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Dimensional effects on the tunneling conductivity of gold-implanted nanocomposite films

Journal of Applied Physics **117**, 125302 (2015); <https://doi.org/10.1063/1.4915944>C. Grimaldi¹, M. Cattani², and M. C. Salvadori²[View Affiliations](#)[View Contributors](#) PDF

We study the dependence of the electrical conductivity on the gold concentration of Au-implanted polymethylmethacrylate (PMMA) and alumina nanocomposite thin films. For Au contents larger than a critical concentration, the conductivity of Au-PMMA and Au-alumina is well described by percolation in two dimensions, indicating that the critical correlation length for percolation is larger than the thickness of the films. Below the critical loading, the conductivity is dominated by tunneling processes between isolated Au particles dispersed in PMMA or alumina continuous matrices. Using an effective medium analysis of the tunneling conductivity, we show that Au-PMMA behaves as a tunneling system in two dimensions, as the film thickness is comparable to the mean Au particle size. On the contrary, the conductivity of Au-alumina films is best described by tunneling in three dimensions, although the film thickness is only a few times larger than the particle size. We interpret the enhancement of the effective dimensionality of Au-alumina films in the tunneling regime as due to the larger film thickness as compared to the mean interparticle distances.

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