Séminaire PIMM

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Large deformation behavior and fatigue of polymers: constitutive modeling and fatigue life

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Two representative polymers are studied in this work: a semi-crystalline thermoplastic (polyethylene) and an elastomer (styrene-butadiene rubber SBR). A physically-based hyperelasticviscoplastic model integrating the crystallinity effects is proposed to describe the mechanical behavior under large deformation of polyethylene. The capabilities of the proposed model to reproduce the mechanical behavior of typical thermoplastic (viscoplastic-hyperelastic) to the mechanical behavior more typical of elastomers (visco-hyperelastic) are demonstrated. The proposed model is modified by incorporating a non-linear viscous component to capture the mechanical behavior of polyethylene under cyclic loading. To describe the damage process under multiaxial cyclic loading of SBR, two complementary approaches have been used. The first one, based on the network alteration theory, allows describing the stress-softening until failure. The comparison between the proposed model and experimental results obtained under uniaxial cyclic loading highlighted the relevance of such approach. The second one, based on the continuum damage mechanics theory, aims to predict the multiaxial fatigue life under complex loadings of rubber-like materials. In this approach, the damage variable is derived from the cracking energy density. After identifying the damage parameters using uniaxial fatigue data, the predictive capabilities of the proposed model are highlighted under multiaxial loadings, combining tension and torsion tests.