

CARBON NANOTUBE-RICH DOMAIN EFFECTS ON BULK ELECTRICAL PROPERTIES OF NANOCOMPOSITES

Chelsea S. Davis, Purdue University, USA
chelsea@purdue.edu

Nathan D. Orloff, Purdue University, USA

Jeremiah W. Woodcock, Purdue University, USA

Christian J. Long, Purdue University, USA

Kevin A. Twedt, Purdue University, USA

Bharath Natarajan, Purdue University, USA

Jabez J. McClelland, Purdue University, USA

Jan Obrzut, Purdue University, USA

J. Alexander Liddle, Purdue University, USA

Jeffrey W. Gilman, National Institute of Standards and Technology

Carbon nanotube (CNT)/epoxy composites are intriguing materials that enable materials scientists and engineers to tailor structural and electrical properties for applications in the automotive and aerospace industries. Recent insights into CNT-rich domain formation and its influence on electrical properties raise questions about which processing variables can be used to tune the overall electrical conductivity. Here, we investigate how mass fraction and curing temperature influence these electrical properties. CNT nanocomposites were fabricated varying the mass fraction of CNT and the epoxy curing temperature. First, scanning lithium ion microscopy coupled with transmission electron microscopy were employed to investigate the morphology of CNT-rich domains that formed more readily at elevated curing temperatures than during room temperature curing. Then, oscillatory shear rheology measurements of the unfilled curing epoxy informed a simple kinetic argument to explain the CNT-rich domain formation. Finally, the electrical conductivity (both alternating and direct current) was characterized with a novel microwave cavity perturbation spectroscopy technique (alternating current conductivity) and a standard four-point probe station (direct current conductivity). The overarching conclusion of the work was that the CNT-rich domains formed a secondary percolated network surrounded by an almost completely unfilled epoxy matrix that allowed for higher conductivities at lower loadings. This work demonstrates that perfect dispersion of the nanoparticulate is, at least in this instance, not necessarily the preferred morphology.