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Chemically-Assisted Fracture in Porous Media: A Phase-Field Fracture Study

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Abstract:

Controlling and predicting fracture initiation and propagation is essential in understanding transport phenomena in many porous systems such as geological porous media. Fracture in such porous media can be controlled by stress and/or chemical environments. Chemical environments impact fracture development in two ways: (i) chemically-assisted fracture growth, and (ii) chemical dissolution/precipitation that alters the mechanical properties of media and fracture. In this work, we present a newly developed phase-field fracture formulation that deals with fracture propagation in a chemically reactive environment. We first show how our coupled numerical model accounts for both mechanical damage and chemical damage that is defined based on the diffusive phase-field method. In this work, the chemical damage is associated with the change in the porosity due to the chemical dissolution. We then illustrate the role of chemical damage by applying our theoretical framework to subsurface rock experiencing calcite dissolution due to exposure to CO_2. Through this numerical tool, we investigated the fracture behavior of sandstone, limestone, and shale. Our results indicate that size of the diffusive damage zone is a function of both porosity as well as initial diffusion coefficients of each porous rock. Moreover, the dissolution plays a dominat role in crack propagation speed and the size of the damage zone [1].

[1]Schuler, L., Ilgen A.G., and Newell, P. (2020). *Chemo-mechanical phase-field modeling of dissolution-assisted fracture.* Computer Methods in Applied Mechanics and Engineering, V 362, 112838.