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A RATE-DEPENDENT PHASE FIELD APPROACH FOR THE FAILURE OF RUBBERLIKE MATERIALS

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Rubbery polymers consist of network of long polymer chains responsible for the elastic response and a secondary free chains superimposed to the elastic network in terms of entanglements leading to the rate-dependent viscoelastic response. The fracture toughness of rubbery polymers is a rate-dependent phenomenon [1]. This effect manifests itself in terms of monotonically increasing fracture toughness with increased crack velocity examined in tearing tests. In this contribution, we propose a rate-dependent phase field approach for the failure of rubberlike materials. The ground state elasticity is modelled with the non-affine microsphere model whereas the superimposed viscous effects are incorporated into the model with a number of Maxwell elements [2]. The deformation gradient is multiplicatively decomposed into elastic and viscous parts. For the evolution of the viscous deformations, micromechanically motivated chain relaxation kinetics is derived. As a novel aspect, local phase field approach similar to damage mechanics formulation governs the failure of the superimposed chains whereas the degradation of the elastic network is governed by a classical Ginzburg-Landau type phase field approach in the sense of Schaenzel et al. [2,3]. The parameter identification is carried out from the existing data from the literature. We demonstrate qualitative results of the proposed model by means of representative numerical examples.

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