Division of Multidisciplinary Chemistry
- Polymer Materials Science -

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

Prof
KANAYA, Toshiji
(D Eng)

Assoc Prof
NISHIDA, Koji
(D Eng)

Assist Prof
MATSUBA, Go
(D Eng)

PD
KAWAI, Takahiko
(D Eng)

Students

OGAWA, Hiroki (D3)
INOUE, Rintaro (D2)
RAHMAN, Nelly (D1)
AKAI, Wataru (M2)
HIRABAYASHI, Tetsuo (M2)
ISEKI, Toru (M2)
ECHIZENYA, Yuki (M1)
HAYASHI, Yuji (M1)
UCHIDA, Hirohito (M1)
YAMAMOTO, Junpei (M1)
TAKEDA, Taijiro (RS)
KARAI, Yuki (UG)
TOMOHISA, Hiroshi (UG)

Visitors

Dame Prof HIGGINS, Julia, S	Imperial College, UK, 27 March 2006
Prof STROBL, Gert	Albert-Ludwigs-Universität Freiburg, Germany, 24 April 2006
Prof BALTA-CALLEJA, Francisco, J	Instituto de Estructura de la Materia, CSIC, Spain, 30 June 2006
Dr DREISS, Cecile, A	King's College, UK, 18 July 2006
Prof PARK, Je-Geun	SungKyunKwan University, Korea, 18 August 2006

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 2006)

Presentations

Phase Separation and Dewetting in Polymer Blend Thin Films, Ogawa H, Kanaya T, Nishida K, Matsuba G, 3rd International Workshop on Dynamics in Confinement, Grenoble, France, 23–26 March.

Crystallization Process of Isotactic Polypropylene under Shear Flow, Ogino Y, Matsuba G, Nishida K, Kanaya T, 55th Annual Meeting of the Society of Polymer Science, Japan, Nagoya, 20–22 May.

Phase Separation and Aggregation in Polyelectrolyte Solutions (Invited), Nishida K, Tsubouchi T, Kanaya T, 11th International Symposium on Colloidal and Molecular Electro-Optics, Kyoto, 25 May.

Crystal Structure and the Melting Behavior of Poly(L-lactic acid), Kawai T, SAS2006, Kyoto, Japan, 9–13 July.

Structural Formation Process of Poly(ethylene terephthalate) under Shear Flow Using Time-Resolved Depolarized Light Scattering Technique, Takahashi N, Matsuba G, Nishida K, Kanaya T, 52nd Meeting of Polymer Science, Kobe, 21 July.

Structure Analysis of Organic-Inorganic Hybrid Low-Melting Glasses as Studied by Static and Dynamic Light Scattering, Iseki T, Inoue R, Matsuba G, Nishida K, Kanaya T, Kakiuchida H, Takahashi M, 55th Discussion Meeting, the Society of Polymer Science Japan, Toyama, 20–22 September.

Precise Analysis for Fiber Structure with Scattering Methods, Matsuba G, Ogino Y, Nishida K, Kanaya T, The Sino-Japanese Fiber Symposium, Xiamen, P. R. China, 23–25 October.

Dynamical Properties of Polystyrene Thin Films, Inoue R, Kanaya T, Nishida K, Tsukushi I, Jülich Soft Matter

Crystallization of Polyethylene Blends of Ultra-high and Low Molecular Weight Components under Shear Flow

Time resolved small-angle X-ray scattering (SAXS) measurements were performed on crystallization processes of ultra-high and low molecular weight polyethylene blends after applying pulse shear in order to clarify effects of ultra-high molecular component on shish-kebab structure formation. Anisotropic scattering pattern due to kebab-structure formation is observed above a certain critical concentration of ultra-high molecular weight polyethylene (Figure 1). The critical concentration is about ~0.1 wt% independent of the crystallization temperature below 125ºC, while it increases with the crystallization temperature above 125ºC. Analyzing the results it is revealed that the shish-kebab formation is dominated by entanglements of the ultra-high molecular weight chains as well as competition between the crystallization rate and the relaxation rate of entanglements.

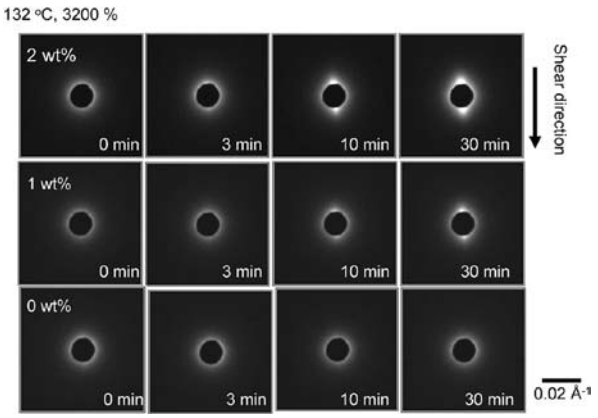

Figure 1. Time evolution of 2D SAXS profiles in various ultra-high molecular weight polyethylene concentrations.

Phase Separation and Dewetting in Polymer Blend Thin Films

We have studied morphology and kinetics of phase separation as well as dewetting in polystyrene (PS) and poly(vinyl methyl ether) (PVME) blend thin films, which are very different from those of bulk blends, using time resolved light scattering (LS), optical microscope (OM) and atomic force microscope (AFM). Time evolution of LS intensity is well described by kinetics of spinodal decomposition type phase separation in the films above ~1 μm (Figure 2(a), (d)) while confinement effects were recognized below about 10 μm. As the film thickness decreases below ~1 μm, a peak in LS profile characteristic to phase separation once disappears (Figure 2(b)). In this thickness region, phase separation and dewetting must competitively occur, resulting in the irregular pattern (Figure 2(e)). As the thickness further decreases below about ~100 nm, a scattering peak is again observed (Figure 2(c)), meaning the dewetting occurs preferentially (Figure 2(f)), which was confirmed by AFM measurements.

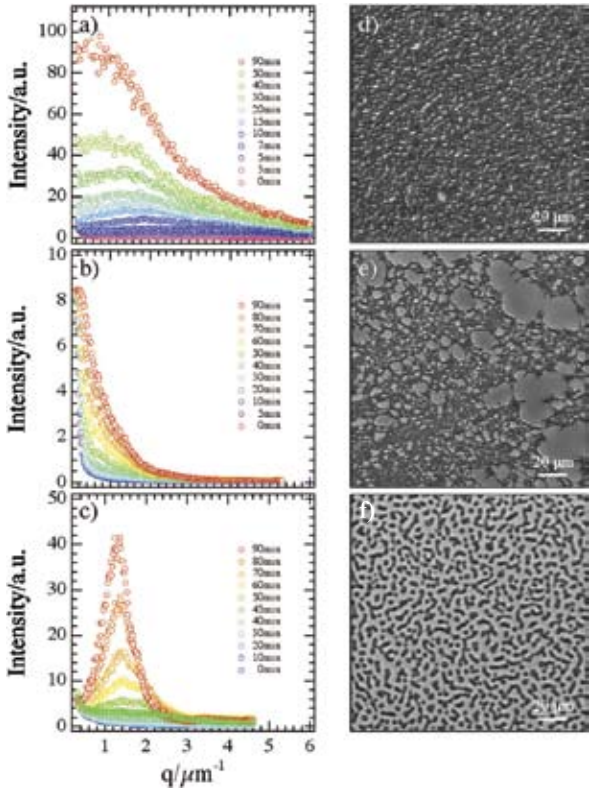

Figure 2. Time-resolved LS profiles for PS/PVME blend films with the thickness of 66 μm (a), 470 nm (b) and 40 nm (c) (left) and OM images 66 μm (d), 470 nm (e) and 40 nm (f) after 90 minutes in two phase region (right).

Days 2006, Bonn, Germany, 14–17 November.

Grants

Kanaya T, Collaboratory on Electron Correlation toward a New Research Network between Physics and Chemistry, Grant-in-Aid for Creative Sientific Research, 1 April 2004–31 March 2006.

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

Matsuba G, Observation of Shish-kebab Structural Formation Processes of Polymers with Neutron Scattering Technique, Grant-in-Aid for Young Scientists (B), 1 April 2005–31 March 2007.