SL 3.1

Modeling the Time-Temperature Dependency of Thermoplastics Used in Solid-Phase Thermoforming Process

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Many constitutive theories, hyperelastic and viscoelastic have been proposed for modeling materials used in solid-phase forming processes such as thermoforming and blow molding. The phenomenological hyperelastic models were developed based purely on mathematical interpretation whereas physically base hyperelastic models were established from the formalism of macromolecular conformation as a thermodynamically reversible process. It has been shown earlier that materials being thermoform experienced rate-temperature dependent deformation ranges from constant width (CW) through to equal biaxial (EB)[1]. Modeling this complex deformation behavior is widely recognized to be un-feasible with typical hyperelastic model, where the fulfillment of energy conservation would renders these models time independent. In order to account for time-temperature dependency, viscoelastic model that encompass the linking of hyperelastic laws and viscous flow theories have been proposed by numerous researchers. This paper revisited and analyzed a number of the rate-temperature-equivalent viscous flow theories commonly used in material modeling, includes the *Williams-Landel-Ferry* (*WLF*)[2], *Arrhenius*[3], and *Vogel-Fulcher-Tammman* (*VFT*)[4,5,6], in term of their effectiveness in interpreting the time-temperature dependent relaxation behavior of polypropylene (PP) and high impact polystyrene (HIPS).