In-Situ Mechanical Characterization of Carbon-Based Materials at the Nanoscale

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Abstract

As technology continues to be miniaturized, understanding mechanical processes at the nanoscale becomes important. New developments in electron microscopy, and specifically the ability to perform quantitative mechanical tests *in-situ* transmission electron microscope (TEM), allow a simultaneous collection of mechanical data with real-time structural images, thereby connecting material structure and properties. However, fabrication of nanometric specimens in specific testing geometries is extremely challenging for soft materials as polymers, as classic fabrication methods are designed for metals, and not always feasible.

We demonstrate here three testing modes in the study of each component of the composite: bending (epoxy), compression (CNTs), and tension (nanocomposite). The direct observation of the mechanical deformation of each material provided insights into the intrinsic mechanical behavior of nano-scale volumes of solids, as well as the extrinsic behavior which evolves from the sample preparation process and the TEM electron beam. Hence, in this work we both established a new experimental methodology for nanoindentation inside a TEM of carbon-based materials, as well as applied this technique on the said systems, demonstrating its potential.

Short Biography

Dr. Noa Lachman is a young member in the department of materials science and engineering in Tel Aviv University. She received a B.S. (2003) in Chemistry and Physics from the Hebrew University in Jerusalem, Israel, and completed her Ph.D. work (2010) at the Weizmann Institute of Science, in the department of Materials and Interfaces, followed by a post-doc with Prof. Brian Wardle at the department of Aeronautics and Astronautics at MIT. Dr. Lachman's major interests are the effects of nanocomposites micro- and nanostructure, and interfacial characteristics, on the composite behavior, and developing and optimizing real-time visual methods to compliment mechanical testing at various length-scales, including nano-scale. She uses fabrication techniques such as additive manufacturing and Chemical Vapor Deposition (CVD) to control the composite's nanostructure, which will enable the design of new materials with improved efficiency and performance. Dr. Lachman has authored and co-authored 31 journal articles, which have been cited together more than 1200 times.