SELF-ASSEMBLIES ACROSS THE LENGTH SCALES BY POLYMER-COLLOID HYBRIDS

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Inspired by biological materials showing functionalities by hierarchical self-assembly and synergistic combinations of several physical and covalent interactions, we describe a few examples for biomimetic materials towards new functions. Highly aligned clay/polymer self-assembled bulk nanocomposites allow strength 220 MPa and fracture toughness 3.4 MPa $m^{1/2}$, approaching those of nacre.[1] Cellulose nanocrystals (CNC) have extensively been explored for structural colours and functional materials due to their chirally twisting liquid crystalline assemblies. On the other hand, individualized CNC incorporate twisting along the nanorods. We exploit this to show chiral plasmonics by ionically complexing gold nanoparticles onto CNCs.[2] More generally, colloids with tunable and even chiral topographies can be obtained by decorating CNCs with anionic polymer brushes which further undergo interpolyelectrolyte complexation with double hydrophilic block copolymers involving a cationic block.[3] By incorporating ureidopyrimidone (UPy) hydrogen bonding units as sacrificial bonds within the polyacrylate side chain brushes around CNC, biomimetic toughening is obtained, as evidenced by noncatastrophic crack growth upon deformation.[4] Incorporating UPy within asymmetric star-shaped low molecular weight polymers involving facially amphiphilic cholic acid core allows sequential self-assembly from nanometric micelles towards micrometer “cotton-ball” structures upon solvent changes.[5]

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