Division of Multidisciplinary Chemistry
- Polymer Materials Science -

http://www.scl.kyoto-u.ac.jp/~kanaya2/e-index.html

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Visitors

Prof HU, Wenbing — Nanjing University, China, P.R., 27 March 2007
Dr ZORN, Reiner — Institut für Festkörperforschung Forscheungszentrum Jülich, Germany, 18 September 2007

Scope of Research

The structure and molecular motion of polymer substances are studied using mainly scattering methods such as neutron, X-ray and light with intension of solving fundamentally important problems in polymer science. The main projects are the mechanism of structural development in crystalline polymers from the glassy or molten state to spherulites; the dynamics in disordered polymer materials including low-energy excitation or excess heat capacity at low temperatures, glass transition and local segmental motions; formation processes and structure of polymer gels; the structure and molecular motion of polyelectrolyte solutions; the structure of polymer liquid crystals.

Research Activities (Year 2007)

Publication

Kanaya T, Matsuba G, Ogino Y, Nishida K, Hierarchic Structure of Shish-Kebab by Neutron Scattering in a Wide Q Range, *Macromolecules*, **40**, 3650-3654 (2007).

Presentations

Hierarchic Structure of Shish-Kebab by Neutron Scattering in a Wide Q Range, Kanaya T, Matsuba G, Ogino Y, Nishida K, 234th ACS Meeting, Boston, 20–22 August 2007.

Structural Formation Process of Polyethylene Blend with Ultra-high Molecular Weight Component, Matsuba G, Nishida K, Kanaya T, 3rd International Symposium on Engineering Plastics, Urumqi, 19–23 August 2007.

Glass Transition of Polymer Thin Films by Inelastic Neutron Scattering, Inoue R, Kanaya T, Nishida K, Tsukushi I, 56th SPSJ Symposium on Macromolecules, Nagoya, 19–21 September 2007.

Effect of Polylactide Stereocomplex Crystallites on Poly(L-Lactic Acid) Crystallization Behavior, Rahman N, Kawai T, Matsuba G, Nishida K, Kanaya T, International Symposium of Polymer Crystallization, Mishima, Japan, 22–24 September 2007.

Structure Formation of Isotactic Polystyrene under Shear Flow, Hayashi Y, Matsuba G, Nishida K, Kanaya T, 2007 Autumn Meeting in the Society of Fiber Science and Technology, Japan, Kyoto, 26–27 October 2007.

Annealing of Mesomorphic Phase of Isotactic Polypropylene, Yamamoto J, Konishi T, Nishida K, Kanaya T, 2007 Autumn Meeting in the Society of Fiber Science and Technology, Japan, Kyoto, 26–27 October 2007.

Crystallization Process of Poly(ethylene terephthalate) under Shear Flow, Tomohisa H, Matsuba G, Nishida K, Kanaya T, 2007 Autumn Meeting in the Society of Fiber Science and Technology, Japan, Kyoto, 26–27 October 2007.

Crystallization of Poly(L-lactic acid): Effect of the Addition of Poly(D-lactic acid) on Poly(L-lactic acid) Crystallization Behavior

Enhancement of crystallization rate of PLLA is a matter of concern when PLLA is utilized for various applications including industrial application. We have been studied the effect of incorporated of poly(D-lactic acid) (PDLA) on crystallization behavior of poly(L-lactide acid) (PLLA) using differential scanning calorimetry (DSC), optical microscope (OM), light scattering (LS), wide (WAXS) and small angle x-ray scattering (SAXS). Blend of PLLA and PDLA crystallizes as stereocomplex crystal. In the non-isothermal crystallization, the existence of stereocomplex crystallite was effective to accelerate PLLA crystallization rate in case of addition of high molecular weight PDLA (h-PDLA) but not in the addition of low molecular weight PDLA (l-PDLA). In the isothermal crystallization, we found that the crystal growth rate (G) value decreased with PDLA concentration for both l-PDLA/PLLA and h-PDLA/PLLA blends. On the other hand, PDLA concentration dependencies of nucleation rate (N) are well agreed with those of overall crystallization rate. It suggests that the effect of the addition of PDLA on PLLA crystallization is mainly due to the enhanced nucleation rate.

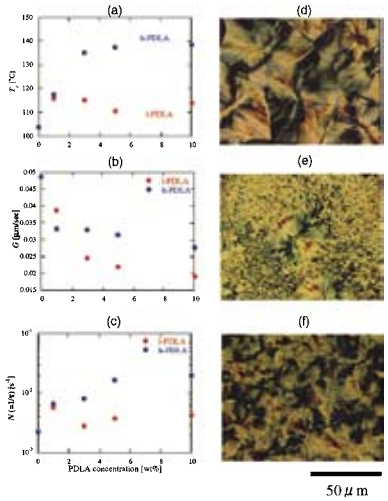

Figure 1. PDLA concentration dependence of crystallization temperature on non-isothermal crystallization (a), Growth rate (b) and Nucleation rate of PLLA spherulites on isothermal crystallization (c) (left) and OM final structure of PLLA (d), PLLA/l-PDLA3% (e) and PLLA/h-PDLA3% (f) after isothermal crystallization at 140°C (right).

Mesomorphic Phase of Poly(buthylene-2,6-naphthalate)

The structure formation of crystalline polymers when they are rapidly quenched from molten state is one of the main subjects in our laboratory. Some polymers are solidified in amorphous when quenched. Some other polymers are crystallized due to their rapid crystallizing nature even when quenched rapidly. However, in a few cases, polymers are solidified in an intermediate state between amorphous and crystal when quenched through a specific kinetic path. We found that a thin film of poly(buthylene-2,6-naphthalate) (PBN) is solidified in such an intermediate state when quenched into 0°C. Here, we refer to such a solid form of PBN as the "mesomorphic" phase of PBN. The mesomorphic PBN at room temperature shows a weak but sharp peak at q = 0.44 Å^{-1} and a strong broad peak at around q = 1.4 Å^{-1} in wide-angle X-ray diffraction (WAXD), where q is the absolute value of the scattering vector (Figure 2). The former and the latter peaks are the characteristics of a smectic structure and an amorphous structure, respectively. Also we found that the mesomorphic PBN has its own glass transition temperature at 71°C besides the glass transition temperature of normal isotropic glass at 48°C.

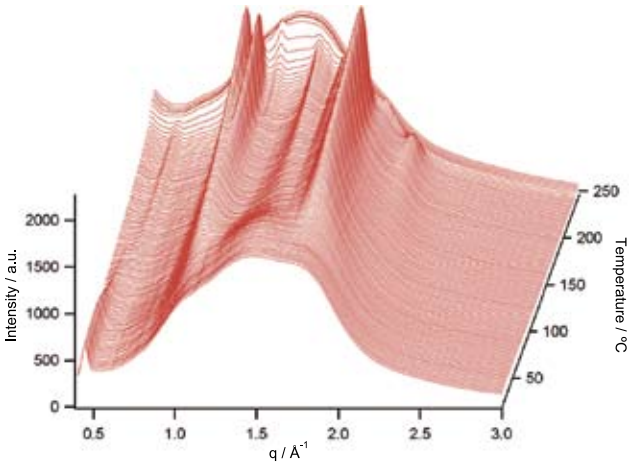

Figure 2. WAXD for the mesomorphic phase of PBN during a heating process.

Grants

Kanaya T, Higher Order Structure Formation in Induction Period of PLA Crystallization and External Fields, Collaboration Research with Toyota Motor Corporation and Toyota CRDL., INC, 15 January 2003–31 March 2008.

Nishida K, Kanaya T, Matsuba G, Control of Higher Order Structure by Crystallization via Mesomorphic Phase, Grant-in-Aid for Scientific Research (C), 1 April 2007–31 March 2009.

Matsuba G, Correlation between Phase Separation and Crystallization of Polyolefins, Grant-in-Aid for Young Scientists (B), 1 April 2007–31 March 2009.

Awards

Kanaya T, The Award of the Society of Polymer Science, Japan, "Studies on Polymer Crystallization and Higher Order Structure", the Society of Polymer Science, Japan, 30 May 2007.

Kanaya T, The Award of the Japanese Society for Neutron Science, "Higher Order Structure and Dynamics of Polymer Systems by Neutron Scattering", The Japanese Society for Neutron Science, Japan, 27 November 2007.