55f Engineering DNA-Mediated Colloidal Self-Assembly: Preparing Sterically Stable Particles and Assembling Them into Ordered Crystal Structures

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The goal of these experiments is the self-assembly of novel, 3-dimensional colloidal crystal structures. The specific binding of complementary DNA strands is used to create short-range attractive interactions between DNA-grafted micron-sized colloids. These colloidal interactions will create multi-component colloidal mixtures where the interactions between each component are independently ‘programmed'. In theory, this technique should be able to produce well-ordered BCC, SC and diamond structures, as well as their alloy counterparts, the CsCl, NaCl and ZnS structures, all at densities near close-packing. We have synthesized the sterically stable DNA-grafted particles using the solvent swelling/deswelling technique. PEG chains provided this extra steric stabilization for these particles. The particles showed the temperature dependent phase behavior and they were also reversible with temperature. In addition, we have successfully assembled the first colloidal crystal structures using them. The crystal structures showed a faceted shape that resembles the RHCP stacked colloidal crystals. The crystals melted immediately when the temperature was raised above the melting temperature (Tm), confirming that they were formed and held together by DNA hybridization. We also find that the particle crystallization kinetics became faster as the grafted DNA density was increased. In addition, we have developed the simple thermodynamic model that predicts the phase behavior (Tm) of the system to within a few degrees. Finally, we also investigate the binary alloy and superlattice structures formed using DNA-mediated self-assembly.