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A Micromechanically Based Network Model for Rubbery Polymers Incorporating Mullins-Type Stress Softening

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We present a new micromechanically based constitutive model that embodies the Mullins-type stress softening in rubberlike materials. The overall rubber network is decomposed into two parts: crosslink-to-crosslink (CC) and particle-to-particle (PP) network. The Mullins-type damage phenomenon is embedded in the PP network. The key idea of the constitutive approach is a two-step procedure: (i) The set up micromechanically based constitutive models for a single chain orientation and (ii) the definition of the macroscopic stress response of the polymer network by a directly evaluated micro-to-macro transition for a discrete orientation space on a micro sphere structure. Due to intrinsic discrete orientation distribution of micro-variables, the model allows to formulate inelasticity in terms of one dimensional scalar variables in lieu of tensorial ones. To this end, the model inherently includes a deformation-induced anisotropic behavior since the different loading histories are experienced by different orientations.

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