BIOENGINEERING & BIOMEDICAL ENGINEERING RESEARCH SEMINAR

EXPANDING MATERIAL PROPERTY SPACE USING BIOINSPIRATION AND ARCHITECTURE

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Architectured materials are characterized by structural features which are larger than what is typically considered microstructure (e.g. grains) but smaller than the size of the component. This class of materials includes lattice materials and foams, and also fully dense materials composed of building blocks of well-defined size and shape. While the deformations of the blocks typically remain small and within elastic limits, their interfaces can channel cracks and undergo large deformations. Building blocks can therefore slide, rotate, separate or interlock collectively, providing a wealth of tunable mechanisms and new pathways to extraordinary properties. Interestingly, nature is well ahead of engineers in terms of harnessing the concept of architecture in materials. For example in nacre and fish scales -two materials we have been studying in our group- the interplay between stiff building blocks and weaker nonlinear interfaces generates powerful combinations of stiffness, strength and toughness not yet found in synthetic materials. Duplicating these structures and mechanisms in engineering materials is very attractive, but fabrication still presents formidable challenges. Here I will discuss how we are using new strategies (three-dimensional laser engraving, 3D printing) to create architectured / bio-inspired materials with highly unusual combinations of properties: High stiffness and high toughness in nacre-like glasses and ceramics, hardness and flexural compliance in fish scale-inspired protective skins.

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