Fe-filled carbon nanotubes synthesized by floating catalyst chemical vapor deposition and their magnetic properties

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Iron-filled carbon nanotubes (CNTs) have been attracting intense attention in recent years. In this nanocomposite, carbon coating can, on the one side, protect ferromagnetic materials from oxidation in the outside environment and, on the other side, reduce magnetic coupling between magnetic phases. Further more, the metal nanowires or nanoparticles encapsulated in CNTs can show quantum effects as their dimensions decrease to the nanoscale. So these materials have unique electronic, magnetic properties. It has been suggested that these materials might find important applications in diverse areas such as magnetic data storage, electromagnetic wave-absorbing materials and magnetic resonance imaging.

In this paper, we report the synthesis of iron-filled CNTs with excessive by floating catalytic chemical vapor deposition (FCCVD). To synthesize iron-filled well-aligned carbon nanotubes, ethanol was employed as carbon source, high pure N2 and 3%H2/Ar as carrier gas, ferrocene as catalyst precursor for CNT growth and the source of iron. We obtained iron-filled carbon nanotube arrays on quartz substrates. The iron-filled carbon nanotubes were characterized by employing scanning electron microscopy, transmission electron microscopy, energy dispersive X-ray spectroscopy, X-ray diffraction and Raman spectroscopy. The magnetic property of as-synthesized iron-filled CNTs was evaluated by vibrating sample magnetometer at room temperature.

We have synthesized iron-filled CNTs by FCCVD with employing extremely excessive ferrocene as both catalyst precursors for growing CNTs and iron source for filling CNTs. So during the growth process, there is sufficient iron source to form better filling of iron into CNTs. The iron filled in CNTs is a mixture of α-Fe, γ-Fe and Fe3C, but the α-Fe phase iron dominates. The magnetic property of these iron-filled CNTs has been investigated using VSM and they exhibit an average coercivity of about 257.05G.

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