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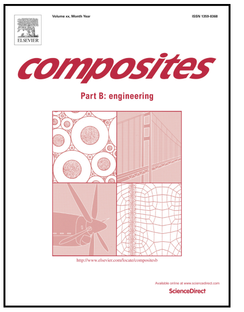

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A new constitutive model for polymeric matrices: Application to biomedical materials

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Abstract: Semi-crystalline polymeric composites are increasingly used as bearing material in the biomedical sector, mainly because of their specific mechanical properties and the new advances in 3D printing technologies that allows for customised devices. Among these applications, total or partial prostheses for surgical purposes must consider the influence of temperature and loading rate. This paper proposes a new constitutive model for semi-crystalline polymers, commonly used as matrix material in a wide variety of biomedical composites, that enables reliable predictions under a wide range of loading conditions. Most of the recent models present limitations to predict the non-linear behaviour of the polymer when it is exposed to large deformations at high strain rates. The proposed model takes into account characteristic behaviours of injected and 3D printed thermoplastic polymers such as material hardening due to strain rate sensitivity, thermal softening, thermal expansion and combines viscoelastic and viscoplastic responses. These viscous-behaviours are relevant for biomedical applications where temperature evolution is expected during the deformation process due to heat generation induced by inelastic dissipation, being essential the thermo-mechanical coupling consideration. The constitutive model is formulated for finite deformations within a thermodynamically consistent framework. Additionally, the model is implemented in a finite element code and its parameters are identified for two biomedical polymers: ultra-high-molecular-weight-polyethylene (UHMWPE) and high density polyethylene (HDPE). Finally, the influence of