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Correlation between Morphology, Rheological Properties, and Fracture Behavior of Binary Triblock Copolymer Blends

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The influence of processing conditions of binary blends of triblock copolymers on morphology, rheological and tensile properties has been studied. Blends of a symmetrical triblock copolymer with thermoplastic elastomeric behaviour (TPE; LN4) and an asymmetrical thermoplastic triblock copolymer (TP; LN3) have been prepared by rolling and subsequent compression moulding. The melt rheological properties have been studied using an ARES rheometer in dynamic mode in the temperature range of 120-220°C. The frequency and temperature dependence of the storage modulus (G') has been studied and master curves were constructed using time-temperature superposition principle based on Williams-Landel-Ferry (WLF) equation. It has been observed that the order-disorder transition increases as the thermoplastic LN3 content increase. Furthermore, the storage modulus (G') was observed to shift to lower values in the low-frequency regime with decreasing LN3 content. The equilibrium morphologies of the blends were found to be highly dependent on the processing. TEM images of the blends show a systematic variation in the equilibrium morphologies from lamellae (100-80 wt.% LN3)-bicontinuous (gyroid) (70 wt.% LN3) –cylinders (~60-30 wt.% LN3) – worms (~20-0 wt.% LN3), as a function of the thermoplastic LN3 content. In the case of the materials prepared by rolling bicontinuous structure could not be found, only oriented lamellae structure (70-100 wt.% LN3) could be observed. These changes in morphology are attributed to shear forces in the melt during rolling process which are clearly reflected in the rheological properties. Furthermore the mechanical and fracture behaviour was found to be highly dependent on the blend composition. The elastomeric behaviour of the LN4 copolymer dominates up to a LN3 content of 60 wt.-%. Beyond 60wt.-% LN3 the stress-strainbehaviour changes up to distinct higher stress values. Young's modulus and yield stress increase and a maximum in Young's modulus has been observed for blends with about 20 wt.-% TPE. Between 60 and 70 wt.-% LN3 a strong increase in resistance against crack propagation was observed which is attributed to a transition from cylindrical morphology to lamellae morphology.