

Mechanical response of spicule nested structure

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Abstract:

Nature provides a rich source of inspiration for scientific inquiry, as evidenced by the success of biomimicry in improving existing technologies. Recent studies have shown that the unique structure of the Euplectella Aspergillum (EA) sponge exhibits similar elevated mechanical properties across all its structural levels. Its intricate design elements, including diagonal bracing and the holdfast apparatus, provide a foundation for researchers to explore how this structure can be applied to other materials. The alternating layers of silica and organic material seen in the EA spicules' structure have been investigated to increase mechanical properties compared to a solid rod, increasing the strength of brittle materials. In this work, we use a phase-field fracture model to understand the mechanical properties of EA spicule structures. We use MOOSE framework as our parallel finite element implementation to simulate EA spicule nested cylindrical structures, revealing the mechanics of the improved toughness of its network. Understanding and mimicking its structure can be fundamental to improving existing biomedical devices and civil engineering designs.