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Multi-step loading/unloading experiments that challenge constitutive models of glassy polymers JAMES CARUTHERS, GRIGORI MEDVEDEV, Purdue University — The mechanical response of glassy polymers depends on the thermal and deformational history, where the resulting relaxation phenomenon remains a significant challenge for constitutive modeling. For strain controlled experiments the stress response is measured during loading/unloading ramps and a constant strain. By judiciously combining the basic steps, a set of multi-step experiments have been designed to challenge existing constitutive models for glassy polymers. A particular example is the “stress memory” experiment, i.e. loading through yield, unloading to zero stress, and holding at final strain, where the subsequent evolution of the stress exhibits an overshoot. The observed dependence of the overshoot on the loading strain rate cannot be explained by the models where the relaxation time is a function of stress or strain. Another discriminating multi-step history experiment involves strain accumulation to test the common assumption that the phenomenon of strain hardening is caused by a purely elastic contribution to stress. Experimental results will be presented for a low Tg epoxy system, and the data will be used to critically analyze the predictions of both traditional viscoelastic/viscoplastic constitutive models and a recently developed Stochastic Constitutive Model.

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