Bioinspired materials with magnetically-controlled microstructures

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The intricate hierarchical organization of biological materials like bone, teeth and plants finds no counterparts within man-made composites. Implementation of such nano-/microstructural design in synthetic composites should enable the creation of materials with unusual combination of properties and functionalities. Despite ongoing efforts to understand the complex cell-mediated processes that lead to such hierarchical architectures, mimicking synthetically the structural organization of natural materials remains a major challenge. An alternative approach is to devise new directed assembly routes to organize colloidal building blocks into bioinspired structures in the absence of cellular control. In this talk, I will present some of our recent attempts to develop such directed assembly routes and how we can utilize them to translating biological design principles into new microstructured materials. A novel approach to obtain polymer-based composites exhibiting deliberate orientation of reinforcing particles using ultra-low magnetic fields will be presented. The ability to control the position and orientation of reinforcing particles within a polymer matrix leads to bioinspired heterogeneous structures with unusual out-of-plane stiffness, wear resistance and self-shaping effects. The examples to be discussed will illustrate the great potential of this bioinspired approach in creating synthetic composites with rich functional behavior using a limited set of building blocks.