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Self-assembled Nanostructures

Wei Lu[1]

Self-assembly is a potential low-cost and high-throughput approach for nanofabrication. In a structure, collective actions of photons, electrons and ions contribute to the free energy. When the configuration of the structure changes, the free energy also changes. This free energy change defines a thermodynamic force which, in its turn, motivates the configuration change and self-assembly of the structure. The effects of such forces may be negligible in macrostructures, but significant in nanostructures. Insight into these forces becomes increasingly valuable as the structures of technological interest miniaturize. This talk presents some of our recent work on the modeling of self-organized nanostructures and guided self-assembly, including self-organized nanophase patterns on solid surfaces, guided assembly by surface chemistry and strain field, organized nanovoids and nanobubbles in a solid, patterning multilayer of molecules via dipole interaction, electric field-induced ordered polymer nanostructures, and tuning nanoparticles in nanocomposites. We have developed a thermodynamic framework to study the remarkable phenomena. Large-scale simulations have been developed to simulate the process of formation and evolution of nanostructures. The simulations reveal remarkably rich dynamics and suggest a significant degree of experimental control in growing ordered nanoscale structures.

[1]Mechanical Engineering, University of Michigan, Ann Arbor, Michigan 48109, USA. weilu@umich.edu