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Particles Bridge the Gap – Relevance of Polymer Graft Architecture on the Properties of Particle Brush Assemblies[1]

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Current interest in the assembly of ligand-coated nanoparticles into 2D and 3D array structures is driven by the opportunities for novel material technologies that derive from the interactions within nanoparticle superlattice structures. A common challenge in the solution-based assembly of particle superlattice structures is the propensity of hard-sphere type particle assemblies to crack formation and brittle fracture during solvent evaporation. Recent progress in controlled radical polymerization offers novel opportunities for polymer-stabilized particle systems (particle brushes) as building blocks of particle superlattice structures. This contribution will discuss synthetic strategies to realize particle brush systems with well defined polymer graft-architecture in the dense or semi-dilute brush regime and discuss the effect of polymer grafting on the structure formation and cohesive interactions in particle brush assemblies. In particular, it will be demonstrated chain entanglements between surface-grafted chains give rise to fracture through polymer-like crazing thus dramatically increasing the toughness and flexibility of the particle assembly. The modulus and toughness of polymer nanocomposites synthesized by self-assembly of particle brush systems will be shown to exceed those of "conventional" particle-filled polymer composites – a result that will be interpreted as a consequence of the particular conformational constraints of surface grafted chains.

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