Microstructure Formation of Coatings of 2D Arrays of Bidisperse Nanoparticles

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Ordered patterns of nanoparticles can be used directly, say as high density magnetic media, or indirectly as templating agents. Formation of such 2D arrays is possible by a combination of coating and evaporation of the suspension. We study computationally the self-organization of bidisperse mixtures of spheres in two dimensions by simulating random sequential adsorption (RSA) and surface diffusion to understand experimentally observed formation of regular arrays of bidisperse nanoparticles with specific size ratios. The spheres interact through either hard-sphere, attractive van der Waals and repulsive steric interparticle potentials. In addition the particles can be compressed due to a combination of lateral capillary forces and solvent evaporation. For all the interparticle potentials, we find that the maximum coverages from RSA alone are well below that observed experimentally for ordered bidisperse particle arrays. Coverages at melting for all the interparticle potentials are greater than that observed experimentally for ordered bidisperse particle arrays. The addition of lateral capillary forces/compression, however, allows the formation of the experimentally observed arrays. These results indicate that ordered arrays of bidisperse particles are not formed by an equilibrium process, and that the process dynamics are critical in the control of the final microstructure.