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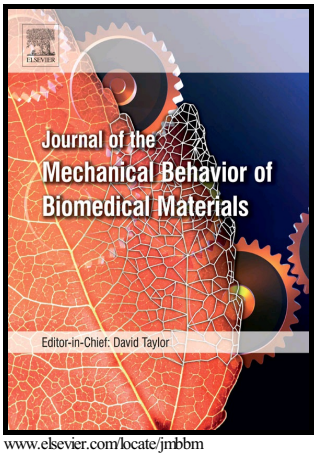

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A Study on the Tubular Composite with Tunable Compression Mechanical Behavior Inspired by wood cell

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Abstract

Biological materials have fascinating mechanical properties built up from simple basic material blocks. It is worthwhile to learn how biological materials are constructed, and to apply the knowledge in advanced manufacturing, and to realize new materials by design. In this study, we chose the tubular cell in the soft wood as a biological prototype, and tried to mimic its intelligent construction principle to regulate the compression mechanical behavior through the helical structure. First, by using the multi-material three-dimensional printing technology, we fabricated a series of tubular composites with the helix fibers of a rigid plastic embedded into an elastomeric matrix. Then, through the uniaxial compression tests, we characterized the mechanical behavior of the specimens, having different fiber angle from 0 to 50 deg at constant volume fraction. The results showed that both stiffness and fracture toughness of the printed composite could be regulated effectively by adjusting the fiber angle of the helical structure. Moreover, the helical structure with high fiber angle is able to improve the compression stability of the tubular composite with big lumen. In addition, for the biomimetic composites, the volume fraction of the reinforcements should exceed 40%. Finally, we proposed a new structural design method by combining the reinforcements of different architectures into a double-layered configuration. The intelligent strategy is proven to balance the conflict between the stiffness and toughness of the composites to some extent, and without changing in the building constituents.

Keywords: fiber-reinforced composite; soft wood; helical structure; compression mechanical behavior; three-dimensional printing