Synthesis of Carbon Nanofibers by Chemical Vapor Deposition Using Polyoxometalates as Catalysts

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ABSTRACT

This work reports a new approach to synthesize carbon nanostructures by the Chemical Vapor Deposition (CVD) technique using Polyoxometalates (POMs) as catalysts. POMs are anionic metal-oxygen complex nanoclusters, which can be synthesized by aqueous chemical processes. Hydrogen and acetylene were used as the carrier gas and the carbon precursor, respectively, for the CVD growth at 700°C. Two methods for the preparation of POM catalysts have been explored: (1) the solution was drop-cast directly onto Si substrates; or (2) the POM solutions were blended with polyvinyl alcohol (PVA) and spin-coated on the substrates. Morphologies and structures of synthesized carbon nanomaterials were examined by the Scanning Electron Microscopy (SEM), the Transmission Electron Microscopy (TEM) and the X-Ray Diffraction (XRD). The results showed that the polyoxomatelates containing cobalt yielded mostly cup-stacked carbon nanofibers (CNFs) with diameter in the range of 10-100 nm, whereas other polyoxomatelates did not seem suitable for carbon nanostructure syntheses. The uniformity, in terms of both the fiber size and the coverage on the substrates, was found to be improved in the case of the spin-coated POM catalysts, compared to the drop-casting method. The XRD results also revealed the remnants of POM catalysts in the synthesized CNFs, mostly in the form of tungsten and tungsten carbide. Future applications of the synthesized CNFs include electrodes for dye-sensitized solar cells, patterned electrodes and gas-sensing materials.

Key words: Carbon nanotubes (CNTs), Polyoxometalates (POMs), Chemical vapor deposition (CVD)