NANOHOUR

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3:00 PM
Beckman Institute - Room 3269

Effect of Nanoscale Silica Inclusions on the Properties of Polymer Composites

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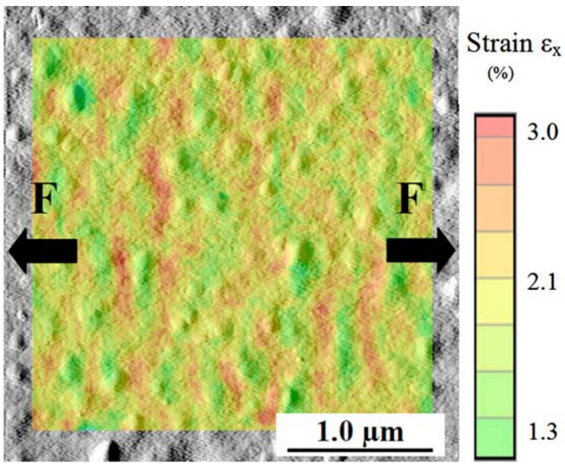

The effect of fumed silica weight fraction (1%, 3%, 5%, and 15%) on the mechanical properties of a polymer nanocomposite was investigated. The composite was fabricated by dispersion of 12 nm spherical silica in Epon 862 by ultrasonication. Uniaxial tension and single edge notched tension (SENT) fracture specimens were tested with a custom-made tensile testing apparatus. Stress-strain curves were calculated by applying digital image correlation (DIC) on optical images. The composite modulus increased monotonically with weight fraction. On the other hand, the ultimate strength was rather insensitive to weight fraction. The critical mode I stress intensity factor increased with silica weight fraction, becoming as high as 35% compared to the neat epoxy for 15 wt.% silica composites. Electron microscopy fractographs showed that the nanoparticles induced micro-flake morphologies to the fracture surface of 15% composites, which contributed to matrix toughening by enhancing matrix yielding. Voids of the size of the nanoparticles were also observed, but their extent was limited compared to surface roughening due to micro-flakes.

Rate Dependent Mechanics of Electrospun Polymeric Nanofibers

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Polymeric nanofibers, fabricated by electrospinning, are versatile building blocks for hierarchically structured materials, such as nanocomposites, high strength fabrics, high density filters, and scaffolds for tissue engineering. The mechanical behavior of nanoscale polymeric fibers in response to quasi-static and intermediate loading rates is unexplored. A novel experimental method that utilizes a MEMS-based mechanical property-testing platform was conceived to investigate the effect of strain rate during cold drawing of single electrospun polyacrylonitrile (PAN) nanofibers with 200-500 nm diameters and tens of microns in length. At sufficiently high strain rates we observed the formation of multiple necks on the fibers, which significantly reduced the strength of the nanofibers by inducing stress concentrations. The formation of such inhomogeneous deformation fields was attributed to the radial inhomogeneities in the nanofibers structures generated during electrospinning process, and the fragmentation of the outer layers of the fibers at moderate strains. At slow stain rates, fibers underwent homogeneous deformation and strain localizations were suppressed by material relaxations. This behavior permitted large fiber deformations and molecular chain alignment, and therefore large fiber strengths. In addition, we investigated the effect of fabrication conditions on the mechanical behavior of polymeric nanofibers and their molecular structures. It was revealed that molecular alignment in nanofibers can be highly tuned by controlling the fabrication conditions, which will result in the formation of stiffer nanofibers.

Coffee and cookies will be served.

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