Modeling and analysis of a nonlinear PDE-system for phase separation and damage

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Materials like alloys, which enable the functionality of technical products, change the microstructure over time. For instance, phase separation, coarsening and damage processes take place.

The Cahn-Hilliard system is a well established model to describe phase separation and coarsening in alloys. To account for elastic effects, the Cahn-Hilliard system is coupled with an elliptic equation for the deformation field, the so-called Cahn-Larché system.

In this talk, we present a new model where the Cahn-Larché system is coupled with a damage phase-field. The coupling takes place in the elastic energy density of the system, which now depends on the strain, the chemical concentration and the damage variable. We assume that the damage process influences its local surrounding and that the damage process is uni-directional, which leads to a differential inclusion for the damage variable.

We present a suitable notion of weak solutions for the introduced system, provide existence and regularity results under appropriate growth conditions for the free energy and show some numerical simulations.

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