Polymer Program

INSTITUTE OF MATERIALS SCIENCE

Seminar: 11:10 am Friday, February 17

Location: Science 1- room 1002

Host: Kelly Burke

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Micromechanical Platform to Study Nonlinear Behavior of Elastomeric Materials

Abstract: Cross-linked elastomers exhibit nonlinear behavior under large deformations with inelastic features such as the Mullins effect, permanent set, deformation-induced anisotropy, and fatigue-induced stress softening due to cyclic deformation. While several constitutive models are developed to consider each of these features individually, there are only a few models which can incorporate damage accumulation in cross-linked elastomers that occur due to multiple parallel factors. In this work, a new modular platform is developed to integrate different inelastic mechanisms into one generalized constitutive model. The concept of network decomposition is the keystone of the proposed platform. The energy of each network is determined through the concept of the unit sphere, in which the total strain energy of the polymer matrix can be estimated by summation of the free energy of sub-networks in all directions. Therefore, a three-dimensional (3D) polymer matrix can be decomposed to unidirectional sub-network elements uniformly distributed over a unit micro-sphere, which hosts a simplified 1D inelastic mechanism. The network models can be substituted, upgraded, or removed without influencing the integrity of the framework. Finally, a micro-mechanical constitutive model is presented for cross-linked elastomers subject to a high number of cyclic deformations and environmental degradation. The model can be particularly used to elucidate inelastic features, such as permanent damage during the deformation of each cycle. Numerical results of the developed models are validated and compared by uniaxial cyclic tensile experimental data of DN gels.