On stress and driving force calculation within phase-field models: Applications to martensitic phase transformation and crack propagation in multiphase systems

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ABSTRACT

Computational models based on the phase-field method have become an indispensable tool for modeling the microstructural evolution in material science and physics. The combination of phase-field modeling with multiphysics applications such as heat and mass transfer, continuum mechanics, fluid flow, micromagnetism and electrochemistry has been achieved. The models typically operate on a mesoscopic length scale and provide valuable information about structural changes in materials through describing the interface motion. The specific parametrization method of the model complicates to satisfy the jump conditions and the formulation of the driving forces at the interfaces, since the sharp interface is stretched over a volumetric region.

In this talk, local homogenization methods of mechanical material parameters are analyzed and a method is presented that guarantees the fulfillment of the mechanical jump conditions and reflects the mechanical configuration forces at diffusely parameterized interfaces [1]. This model is extended for applications in multiphase systems and applied to the martensitic phase transformation process [2]. The mechanically driven interface motion also includes the propagation and development of cracks. To analyze these processes, a multiphase-field model is presented to study the crack propagation in polycrystalline materials coupled with a phase transformation process. The model is applied to polycrystalline materials with heterogeneous crack resistance. Additionally, the influence of the grain boundary energy between the solid phases on the resulting crack path is demonstrated [3, 4].

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