Toughness and Strength Performance of Hierarchical Composites

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Abstract.

It is well known that hierarchical structure is an important feature in biological materials to optimize various properties, including mechanical ones. It is however still unclear how these hierarchical architectures can improve composite material characteristics, for example strength and toughness, and their transposition to bioinspired materials remains to be perfected. In this paper, we systematically investigate the role of hierarchy in fibre-based composite materials using a modified Fibre Bundle Model, and in biological protein materials using the Hierarchical Bell Model. Results show that hierarchy indeed plays an important role and through appropriate choice of structure it is possible to "tune" the strength and toughness of composites in a wide range of values. In limited cases, it is possible to achieve high strength and toughness, normally considered mutually exclusive properties in artificial materials. Thus, drawing from biological examples can help in the design of new composite materials with optimized properties.

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