# The fracture of Nacre-like graphite

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**Abstract**

Due to its unique bond configuration with weakly bonded graphene layers, graphite is a lightweight material that exhibits excellent and highly anisotropic thermal and electrical conductivities and unique mechanical properties combined with good thermal and chemical stability. For these reasons, graphite is a material of interest for many advanced applications from thermal management to nuclear fusion. In this work, a novel highly aligned nacre-like graphite/ceramic composite was synthesized via pressure assisted sintering. In these composites, single crystal graphite platelets, with dimensions ranging from 10 to 20 $\mu$m, act as bricks bonded with a refractory ceramic mortar. We have analysed the strength and fracture resistance of the resultant composites using a combination of ex-situ and in-situ testing in the scanning electron microscope. The materials retain bending strengths ranging from 30 to 100 MPa and their nacre-like structure results in a unique fracture behaviour in which crack propagation is accompanied by the bending and exfoliation of graphite platelets. As a result, the composites exhibit a characteristic raising R-curve with toughness reaching values above 3 MPam1/2. The in-situ experiments allow us to identify the toughening mechanisms and relate them to the materials microstructure. The behaviour is compared to micromechanical tests performed in single graphite platelets. This work will help us to design improved graphite-based composites combining structural and functional capabilities.

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