Effect of dispersity of particle length on the electrical conductivity of the two-dimensional systems

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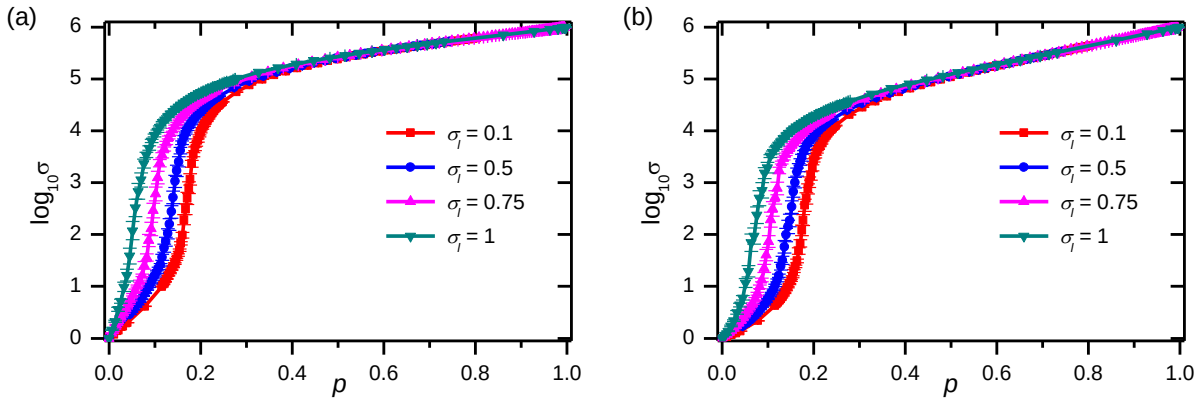
Recently, simulations of electrical conductivity of two-dimensional systems with rod-like fillers of equal length have been performed both in lattice [1–3] and in continuous [4,5] approaches. By contrast, fillers in real systems of conductive nanocomposites have different lengths follow a lognormal distribution [6]. By means of computer simulation, we examined effect of dispersity of filler length on electrical conductivity of two-dimensional (2D) composites with rod-like fillers. Continuous approach has been used. Highly conductive zero-width rod-like particles deposited uniformly with given anisotropy onto a poorly conductive substrate. Length of particles, l, varies according to the lognormal distribution. Probability density function is $f(l)=\frac{1}{l\sigma_l\sqrt{2\pi}}\exp\left(-\frac{\left(\ln l-\mu_l\right)^2}{2\sigma_l^2}\right)$. We performed simulations for the fixed value of the parameter $\mu_l=0$ and different values of the parameter $\sigma_l=0.1,0.5,0.75,1$ and for different values of the order parameter $s=N^{-1}\sum_{i=1}^{N}\cos 2\theta_i$, where θ_i is the angle between the axis of the i-th rod and the horizontal axis x, and N is the total number of rods in the system. The figure shows the results of a numerical calculation of the dependence of the logarithm of the effective electrical conductivity on the filling fraction along the direction of alignment of the rods (a) and in the perpendicular direction (b) at $s=0.5$. As the parameter σ_l was increased, the insulator—metal transition occurred at a smaller fraction of the occupation by the particles.



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