New breakup phenomena in relaxation after equibiaxial elongation of PS/PMMA blends

U.A. Handge

Institute of Polymers, HCI H 529, Department of Materials, ETH Zürich

In order to optimise the end-use properties of polymeric materials, blending of polymers has become a widely applied industrial routine. The morphology of blends of immiscible polymers strongly influences the end-use properties of multiphase blends. Consequently, understanding the mechanisms which lead to different morphologies is crucial for an efficient polymer processing. In this context, interfacial tension driven flows play an important role for the development of the morphology. Here we studied interfacial tension driven phenomena in polystyrene(PS)/poly(methyl methacrylate) (PMMA) blends in relaxation after melt elongation.

If a PS/PMMA blend is elongated in the molten state, the macroscopic deformation of the blend causes an increase of the interfacial area between the two phases. If polystyrene is the disperse phase, then the initially spherical PS drops are deformed into a nearly ellipsoidal shape. In subsequent relaxation, these elongated PS drops minimize their interfacial energy. If the drops have been deformed into long nearly cylindrical needles (i.e. during simple elongation), such an elongated PS drop can retract back to a single drop or break up into many smaller droplets via sinusoidal undulations of the Rayleigh instability. In this study, we investigated the relaxation of an equibiaxially deformed PS drop in a PMMA matrix. In equibiaxial elongation, the PS drop is deformed into a flat circular disc for large stretch ratios. Using a hotstage that was mounted on a light microscope, we observed the breakup of this PS disc during relaxation. In our experiments, the elongated PS drop broke up by the formation of holes and fingers. The holes were preferentially formed close to the rim of the PS disc. The number and the size of the holes increased with time. When two holes approached, a cylindrical filament was formed which disintegrated by the formation of thicker and thinner zones into smaller droplets. The fingers were located at the rim of the PS disc and formed a bulbous end which finally separated from the fingers. At the end of the relaxation experiment, the original PS drop had been disintegrated into a very large number of small PS droplets.