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Load transfer mechanisms in cross-linked DWNT fibers T. FILLETER, M. NARAGHI, A. MORAVSKY, R. BERNAL, R.O. LOUTFY, H.D. ESPINOSA — The application of carbon nanotubes (CNT) to macroscopic composite fibers has been limited by weak shear interfaces between adjacent CNT shells and composite matrix elements. A fundamental understanding of load transfer at multiple length-scales is needed to identify how the exceptional mechanical properties of CNTs can be scaled to produce high-performance fibers. Through in-situ electron microscopy tensile testing we have elucidated load transfer mechanisms across multiple scales of cross-linked double-walled nanotube (DWNT) fibers. A low density of polymer cross-links is found to increase the total energy dissipated at failure and ductility of fibers by 5 and 10X, respectively, without reducing strength. This mutiscale approach has identified a need to enhance shear interactions between individual DWNTs within the hierarchical DWNT fiber structures. Through in-situ TEM electron irradiation studies we have shown that load can be effectively transferred to inner DWNTs within bundles by covalently cross-linking the interfaces of adjacent DWNTs and shells. We have observed order of magnitude increases in strength and modulus and identified their dependence on irradiation dose. In future a combined approach of irradiation induced covalent and polymer cross-linking may lead to high-performance DWNT-based fibers and composites with tunable mechanical properties.

T. Filleter

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