mgr Justyna Krajenta

Tytuł pracy doktorskiej: Wpływ ograniczenia splątań makrocząsteczek na formowanie i właściwości wybranych polimerów krystalizujących

Centrum Badań Molekularnych i Makromolekularnych Polskiej Akademii Nauk

ul. Sienkiewicza 112

90-363 Łódź

Abstract in English

The aim of this study was to investigate the effect of reducing the entanglement of macromolecules on the physico-chemical properties of crystallizing polymers. The subject of these research were two types of isotactic polypropylenes (iPP), differing in molecular weight, polylactide (PLA) - biodegradable polymer, and polyethylene oxide (PEO). Methods of disentangling these polymers have been mastered, leading to a 2-6 fold reduction in entanglement density. The first step in these procedures was dissolving the polymer: in xylene or mineral oil (PP), methylene chloride (PLA), water (PEO), then stabilization of the partial disentangling of macromolecules, and the last removing the residual solvent from the solidified polymer. The research confirmed the impact of limiting the entanglement of macromolecules on rheological, mechanical and thermal properties. It has been shown that the crystallization process is faster in more disentangled polymers and that less defective crystals grow in them. Crystallization studies also showed a shift in the ranges of crystallization regimes in polymers with reduced entanglement density. An interesting point of the work was to show that the reduction of entanglement promotes the occurrence of the cavitation phenomenon during deformation of polymers (PP and PLA). The intensity of the formation of voids in the structure of polymers as a function of strain and temperature was estimated.

In this work, for the first time, the conditions under which re-entangling occur, as a result of thermal movements, were investigated comprehensively, analyzing the change with the time of annealing of the polymer in the rheological and mechanical properties and the ability to crystallize. It was found that the times of re-entanglement of macromolecules in the previously disentangled polymer depend on the type of polymer (the shortest was for polyethylene oxide), the annealing temperature, but also that the obtained results depend on the type of test performed. For example, in rheological tests of polypropylene, changes indicating entanglement of macromolecules are visible after approx. 15 minutes, but full entanglement is achieved after a much longer stay in the melt. The mechanical test showed that only after 2 hours of annealing in the melt, the polymer with a reduced entanglement density by 50% returns the typical entangled properties.

Finally, the possibility of application partially disentangled polymers to produce all-polymer composites, using a mini extruder or a mixer in the mixing process, when the partially disentangled polymer remains solid and the forces transmitted by the second, molten polymer cause its deformation and the formation of nanofibers are described. After solidification, a fully polymeric composite is obtained. Examples of such nanocomposites are shown: partially disentangled PP in an ethylene-octene copolymer matrix, partially disentangled PP in a polystyrene (PS) matrix, partially disentangled PLA in a PS matrix, partially disentangled PLA in a poly (butylene succinate) (PBS) matrix. It has been proved that by producing in-situ

polymer nanofibers, it was possible to obtain reinforcement of the polymer matrix. For the PS/PP and PS/PLA systems, the contribution of the resulting network of nanofibers to stress transmission was separated.