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Dependence of Electrical Percolation Behavior on Filler Aspect Ratio in Isotropic Silver Nanowire-Polystyrene Composites ROSE M. MUTISO, SADIE I. WHITE, DAVID JAHNKE, SAM HSU, PATRICK M. VORA, JAMES M. KIKKAWA, JU LI, KAREN I. WINEY, University of Pennsylvania
— Electrical percolation behaviors in networks of conductive cylindrical particles in insulating matrices have been studied extensively by analytical models, simulations and experiments. Most analytical techniques assume that the particles have effectively infinite aspect ratios; however, many nanoparticle processing approaches result in cylindrical fillers with finite aspect ratios. We report percolation behavior in isotropic silver nanowire/polystyrene composites in which the nanowires have finite, controlled aspect ratios (L/D=31.0 $\pm$ 3.7, 16.4 $\pm$ 1.5, and 8.23 $\pm$ 0.57). We then compare the critical volume fractions, ϕ_c, obtained from our experiments to (1) simulations of percolation behavior of soft-core rods with finite aspect ratio, and analytical percolation models for (2) soft-core and (3) core-shell rods, to determine the contributions of the soft-core and infinite-aspect-ratio assumptions to the discrepancies between experimental and analytical percolation behaviors. Our experimental values of ϕ_c are in better agreement with our soft-core simulations than with both core-shell and soft-core analytical models. Thus, we conclude that the infinite-aspect-ratio assumption contributes more significantly to errors in predicting percolation onset than the soft-core assumption.

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