Abstract

To what extent is the structure of a random composite compatible with a percolation model?

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Recent developments of local field microscopy allow a considerable improvement over more traditional techniques (like transmission electron microscopy) of the knowledge of the actual structure of composites made of conducting particles dispersed in an insulating polymer matrix. The Resiscope is an attachment to an AFM microscope that provides at the same time a classical image of the sample surface and a new image representative of the local electrical conduction through the sample, between the tip and the back. Using the thickness of the sample as an independent variable, we have obtained original data on the 3D structure of the finite clusters as well as of the infinite cluster and their relative variations with the particle concentration in a series of carbon black filled elastomers. These data are concerned with the geometry and the electrical resistance of the conducting paths inside the material and provide new conducting path size and local resistance histograms. The comparison of their respective behaviors with sample thickness and particle concentration with classical scaling results of percolation theory turned out to be difficult due to the particular "tip-to-bottom" plane experimental geometry, that has never been considered in the literature. We have performed computer simulations on percolation cubic networks aimed at providing similar data when both the filling factor p and the sample "thickness" (number of planes) are allow to vary. We have found that in spite of a general agreement between experimental and calculated data, there exist significant differences that seem to prove that the actual structure is more complex than the one predicted by a classical percolation model of random composite.

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