conducting polymers, structure-properties relationship

P12.01.01

Acta Cryst. (2008). A**64**, C547

Relationship between crystallinity and surface morphology of blended PHB thin films

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Our concerns about environmental issue have rapidly increased, partly pushed by the recent rise in gasoline prices. Especially, the problem of waste is really serious under the situation in which we should not increase greenhouse gases any more by careless incinerations. Polymers decomposed by bacteria are thus subjected to be extensive researches in the whole world. Poly (3-hydroxyalcanote)s (PHAs) are the only microbial biodegradable polymers with decent thermo-plasticity. Among the PHA family, Poly (3-hydroxybutylate) (PHB) is known to exhibit high crystallinity and excellent biocompatibility. However, PHB may not be considered to completely replace petroleum plastics because of its rigidity and fragility. Polymer blend is a widely-used technique to improve physical properties like flexibility and thermal resistance. Quantitative characterization of surface morphology and physical properties of thin films are crucial in application of polymers. We have exploited surface-sensitive X-ray diffraction techniques to reveal the relationship of surface morphology and crystal structure in the surface region of PHB and its random copolymers [1]. In the present study, we investigate the surface structure and morphology of natural, isotactic PHB thin layers blended with synthesized, atactic PHB by using grazing incidence X-ray diffraction (GIXD), X-ray reflectivity and AFM. Small amount of the synthesized PHB is found to effectively affect the surface morphology of blended PHB, although the out-of-plane GIXD indicates (020) Bragg reflection unchanged.
[1] K. Mori et al., Macromolecules

Keywords: biodegradable polymers, surface morphology, X-ray diffraction

P12.01.02

Acta Cryst. (2008). A**64**, C547

Surface structure of biodegradable polymer blend of poly(hydroxybutyrate) and poly(lactaide)

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A treatment of surface is one of the key issues for many practical applications of biodegradable polymer thin films and fibers, since physical properties and biodegradability of films and fibers strongly affected by their surface structure and surface morphology. Polymer blend (polymer alloy) is a widely-accepted technique for improving the physical properties with relatively less development costs. However, it does not seem to be applied for biodegradable polymers effectively due to the small number of biodegradable polymers we have. Instead of the polymer blend, many ingenious plans have been employed: Stereocomplexation of L- and D-configured polymer chain of biodegradable polylactide (PLA) revealed a substantial improvement of mechanical properties of bulk; for biodegradable polyhydroxybutyrates (PHBs), random copolymers have been synthesized to exploit the possibility of practical use, although the major part of these efforts have been focused on bulk properties. In the present study, we prepared thin films of PHB blended with PLA to investigate how a small amount of PLA affects the surface structure and morphology. The polymers were dissolved in hot chloroform to form spin-coated ultrathin films on Si (100) and thick films with several mm thick. X-ray reflectivity and grazing incident X-ray diffraction were utilized as tools for investigation of surface morphology and crystallinity in the surface region, respectively. Relationship between crystallinity and secondary structure peculiar to the surface will be addressed on a microscopic standpoint.

Keywords: surface morphology, X-ray diffraction, thin films

P12.01.03

Acta Cryst. (2008). A**64**, C547

Relationship between contact angle and crystallinity in surface region of polyethylene polymer alloy

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Physical properties of polymers, e.g., viscosity, melt temperature, strength strongly depend on its molecular weight. Roles of physical parameters like molecular length on polymer properties can be sharply distinguished from chemical properties by a comprehensive study of a standard polymer blended with the polymer having the same chemical composition (monomer) with different molecular weight. Surface energy, surface morphology, and lamella structure in surface region would also be affected by the molecular weight, which should be crucial for the usage of intelligent polymers for micro fabrication technologies. In the present study, we choose polyethylene (PE) as a standard crystalline polymer, and prepare polymer alloys made from two different molecular weights to serve as quantitative investigations on macroscopic scale as well as those on microscopic standpoints. The former is observation on contact angle between molten PE droplet and a flat Si (100) plane, and that between a droplet of pure water and flat PE surfaces; the latter is surface-sensitive X-ray diffraction (X-ray reflectivity (XR) for characterizing surface morphology, and grazing incidence X-ray diffraction (GIXD) for crystalline lamellae structure). Two PE samples (Mn (number average molecular weight): 33,000 and 480) and a high-precision four-circle diffractometer with rotating-anode X-ray generator (SLX2000+UltraX) were used. Contact angles were fitted from images taken by digital cameras. Although the contact angle between molten PE and Si and crystallinity in the surface region monotonously vary with the mixing ratio, the contact angle between water and PE show and surface roughness show a maximum at an intermediate mixing ratio.

Keywords: surface structure, crystalline polymers, X-ray diffraction