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Wrinkling and strain softening in polymer supported networks of pristine single-wall carbon nanotubes ERIK K. HOBBIE, North Dakota State University, DANEESH SIMIEN, JEFFREY FAGAN, JI YEON HUH, JUN YOUNG CHUNG, STEVEN HUDSON, JAN OBRZUT, CHRISTOPHER STAFFORD, NIST — Single-wall carbon nanotubes (SWCNTs) represent mesoscale analogs of semiflexible polymers. We study the deformation mechanics of quasi two-dimensional SWCNT networks by assembling them as thin isotropic films on stretched polymer substrates. After the strain is released, the morphology and topography of the deformed membranes are characterized through a combination of optical microscopy, light scattering, atomic force microscopy, scanning electron microscopy, transmission electron microscopy, and impedance spectroscopy. Above a critical surface density, films assembled from SWCNTs of well-defined length and/or electronic type (metallic vs. semiconducting) exhibit a strongly nonlinear response under prestrains of 1% to 20%. The strain dependence of the wrinkling wavelength suggests that the films soften dramatically under small deformation, and we develop a model to extract the network modulus and yield strain from the nonlinear mechanical response. The softening results from local anisotropy that develops under the Poisson expansion of the soft polymer support, which induces bond slip and the rupture of network junctions. This loss of connectivity leads to a drop in electrical conductivity normal to the direction of strain.

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