

Bioinspired Design

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Abstract

Bioinspired design involves the use of concepts observed in natural biological materials in engineering design. The hope is that the leveraging of biological materials in the engineering domain can lead to many technological innovations and novel products. This work presents the initial material characterization of *kinixys erosa* tortoise shell using a combination of x-ray diffraction, optical/scanning electron microscopy and micro-mechanical testing. The results were used in the analytical/computational modelling of shell structures. The potential implications or the results were then discussed to give fundamental understanding of deformation and stress responses of shell structures

1.0 Introduction

Bioinspired design involves the use of concepts observed in natural biological materials in engineering design. The hope is that the leveraging of biological materials in the engineering domain can lead to many technological innovations and novel products [1]. Similarly, the field of Biomimetics involves the imitation of nature [2]. It is a multidisciplinary field that can also results in the development of novel materials with remarkable mechanical properties.

Many biological tissues and devices have remarkable engineering properties [3]. For example, the toughness of spider silk [3], the specific strength and stiffness of bamboo [3] or the adhesion abilities of the gecko feet [3] are a few of the many examples of high- performance natural materials [3, 4].

Unlike the design of conventional engineering materials that often involve the use of multiple materials chemistries in the design of engineering components and systems, natural biological materials are made from relatively few chemical constituents. For example, a molecule such as type I collagen serves as the building block for a variety of tissues in the human body. These include: bone; cartilage; skin and the cornea in the eye.

In many cases, hard biological materials exist as composites. These high-performance natural composites are made up of relatively weak components (brittle minerals and soft proteins) arranged in intricate ways to achieve specific combinations of stiffness, strength and fracture toughness (resistance to cracking). Determining which features control the performance of biological materials is the first step in Biomimetics. These 'key features' can then be implemented into artificial bio-inspired synthetic materials, using innovative techniques such as layer-by-layer assembly of nanocomposites [2] or ice-templated crystallization or freeze casting [6, 7].

Meyers et al. [5] studied several biological materials (e.g. nacre, ligaments, hoofs, blood vessels, beak interiors, chameleon, etc.) using diverse materials approaches. Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), nanoindentation, and molecular simulations and modelling were used to study the layered structures