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Rheological behavior and structure development in thermoplastic polyurethanes under uniaxial extensional flow

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ABSTRACT

In this work, the rheological and structural changes induced by uniaxial extensional flows are studied for two aromatic TPUs: an elastomeric (soft) material composed both of hard and soft segments and an amorphous glass (hard) one composed almost exclusively by hard segments. The uniaxial extensional viscosity was measured on a Sentmanat fixture (SER) at single temperature of 175°C, showing that at high strain rates both materials initially strain-soften before eventually strain-hardening at higher Hencky strains. This effect is smoother and occurs at lower strain rates for the soft TPU. Optical microscopy, atomic force microscopy and X-ray scattering show this behavior to be related with structural changes induced by the flow. Strain-softening is attributed to the orientation of hard domains in the flow direction. In the soft TPU strain-hardening is caused by the stretching of entangled soft segments but in the hard one it appears to be associated with microcracks and with the development of a hitherto unreported hierarchical structure in the molten material.

Keywords: Thermoplastic polyurethanes; Extensional flow; Structure development

1. Introduction

Thermoplastic polyurethanes (TPUs) are multi-block copolymers usually consisting of hard and soft segments. The hard segments (HSs), which are composed of diisocyanate