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# Exploring material property space using bioinspiration and architecture

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## KEYWORDS:

Architecture, Bio-inspiration, Toughness, Morphing materials

Architected materials are high-information materials with controlled structures at intermediate length scales between microstructure and whole component [1, 2], and manipulating material architecture is a powerful approach to generate new combinations of properties that expand material property space [3]. We have recently focused on dense architected materials, made of hard and stiff building blocks joined by weaker and more deformable interfaces. These interfaces can deflect and guide cracks into toughening configurations, or channel large nonlinear deformations. These general principles lead to building blocks which can slide, rotate, separate or interlock collectively, providing a wealth of tunable mechanisms, precise structural properties and functionalities [4]. Interestingly, nature is well ahead of us at making and using architected materials. Bone, teeth and mollusc shells rely on stiff mineral building blocks and on weak proteinaceous interfaces [5, 6] to generate unusual and useful combinations of stiffness, strength and toughness [7]. Other natural architected materials such as scaled skins and fish fins combine hard and soft to create flexible armors and exoskeletons [8], or to achieve morphing capabilities [9]. Here I will discuss how we are exploring material architecture and bioinspiration to design, fabricate and test new materials and structures based on very hard and very soft materials (Fig. 1): nacre-like ceramics and glasses [10], sutured interfaces [11], laminated glasses augmented with bioinspired cross plies, topologically interlocked structures from platonic solids [12], flexible protective skins covered with hard elements of tunable shape and arrangements [13]. To explore this vast design space we use finite elements models, discrete element models, 3D printing, 3D laser engraving and a variety of mechanical tests. Our materials display a rich array of mechanisms which can be finely tuned to achieve desired sets of properties. They can also be fabricated in large volumes with relatively simple methods, making them suitable for rapid implementation in various engineering applications.

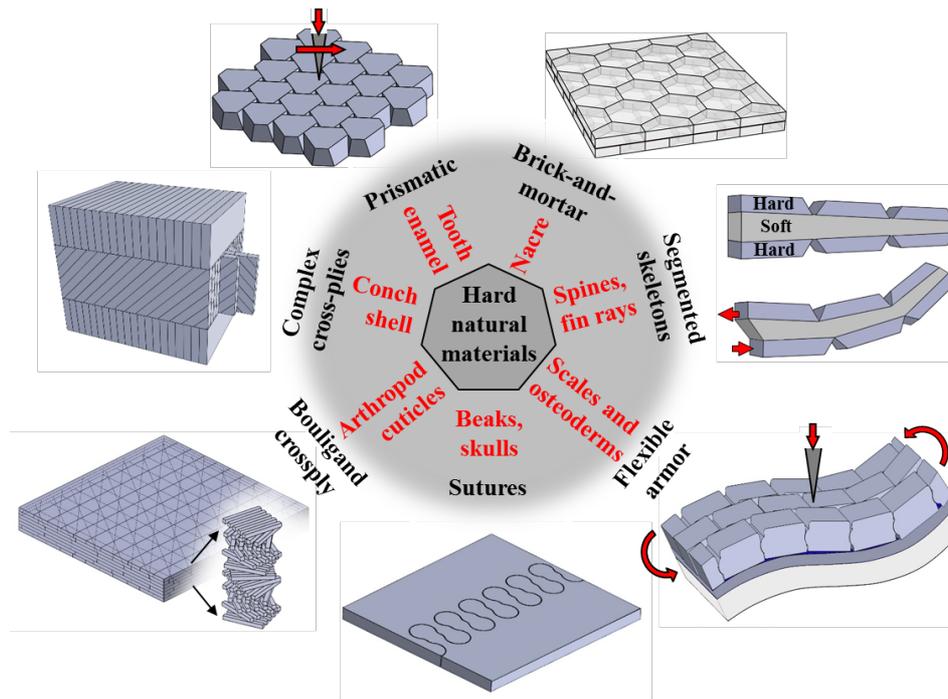


Figure 1: Bio-inspired materials and structures derived from hard biological materials

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