A Cahn–Hilliard phase field model coupled to viscoelasticity at large strains

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In this talk I will present a new Cahn–Hilliard phase field model coupled to incompressible viscoelasticity at large strains, obtained from a diffuse interface mixture model and formulated in the Eulerian configuration.

The free energy density of the system is given as the sum of a Cahn–Hilliard term and an elastic term, with a coupling between the phase field variable and the elastic deformation gradient in the elastic contribution. I will introduce different kinds of diffusive regularizations of the transport equation for the deformation gradient, and I will discuss the proof of the global existence of weak solutions in three space dimensions for the regularized system with generic nonlinear elastic energy densities with polynomial growth, comprising the relevant cases of polyconvex Mooney–Rivlin and Ogden elastic energies. I will also propose two kinds of well posed and unconditionally energy stable finite element approximations of the model, based on convex splitting ideas and on the use of a scalar auxiliary variable. Finally, I will show numerical results for different test cases with shape memory alloy type free energy, and I will discuss some possible applications and future developments of the model in the field of biomathematical modeling for computational medicine.

This is a joint work with Pierluigi Colli, Harald Garcke and Elisabetta Rocca.