Building Ceramic-based Hierarchical Materials

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Abstract

One of the major scientific challenges for the 21st century is the development of new stronger and tougher lightweight structural materials to support advances in strategic fields as diverse as building, transportation, energy or healthcare. In many cases, ceramic-based materials are a natural alternative but, so far, they are marred by low toughness and flaw sensitivity. In addition, the mechanical response should be quite often combined with very specific functional properties, e.g. in materials used to support the engineering of new tissue. Scientist and engineers are looking now at nature in search of inspiration to solve these challenges. Natural materials such as bone or nacre exhibit unique combinations of properties through the use of sophisticated structural designs that span multiple length-scales from atomic to macroscopic dimensions combined with carefully engineered internal interfaces. However, the development of new fabrication techniques able to deliver the degree of structural control required to translate natural designs is proving extremely complex. In this presentation we will review several top-down and bottom-up approaches for the fabrication of ceramic-based hybrid materials, from the bio-inspired mineralization of polymer scaffolds to the freezing of ceramic suspensions. The main characteristics of these processes and the resulting materials will be compared. The goal is to summarize current achievements and outline key challenges in the field.