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SPM Imaging of Frequency-Dependent Electrical Transport through Carbon Nanotube Networks in Polymers

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Frequency-dependent electrical transport in the conducting networks of single-walled carbon nanotubes (SWNTs) within an insulating poly-methyl methacrylate (PMMA) matrix was studied by Scanning Impedance Microscopy (SIM). SIM amplitude images reveal the networks of biased SWNTs and SWNT bundles embedded in the polymer and characterize the conducting pathways between planar electrode structures. The conductance of the composite is shown to be limited by a small number of bundle-bundle and bundle-contact junctions. For high frequencies, the SIM phase distribution along the networks is governed by the capacitive interaction between the nanotubes and the substrate and was in agreement with a transmission line model. For low frequencies, the potential distribution along the network can be determined after accounting for tip-surface capacitance variations at specific locations such as near electrodes. These approaches constitute a direct method to characterize and understand transport through percolation networks formed by nanotube bundles in polymers, or more generally, nanorods in various matrices.

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