prize (Sweden) and the Balzan Prize (Italy and Switzerland). He was also elected as the foreign associate of the National Academy of Science (USA).

Abstract

Carbon Nanotubes: Synthesis, Modification and Characterizations

Unique properties of CNTs depend on their structures and morphologies, and well-controlled specimens (diameter, length, quantity, chirality, structural perfection, impurity, homogeneity) will be needed for precise and reliable experiments. It is also required for their industrial applications. Regarding the production of well-controlled single-wall carbon nanotubes (SWCNT), two important breakthroughs in SWCNT growth were made in our group at AIST (1). One is a direct injection pyrolytic synthesis (DIPS) method, which can provide controlled tube diameters and extremely high purity tubes on the industrial scale production. Some of the industrial use of the product is for transparent and flexible conductive films, thin film transistors, SWCNT threads and sheets. Another is the “Super-Growth” of SWCNTs, which grow vertically on various substrates including *metal foils* of “A4 size”. Thus produced substantially cheap SWCNTs are used for *high power density capacitors*. For characterization of the SWCNTs, Raman spectroscopy of radial breathing mode (RBM) is a standard method. Another spectroscopic characterization of SWCNTs is *two-D mapping* of photoluminessence, particularly for semiconducting tubes that can be specified in terms of band gaps. The method has been applied to study the band-gap modulation of SWCNTs mostly due to stress, which is induced by doping various molecules inside the central hollows of the tubes.

The importance of characterization of nano-structured materials will be demonstrated by showing the latest results of atomic structures of CNTs and their related structures, which have been revealed by an ultra-high resolution TEM with a spherical aberration corrector. *Individual carbon atoms, local atomic defects* of SWCNTs and individual fullerene molecules were directly recorded. Dynamic behaviors of those atoms and defects as well as doped metal atoms and organic molecules inside the tubes are of interest in terms of a sophisticated device application of CNTs (2).

The talk will cover some applications of nano-biotechnology such as drug delivery system in which we used single wall-carbon “nanohorns” as a drug carrier(3).