Synthesis and Properties of Poly(ethylene Glycol)-Nylon 6 Block Copolymer

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PEG-b-nylon 6, A-B-A block copolymers of which the main chains of nylon 6 are blocked with a hydrophilic PEG were prepared by anionic copolymerization of ε-caprolactam using the ε-caprolactam-terminated PEG-HMDI prepolymer as an activator. The products of this copolymerization were molded by reaction injection molding (RIM) technology. In this anionic polymerization process, it was possible to increase the polymerization reaction rate at the lower temperature than that of the polymerization process employed commercially in the nylon 6 production. It was shown that the molecular weight of PEG-b-nylon 6 is higher than that of a commercial nylon 6 and is increased with the increase of PEG content of the block copolymer. Hydrophilicity and electrostatic property of PEG-b-nylon 6 were improved as compared to those of nylon 6. The filament fiber obtained from melt-spinning of PEG-b-nylon 6 has a well-developed fibril structure.

Isothermal and non-isothermal crystallization have been carried out on the DSC to compare the crystallization behavior and crystal morphology of PEG-b-nylon 6 and nylon 6 homopolymer. The thermal analysis result has substantiated that both the cold- and melt-crystallization rates of PEG-b-nylon 6 are faster

than those of nylon 6, and that the Avrami exponent n of PEG-b-nylon 6 is greater than that of nylon 6. The rapid crystallization rate of PEG-b-nylon 6 is highly attributed to the depression of free energy required for the formation of critical nucleus.

The melting point depression of PEG-b-nylon 6 is highly related to both the intermolecular interaction effect giving a rise to a negative χ_{12} value and the morphological effect of the decrease of lamellar thickness with an increase of diluent content. Melting transition curves showed the discrete double melting peaks when nylon 6 and PEG-b-nylon 6 were melted on DSC. This phenomenon for double melting transition has been interpreted in terms of the recrystallization-remelting concept.

The PEG block in PEG-b-nylon 6 exists in an amorphous state even at the temperature lower than the melting point of the corresponding PEG-HMDI prepolymer. This was confirmed from the isolated IR spectra of the PEG block in PEG-b-nylon 6 at various temperatures. The dynamic mechanical spectrum of PEG-b-nylon 6 indicated that two phases are separated in the solid state.