Phase field modeling of interfacial crack propagation in quasi-brittle heterogeneous materials

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ABSTRACT

Phase field model has been proved to be a useful tool to study the fracture behaviors in heterogeneous materials [1, 2]. This method is able to model complex, multiple crack fronts, and branching in both 2D/3D without ad-hoc numerical treatments. In this study, a new interfacial cracking model in the phase field framework is proposed [3]. The effects of both stiff and soft interphases on the fracture response of composite materials are considered. A dimensional-reduced model based on a rigorous asymptotic analysis is adapted to derive the null thickness imperfect interface models from an original configuration containing thin interphase. The idea of mixing the bulk and interfacial energy within the phase field framework in Nguyen et al. [2] is then used to describe the material degradation both on the interface and in bulk. Moreover, in order to ensure the physical crack propagation patterns, a unilateral contact condition is also proposed for the case of spring imperfect interface. The complex cracking phenomena on interfaces such as initiation, delamination, coalescence, deflection, as well as the competition between the interface and bulk cracking are successfully predicted by the present method. Concerning the numerical aspect, the one-pass staggered algorithm is adapted, providing an extremely robust approach to study interfacial cracking phenomena in a broad class of heterogeneous materials.

REFERENCES

[1] Nguyen, T. T., Yvonnet, J., Zhu, Q. Z., Bornert, M., and Chateau, C. A phase field method to simulate crack nucleation and propagation in strongly heterogeneous materials from direct imaging of their microstructure. *Eng Fract Mech.* (2015) **139**:18–39

[2] Nguyen, T. T., Yvonnet, J., Zhu, Q. Z., Bornert, M., and Chateau, C. A phase-field method for computational modeling of interfacial damage interacting with crack propagation in realistic microstructures obtained by microtomography. *Comput Methods Appl Mech Eng.* (2016) **312**:567–595.

[3] Nguyen, T. T., Yvonnet, J., Waldmann, D., and He, Q.C. Phase field simulation of interfacial cracking in heterogeneous materials. *In preparation* (2019)