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A Unified Constitutive Model for the Thermoplastic/Elastomeric-Like Cyclic Response of Polyethylene with Different Crystal Contents

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Abstract : In this contribution, the effect of crystal content on the cyclic response of semi-crystalline polyethylene is studied over a large strain range. Experimental observations on a high-density polyethylene with 72% crystal content and an ultralow density polyethylene with 15% crystal content are reported. The cyclic stretching does appear a thermoplastic-like response for high crystallinity and an elastomeric-like response for low crystallinity, both characterized by a stress-softening, a hysteresis and a residual strain, whose amount depends on the crystallinity and the applied strain. Based on the experimental observations, a unified viscoelastic-viscoplastic constitutive model capturing the polyethylene cyclic response features is proposed. A two-phase representation of the polyethylene microstructure allows taking into consideration the effective contribution of the crystalline and amorphous phases to the intermolecular resistance to deformation which is coupled, to capture the strain hardening, to a resistance to molecular orientation. The polyethylene cyclic response features are captured by introducing evolution laws for the model parameters affected by the microstructure alteration due to the cyclic stretching.

Keywords : cyclic loading unloading, polyethylene, semi-crystalline polymer, viscoelastic-viscoplastic constitutive model
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