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Multiphysics and Multiscale modelling of non-local phase-field fractures

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Phase-field fracture is a very active research field with numerous applications. The model is used to describe the crack propagation in brittle materials (e.g., concrete and ceramics), ductile materials such as metals and steel, and multiphysics phenomena such as hydraulic fracture (extracting oil and natural gases), corrosion and thermally induced fracture problems. This topic is numerically challenging since (i) the energy functional may admit several local minimizers, (ii) imposing the global irreversibility of the fracture field often requires special treatment, (iii) dependency of regularization parameter with discretization size, and (iv) the coupled equations are typically ill-conditioned. In this mini-symposium, we would like to address these computational challenges. Moreover, materials often considered homogeneous have a large variation in material properties due to the underlying microstructure. These variations/fluctuations are resolved via multiscale modelling. So, another aspect aimed to be addressed is the extension of the phase-field fracture model towards multiscale problems. In this case, the prolongation of macroscale response onto the microstructure and upscaling the microstructural response to the macroscale remains a key challenge (for both concurrent and hierarchical models). But, the cost of multiscale modelling coupled with fracture analysis is computationally demanding. As such, model order reduction techniques may be an interesting avenue.

To sum up, the following research areas (but not limited to) in the mini-symposium are:

a. Computational challenges (non-convexity of energy, variational inequality minimization, hp adaptivity).

b. Multiphysics modeling with coupling techniques.

c. Multiscale modeling (concurrent and hierarchical formulations, surrogate modeling), and related model order reduction techniques.

d. Fatigue life prediction.

e. Numerical analysis, error estimates, and adaptive schemes.

f. Uncertainty quantification with Bayesian inversion and stochastic analysis.