Phase-field Modelling and Simulation of Crack Branching and Deflection in Heterogeneous Media

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ABSTRACT

Modern material design often makes use of composites, i.e. superior properties are achieved by combining at least two different constituents, for example fibres embedded in a polymer. For such structures, it is inevitable to account for the properties of the interfaces connecting both materials, especially when it comes to crack propagation within the structure.

In previous works, a phase-field model was presented, which incorporates the material heterogeneity in a regularised manner, i.e. the formerly discrete interface can be assigned a finite characteristic width, which is still very small compared to the domain dimension. It was shown in previous investigations [1, 2], that the regularisation of both, crack and interface, yield deviations in the effective numerical fracture toughness of the interface, that has to be accounted for. To allow for efficient computations, the model [1] is implemented in the finite element framework FEniCS [3].

In this contribution, the approach is compared to and validated for more complex numerical examples from linear elastic fracture mechanics [4]. Furthermore, different interface regularisations are investigated and the results and limitations are discussed qualitatively and quantitatively using configurational forces [5]. Finally, the approach is extended to elastic heterogeneities.

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