The structure and stability of two-dimensional colloidal alloys

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We study both experimentally and theoretically the structure of mixed monolayers of large (3 μm) and small (1μm) very hydrophobic silica particles at an octane/water interface as a function of the number fraction of small particles. We find that a rich variety of two-dimensional hexagonal super-lattices of large and small particles can be obtained in this system experimentally due to strong and long-range electrostatic repulsions through the nonpolar oil phase. These represent the first experimental results for long-range order in a 2D binary colloid system. The structures obtained for the different compositions are in good agreement with zero temperature lattice sum calculations and finite temperature Monte Carlo simulations [1]. Our theoretical analysis also reveals that the melting behaviour of the superlattice structures is very rich, proceeding via a multi-stage process, with melting temperatures that have a very strong and non-monotonic dependence on composition [2].

[1] A.D. Law, D.M.A. Buzza, T.S. Horozov, Phys. Rev. Lett., 106, 128302 (2011).
[2] A.D. Law, T.S. Horozov, D.M.A. Buzza, Soft Matter 7, 8923 (2011).