Formation of chains of graphitic nanoparticles by heating fullerene blacks covered with thin metal films

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Abstract:

Strongly bent, fibrous carbon nanostructures with outer diameters usually between 35 and 90 nm were generated by the pyrolysis above 800°C of a fullerene black which had been covered with a thin nickel film. Transmission electron microscopy (TEM) and electron energy loss spectrometry (EELS) revealed that the material consists of chains of hollow elongated multi-wall graphitic nanoparticles. The worm-like nanostructures only arose from the nickel-covered parts of the fullerene black as checked with scanning electron microscopy (SEM) and energy-dispersive X-ray spectrometry (EDX). Attempts to generate similar structures from commercial carbon blacks, arc-produced fullerene-free carbon blacks and glassy carbon failed. Substituting nickel by cobalt or molybdenum also did not lead to the generation of fibrous structures. Additionally, the pyrolysis-induced changes of metal films on graphite and glassy carbon and the direct interaction of nickel films with fullerene vapour were investigated. A growth model for the nanochains is proposed, which includes the diffusion of carbon through a metal particle, the segregation of carbon and the repeated surface melting and solidification of the metal.