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Multi-step deformations – a stringent test for constitutive models for polymer glasses GRIGORI MEDVEDEV, JAMES CARUTHERS, Purdue University — A number of constitutive models have been proposed to describe mechanical behavior of polymer glasses, where the focus has been on the stress-strain curve observed in a constant strain rate deformation. The stress-strain curve possesses several prominent features, including yield, post-yield softening, flow, and hardening, which have proven challenging to predict. As a result, both viscoplastic and nonlinear viscoelastic constitutive models have become quite intricate, where a new mechanism is invoked for each bend of the stress-strain curve. We demonstrate on several examples that when the models are used to describe the multi-step deformations vs. the more common single strain rate deformation, they produce responses that are qualitatively incorrect, revealing the existing models to be parameterizations of a single-step curve. A recently developed stochastic constitutive model has fewer problems than the traditional viscoelastic/viscoplastic models, but it also has difficulties. The implications for the mechanics and physics of glassy polymers will be discussed.

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