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Novel Functions in Double Walled Carbon Nanotubes

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Nano-sized carbon nanotubes with hollow core were observed when hydrocarbons were catalytically decomposed in the existence of nano-sized catalyst such as iron at higher temperature. Up to now, this catalytic chemical vapor deposition (CCVD) method has been utilized as the most powerful technique for the selective and large-scale production of carbon nanotubes. Since large amount of multi-walled carbon nanotubes (up to 250 ton/year) are available, much efforts has intensified on the development of their industrial usages. A recent hot topic has focused on the synthesis of double walled carbon nanotubes (DWNTs) because these tubes are more thermally and chemically stable when compared to single wall carbon nanotubes (SWNTs); they also exhibiting the 1D character of a quantum wire. In addition, DWNTs could also be used in the fabrication of electron field emitter and nano-composites. Very recently, we have successfully prepared highly pure and crystalline DWNTs by the combination of the CCVD and the subsequent oxidative purification process. In this talk, I will describe the preferential growth of DWNTs over SWNT or MWNTs, their structural characterizations using various analytic techniques and their possible applications. We found that these coaxial tubes consist of two relatively round, small and homogeneous-sized (below 2 nm in the outer shell) concentric tubules and are packed in a hexagonal array. Then, I will discuss a novel and stable structure consisting of flattened tubules containing two SWNTs via the coalescence of two adjacent tubes, chemical doping effect as a tunable way of electronic structure of DWNTs, and formation of atomic scale metal wires in the hollow core of DWNTs. Finally, I will report their transport properties as well as their performance in field effect transistors as compared with those of SWNTs. Therefore, in the near future, it may be possible that DWNTs replace SWNTs in specific carbon nanotube devices used today.