Advanced composites inspired by nature

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Natural composites like seashells, teeth and bone are made of soft organic and hard inorganic building blocks assembled into unique hierarchical architectures. The ubiquitous micro- and nanostructures of such natural materials lead to outstanding mechanical properties and find no counterparts within man-made composites. In this talk, I will present our recent attempts to replicate in artificial materials the unique architecture and design principles of biological composites. First, I will show that polymer-based composites with remarkable strength and ductility can be fabricated using ductile polymer matrices and reinforcing platelets with geometry optimized according to one of the seashell's design principles. Current issues related to the fabrication process and maximum concentration of platelets that can be achieved in these materials will be outlined. In the second part of the talk, I will present a new approach to obtain polymer-based composites exhibiting bioinspired deliberate orientation of reinforcing particles using ultra-low magnetic fields. I will demonstrate that our ability to control the position and orientation of reinforcing particles within a polymer matrix can lead to unique heterogeneous structures with unusual out-of-plane stiffness, wear resistance, tailored local mechanical response and shape-changing effects.

References: