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Modelling of Thermoplastic PolyOlefin (TPO) sheets for thermoforming applications

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Thermoplastic PolyOlefin (TPO) materials have shown great interest for automotive applications. The mechanical characteristics of these materials are in good agreements with the environmental and economical context of the last decade. In fact, beyond their cost and recyclability, they allow important weight gain, excellent design flexibility, and high quality whether in term of appearance or tactile and olfactory perceptions.

The aim of this study was to model the behaviour of new TPO sheets for thermoforming applications. The studied material can reach very high stretch ranges (up to 800%) and was found to be transversely isotropic. In order to properly predict the thickness distribution of the final thermoformed parts, uniaxial tensile tests were performed along the longitudinal, transverse and diagonal directions, at 5 different temperatures from ambient to 120°C. A new transversely isotropic hyperelastic model was developed using User Subroutines in Abaqus software. The material parameters at each temperature have been identified using inverse methods, and good results have been obtained.

The identification procedure has shown to be difficult because of the high sensitivity of the material parameters and the instability problems at high stretch ranges. This paper focuses on the fitting of the material parameters using the new anisotropic hyperelastic model which have proved to be very flexible and efficient to model different hyperelastic response shapes. On the other hand, the contribution of each material parameter and its effects on the mechanical behaviour has been studied for a faster and a more stable result of the fitting procedure.

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