ID 1530

Composite Materials at the Nanometer Scale: from Carbon Nanotubes to Bone

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Keywords: carbon nanotubes, composites, bone

In this lecture some of our recent experimental and theoretical results regarding materials at the nanoscale will briefly be reviewed. The main theme include carbon nanotubes and nanotube-based composite materials. Brief comments about nanoscale biological composites, such as hydroxyapatite-collagen composites (bone), will also be given. Carbon nanotubes hold great promises as a possible reinforcing phase in composite materials of a new kind. Such developments still present, however, enormous practical challenges, in particular when attempting to probe the properties of individual nanotubes, for which most studies consist of computer simulations. Experimental observations of various deformation and fracture modes under compression of single multi-walled carbon nanotubes, obtained as a result of embedment within a polymeric film, are reported. Based on a combination of experimental measurements and the theory of elastic stability, the compressive strengths of nanotubes are found to be about two orders of magnitude higher than the compressive strength of any known fiber. We report some evidence of polymer-nanotube wetting and interfacial adhesion. Recent advances in the potential use of nanotubes as sensors in composite matrices are also briefly outlined.