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Controllable synthesis of single, double and triple walled carbon nanotubes from asphalt and petroleum coke

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Since carbon nanotubes (CNTs) was detailed analyzed by Iijima in 1991, it has remained an exciting material due to its extraordinary properties: many-fold stronger than steel, harder than diamond, electrical conductivity higher than copper, thermal conductivity higher than diamond, etc. There are thousands of publications and patents on innumerous potential applications of CNTs in almost all the walks of life: media, entertainment, communication, transport, health and environment. The properties of CNTs are strongly related to the number layers of CNTs. In our work, it was found that different buffer gases (He, N2, Ar) strongly affected the number layers in the synthesized nanotubes by an arc discharge method with Fe (100 mesh) as catalyst and using Changping asphalt or Lanzhou petroleum coke (in China) as carbon source. Namely, the CNTs with different layers can be selectively synthesized from asphalt or coke by arc discharge.

Our results indicate that pure single-walled CNTs (SWNTs) can be synthesized from both asphalt and petroleum coke in the He gas atmosphere by arc discharge. In the Ar gas atmosphere, double-walled CNTs (DWNTs) can be synthesized from petroleum coke and triple-walled CNTs (TWNTs) can be synthesized from asphalt. In the N2 gas atmosphere, both SWNTs and DWNTs were synthesized from asphalt and petroleum coke. The morphology and structure of three kinds of CNTs were characterized by scanning electron microscopy (SEM), high-resolution transmission electron microscopy (HRTEM), Raman spectroscopy and energy dispersive X-ray spectroscopy (EDX). This technique opens up the possibility for preparing CNTs with controlled structure by an economically way in which asphalt and petroleum coke are much cheaper than graphite which is traditionally used as carbon source for the CNT synthesis. Moreover, our research paves a promising way for the high value-added utilization of oil residue.

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