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Directed Assembly of Nano-Colloids: Toward Discrete and Defined Polymer-Inorganic Architectures

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Analogies between controlled flocculation and the chemistry of macromolecular polymerization are informing new methods for bottom up fabrication of discrete polymer-inorganic architectures. Conceptually, hybrid nano-colloids with a narrow distribution of composition and structure ("monomers") are assembled via external control of the agglomeration kinetics ("polymerization"). The challenge however is to impart a level of predictability between nanoparticle design and resultant assembly, as embodied in monomer design and macromolecular architecture. Depending on the magnitude and directionality of the interparticle interactions, the controlled assembly of these hybrid nano-colloids can span from discrete, soluble proto-assemblies to single-component, bulk mediums with local order ranging from liquid-like to long-range translational coherence. Using nanoparticle shape, organic corona structure, and processing conditions (e.g. modulating the stability of the nano-colloid via solvent quality rather than number density), we demonstrate the fabrication of various discrete and defined metallic and metal oxide hybrid architectures, and discuss the unique properties of the assemblies, which reflect the uniformity of structure, nano-scale separation of the inorganic particles, and confinement of the polymer chains.