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ABSTRACT

A Thermoviscoelastic Approach to Model the Frequency Dependence of Mechanical Material Properties, Thermal Expansion and Specific Heat

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Thermoplastic polymers exhibit frequency dependences in their mechanical response functions, their thermal expansion behaviour and their specific heat capacity, which are detectable under harmonic mechanical or thermal loads. Harmonic mechanical loads are standard, but harmonic temperature changes in calorimetry or dilatometry are regularly not incorporated in portfolios of experimental labs. In order to represent such behaviour in continuum mechanics, a three-dimensional approach based on a hybrid free energy function is proposed and evaluated considering the Clausius Duhem inequality. The Gibbs part of the free energy describes the volumetric behaviour and depends on pressure, temperature and internal variables. The Helmholtz part depends on the deviatoric part of the infinitesimal strain tensor, the temperature and other internal variables. With customary methods, frequency dependent relations for the specific heat, the thermal expansion coefficient and the dynamic moduli are computed in closed form. The outcome of the model is discussed in the context of observations from literature.