MULTIWALLED CARBON NANOTUBES: SYNTHESIS AND APPLICATIONS.

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In a recent publication we have described the synthesis of multiwalled carbon nanotubes (MWNTs) by the reaction of a hydrocarbon vapor over a dispersed iron catalyst that is deposited on quartz substrates [1]. The usual system configuration involves entraining a mixture of xylene and ferrocene into an inert gas stream. The mixture flows into a quartz tube furnace in which are placed quartz plates to provide additional substrate area. Decomposition of the ferrocene at temperatures in the range 625-775 C, and at atmospheric pressure, produces a coating of iron nanoparticles on the quartz surfaces, and these metal sites function as catalysts for the formation and growth of MWNTs. The operating parameters that effect MWNT yield, purity, and other characteristics (diameter distribution,length) will be discussed. These parameters include the feed injection temperature, furnace temperature, hydrocarbon partial pressure, reaction time, space velocity, and iron to carbon ratio in the feed. Under selected conditions, we have found that it is possible to produce essentially pure MWNTs, with little or no amorphous carbon, and to greatly increase the yield (approaching 65% carbon yield).

Harnessing the unique physical properties of MWNTs in materials applications is yet to be fully realized. In recent work at CAER, MWNT have been dispersed in polymer and pitch matrices by using high energy ultrasonics to disperse MWNT into solutions. However, this approach, although providing valuable information on methods for realizing the remarkable properties of the MWNT, is not readily transferable to industrial practice. A more practical method of producing MWNT composites is by shear mixing followed by extrusion or injection molding. The dispersion of nanotubes into polymers and pitch matrices utilizing traditional polymer processing technologies will be discussed. Sufficient dispersion is found to be the key in realizing the potential of these unique nanoparticle reinforcements.

[1] R. Andrews et al., Chem Phys Lets, 303 (1999) 467-474.