Electrical properties of composite films

S. Novák[1], M. Švec[1], R. Hrach[1,2], J. Pavlík[1]

[1] Department of Physics, Faculty of Science, J. E. Purkinje University,
České mládeže 8, 400 96 Ústí nad Labem, Czech Republic
[2] Department of Surface and Plasma Science, Faculty of Mathematics and Physics,
Charles University, V Holešovičkách 2, 180 00 Prague 8, Czech Republic

Composite films belong to very interesting materials with a huge scale of applications for their mechanical, optical and electrical properties. In our contribution we present a study of their electrical properties by the help of self-made software analytical tools. We concentrate on connection of these properties with structure parameters of the films.

Several models of composite films were prepared at first. We used the molecular dynamics and Monte Carlo method in this part of the computer experiment, including hard-sphere and soft-sphere models [1]. Then the structures were studied to obtain structural parameters, so methods of mathematical morphology [2] were used here. The electrical properties are studied especially below and close to so-called percolation threshold [3] of the structure. When the structure reaches the percolation threshold it assigns interesting behaviour. The Monte Carlo method and the theory of percolation were used for the study of electrical properties. The electric transport is carried out through individual channels with tunnel or ohmic conductivity mechanisms [4]. These channels can be described in terms similar to standard ohmic conductivity, e.g. infinite cluster, its backbone, dead-ends, etc., however the tunnel conductivity channels have a fuzzy characters, so the usual terms of the percolation theory must be redefined and some new parameters added.

As main results of our contribution we show both correlations of electrical properties with morphology of the structures and analysis of current noise in composite films.

References

[1] Rapaport D.C.: The Art of Molecular Dynamics Simulation, Cambridge University Press, Cambridge, 1995.
[2] Serra J., Image Analysis and Mathematical Morphology, Academic Press, London, 1982.
[3] Stauffer D., Aharony A., Introduction to Percolation Theory, Taylor and Francis, London, 2003.
[4] Hrach R., Novák S., Švec M., Škvor J.: Study of Electron Transport in Composite Films below Percolation Threshold, LNCS 3991, 806 (2006).