Thermodynamically based finite strain viscoelastic viscoplastic constitutive model for glassy polymers: isotropic and anisotropic versions

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ABSTRACT

A coupled viscoelastic (VE) and viscoplastic (VP) constitutive model in the finite strain regime was recently proposed for polymers under isotropic and isothermal conditions (Gudimetla and Doghri [2017]). The proposed model extends the infinitesimal strain models of Miled et al., [2011] and Krairi and Doghri [2014] to the large strain deformation and includes a pressure-dependent VP response. The model is derived from a thermodynamic framework by satisfying the Clausis-Duhem non-negative dissipation inequality. The VE part has an integral form similar to Christensen [1982] for pure VE and the time-dependent response is taken into account by a non-classical VE strain measure. The flow rules and the VP response are formulated using the deviatoric and hydrostatic parts of the Mandel stress tensor which is defined in the reference configuration. Fully implicit time integration algorithm was developed and implemented. The comparison between the predictions from the proposed VE-VP model and experimental data for RTM6-epoxy resin (Morelle [2017]) demonstrate that the model is able to represent the observed time-dependent mechanical behavior of the RTM6 epoxy resin both qualitatively and quantitatively. The finite strain VE-VP model was recently extended to the anisotropic case. The results of the numerical simulations are presented and discussed.

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