

MAR12-2011-020229

Abstract for an Invited Paper  
for the MAR12 Meeting of  
the American Physical Society

### **Mechanocapillary forming of carbon nanotube microstructures**

A. JOHN HART, University of Michigan

The hierarchical structure and organization of filaments within both natural and synthetic materials can determine a wide variety of collective chemical and physical functionalities. Carbon nanotubes (CNTs) are known for their record properties, and densely packed CNTs are therefore expected to enable new materials having outstanding multifunctional performance. However, it remains a significant challenge to build highly ordered assemblies of CNTs, and this challenge has largely limited the design and properties of macroscale CNT yarns and sheets, and CNT-based surfaces and interfaces. We have created a versatile technique called *capillary forming* to manipulate patterned vertically aligned (VA-) CNTs into diverse 3D microarchitectures, and to enable their integration in applications ranging from microsystems to macroscale functional films. Capillary forming relies on shape-directed capillary rise during solvent condensation, followed by evaporation-induced shrinkage. Three-dimensional transformations result from shrinkage of the vapor-liquid-solid interface and the resulting heterogeneous strain distribution in the microstructures. A portfolio of microscale CNT assemblies with highly ordered internal structure and freeform geometries including straight, bent, folded and helical profiles, are fabricated using capillary forming. The mechanical stiffness and electrical conductivity of capillary formed CNT micropillars are 5 GPa and  $10^4$  S/m respectively. These values are at least hundred-fold higher than as-grown CNT forests and exceed the properties of typical microfabrication polymers. Finally, the potential applications of these structures are demonstrated as vertical microsprings with geometrically tunable compliance, and hydrogel-driven microtransducers.