VOLUMETRIC RHEOLOGY OF POLYMERS: THE INFLUENCE OF SHEAR FLOW COOLING RATE AND PRESSURE ON THE SPECIFIC VOLUME OF IPP HOMOPOLYMERS

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Abstract

Polypropylene as a commodity polymer has a high market share and therefore a huge data set for simulation and processing parameters are available. However, the relationship between rheology, processing conditions and the main properties determining macroscopic shrinkage (i.e. specific volume) is still not understood in sufficient detail to predict the resulting dimensions of a product. Since specific volume is the key parameter for the final shape of a product, e.g.: Injection moulding, a custom designed dilatometer was used for the quantification of the influence of shear, pressure and cooling rate on specific volume. The fully automated dilatometer achieves cooling rates up to100 ºC/s, elevated pressures up to 100 MPa and shear rates up to 200 s^{-1}. In this study three different iPP homopolymers grades, different in molecular weight and molecular weight distribution, were investigated. Isotactic polypropylene iPP1 had a molecular weigth of M_w~310 kg/mol and a PDI of M_w/M_n~3.4, iPP2 a molar mass of M_w~376 kg/mol and a molecular weight distribution of M_w/M_n~6.7 and finally the molecular characteristics of iPP3 were M_w~466 kg/mol and M_w/M_n~6.6. Experiments at different cooling rates were performed at elevated pressures in the range of 10 MPa to 60 MPa and cooling rates of 0.1 ºC/s and 1.5 ºC/s. Shear experiments at elevated pressures in the range of 10 MPa to 60 MPa, a cooling rate of 1.5 ºC/s and a constant shear rate of 67s^{-1} applied at two different temperatures of 143ºC and 164ºC respectively. Dependent of the molecular characteristics of the materials, cooling rates and shear flow pronounced effects on the temperature indicating the transition in specific volume T_c and the rate of transition were found. In order to investigate the crystalline morphology, additional ex situ measurements were performed with optical microscopy.

References

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