Workshop on Experimental and Computational Fracture Mechanics
March 4-6, 2024, Baton Rouge, LA

A BOND-BASED PERIDYNAMICS MODELING OF POLYMERIC MATERIAL FRACTURE UNDER FINITE DEFORMATION

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ABSTRACT

We have developed a bond-based peridynamics model to study the fracture of polymer networks under finite deformation [1]. Our approach is based on the Kuhn-Grün model [2] of randomly jointed polymers with extensible chains, which allows the rupture of polymers through the chain scission mechanism [3]. We introduced a novel mesoscale potential function into a nonlocal continuum framework with the purpose of modeling the mechanical response and fracture of polymers. We have demonstrated through a series of numerical examples, both two-dimensional and three-dimensional, that the proposed model is robust and efficient in modeling crack growth in polymeric materials. The model is carefully validated with experimental data and numerical results obtained on the basis of existing continuum mechanics polymer models. We have shown that the proposed peridynamics model is accurate and stable in various configurations and loading modes, such as mode-I and shear crack opening. In comparison to existing continuum polymer models and fracture modeling methods, our technique has the advantages of being theoretically simple, rigorous, and computationally fast. The numerical results show that the nonlocal polymer model can easily capture the fracture process in polymeric materials without complex ad hoc modeling parameters under finite deformation, and it has the potential to become a convenient simulation tool for modeling the polymer failure process in the design and optimization of polymeric materials.

REFERENCES

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