Patterns formed by multiparticle DLA

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The process of diffusion limited aggregation (DLA) has firstly been considered in 1981 by T.Witten and L.Sander, and up to the present attract the considerable attention as a suitable model of a series of physical processes of pattern formation.

It is possible to generalize the DLA process for system with different immiscible particles. Let us suppose that we have a plane annular area bounded by an impenetrable wall. In the center of this area there is a seed consisting of the particles of K different kinds. A new particle of an arbitrary kind appears at a quite large distance from the seed. This particle is randomly walking until the collision with a seed particle of the same kind. After the collision this particle and the seed they stick together with the probability 1. In this time a new particle of the same kind appears. Particles of different kinds cannot stick together. This means that the free particle after the collision with the particle of another kind in the cluster reflects from it. Such a model can simulate some class of pattern formation in biological (opulation dynamics, spread of epidemics, etc.) and chemical (multicomponent electrochemical deposition) models. It should be noted that firstly the similar approach has been advanced in paper [1]. However, the authors considered two-particle the diffuse process as a generalization of the problem concerning percolation in the plane: the cluster parts are identified with two possible percolation channels. Besides they analyzed only the geometrical steady-state properties of the formed pathways but did not consider precisely the kinetics of a growth.

We present the results of numerical simulation of DLA–cluster consisting of two and three immiscible kinds of particles in the square-lattice and off-lattice cases. The geometry is axial-symmetrical or cylindrical with the periodic boundary condition. We changed the number of particles along each side and the number of different areas and have found the phenomenon of a loss of memory about initial distribution. Our simulation showed that, independently on the initial distribution of different kinds of particles, the final cluster usually has no more than 5 branches of each kind.

We use a continuous model which describes the kinetic of DLA–fractal growth by partial differential equations. As in the previous our investigations [2], the basic distinction of the proposed approach consists of the fact that it allows us to take into account the discrete cluster structure by the introduction of the roughening of the time scale: we supposed that the cluster density is discretely changed after the fact that particles have filled the accessible perimeter. The last one is controlled by the effect of screening. We may use mean–field approach with the sequential roughening of the time scale if the length of arc which is screened at the close packing is less than the length of the arc occupied by the germ. The results on fractal dimension are in a quite good agreement with values found by the direct numerical simulations.

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