MICROSTRUCTURE-MECHANICAL PROPERTY RELATIONSHIPS IN CARBON NANOFIBERS

ABSTRACT

Carbon nanofibers, though radially more homogeneous compared to carbon fibers, currently do not possess mechanical properties as high as carbon fibers. By principles of size effect, carbon nanofibers are expected to possess considerably higher strengths than carbon fibers. The gap in theoretical and experimental work is mainly because of graphitic alignment in the nanofiber, radial structure of the nanofiber and presence of surface defects. The work presented in this dissertation aims at closing the gap via relating the microstructure and mechanical properties of carbon nanofibers. Graphitic alignment in carbon nanofibers impart high modulus and strength to the fibers. This alignment of graphitic domains arises from the induced molecular alignment in precursor fiber. The precursor is polyacrylonitrile (PAN) nanofiber obtained from electrospinning of PAN in Dimethylformamide (DMF) solution. As limited molecular alignment is achievable with electrospinning, alignment is achieved by hot drawing of nanofibers which takes place at temperatures above the Tg of the polymer. The molecular alignment obtained in the hot drawing process facilitates the improvement in graphitic alignment in the carbon nanofiber formed. The effect of this enhanced alignment on single carbon nanofibers with diameters of 250nm-700nm is studied via mechanical tests performed using a microelectromechanical system (MEMS) device in conjunction with digital image correlation (DIC).

SELECTED PUBLICATION