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The phase field fracture method and its application for predicting the failure of composite materials

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ABSTRACT

The phase field fracture method has quickly gained traction as a powerful numerical tool. Advanced cracking phenomena, such as crack branching, merging, initiation from arbitrary sites and complex crack trajectories, can be captured without convergence problems and on the original finite element mesh - see Ref. [1] for an overview.

In this work, the phase field paradigm is exploited to gain insight into the behaviour of composites materials across the scales. First, it will be shown how phase field fracture can be combined with cohesive zone models to resolve the micro-mechanical behaviour of fibre-reinforced composite materials and predict matrix cracking, fibre cracking, and fibre-matrix decohesion [2]. For the first time, 3D simulations are conducted and hence toughening mechanisms such as fibre-bridging are predicted as an output of the modelling for various composite microstructures [3]. In addition, environmental-material interactions can readily accounted for. Specifically, we investigate the role of moisture content upon the degradation of composite materials at the micro-scale, meso-scale (ply-level), and macro-scale (laminate-level) [4]. Moreover, the electro-mechanical analysis of smart (CNT-based) composites undergoing fracture will also be discussed [5, 6].

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