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IUTAM Symposium Architectured Materials Mechanics | Symposium Contributions

Sep 17th, 12:00 AM - Sep 19th, 12:00 AM

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**IUTAM Symposium Architectured Material Mechanics,**
**T. Siegmund, F. Barthelat, eds**
**September 17-19, 2018, Chicago, IL, USA, , Chicago, IL, USA**

# Role of Architecture in Controlling Crack Propagation Direction Bio-Inspired From Boxfish Scute

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**KEYWORDS:**
Patterned interface, Crack direction, Finite element analysis, Biomimetic

The boxfish carapace (*Lactoria Cornuta*) contains hexagonal dermal scutes, a combination of the brittle hexagonal plate (hydroxyapatite) on top of a very compliant (collagen) material. This offers a flexible armor that protects the boxfish against predators. While the mineral plates are separated by patterned sutures, there is no interphase material connecting them. Instead, the connection between mineralized plates is done through the collagen base. This is different from other naturally-occurring sutures (e.g. sutures in turtle, alligator, armadillo). It is hypothesized that this architecture (combination of sutures, brittle material, and collagen base) helps prevent catastrophic failure of the mineral plates under various multiaxial loading conditions (including bending and shear). In this work, we investigated the protective role of this architecture in controlling the crack directions under shear loading. The material properties of the boxfish scute (mineralized plate and collagen sub-base) are characterized through a combination of using *in-situ* tests and FE models. Our numerical results reveals that architecture of the sutures and combination of materials play a significant role in controlling crack direction. We present a parametric and systematic study along employing analytical and numerical tools to understand the role of different geometrical and material parameters of the system (e.g., sutures angle, dimensional aspect ratios, and modulus aspect ratio of hard and soft material properties) in controlling the crack direction. We also built bio-inspired specimens using gypsum (brittle plate) and silicone (soft substrate) in order to demonstrate this effect and understand this behavior.

**Acknowledgments**

This work is funded by a Multi-University Research Initiative through the Air Force Office of Scientific Research (AFOSR-FA9550-15-1-0009), National Science Foundation, Biomaterials Grant DMR-1507978 and NSF CAREER award CMMI 1254864.