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Thin-Film Nanowire Networks for Transparent Conductor Applications: Simulations of Sheet Resistance and Percolation Thresholds
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— Thin-film metal nanowire networks are being pursued as a viable alternative to the expensive and brittle indium tin oxide (ITO) for transparent conductors. For high performance applications, nanowire networks must exhibit high transmittance at low sheet resistance. Previously, we have used complimentary experimental, simulation and theoretical techniques to explore the effects of filler aspect ratio (L/D), orientation, and size-dispersity on the electrical conductivity of three-dimensional rod-networks in bulk polymer nanocomposites. We adapted our 3D simulation approach and analytical percolation model to study the electrical properties of thin-film rod-networks. By fitting our simulation results to experimental results, we determined the average effective contact resistance between silver nanowires. This contact resistance was then used to quantify how the sheet resistance depends on the aspect ratio of the rods and to show that networks made of nanowires with L/D greater than 100 yield sheet resistances lower than the required 100 Ohm/sq. We also report the critical area fraction of rods required to form a percolated network in thin-film networks and provide an analytical expression for the critical area fraction as a function of L/D.

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