

# Division of Multidisciplinary Chemistry - Polymer Materials Science -

[http://www.scl.kyoto-u.ac.jp/~kanaya2/e\\_index.html](http://www.scl.kyoto-u.ac.jp/~kanaya2/e_index.html)



Prof  
KANAYA, Toshiji  
(D Eng)



Assoc Prof  
NISHIDA, Koji  
(D Eng)



Assist Prof  
INOUE, Rintaro  
(D Eng)

## Students

MIZUIKE, Atsuko (RF)  
ASAKAWA, Harutoshi (D2)  
KAWABATA, Jun (M2)  
KAWASHIMA, Kazuko (M2)  
MORITA, Hideyuki (M2)

ZHAO, Yunfeng (M2)  
FUJIWARA, Tetsuaki (M1)  
MATSUI, Kazuya (M1)  
MATSUMOTO, Norihiro (M1)  
JIN, Ling (RS)

MATSUI, Tamito (UG)  
IMAMURA, Satoshi (UG)  
NAKAMURA, Makoto (UG)  
FUJITA, Takuya (UG)  
YAJIMA, Daishi (UG)

## Visitors

Prof WU, Chi                    The Chinese University of Hong Kong, China, 1 May 2009  
Prof GENZER, Jan            North Carolina State University, USA, 1 June 2009  
Prof RICHTER, Dieter        Institut für Festkörperforschung, Forschungs Zentrum Jülich, Germany, 22 October 2009  
Prof TANDON, Poonam        University of Lackron, India, 18 December 2009

## 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 glassy or molten state to spherulites, the dynamics in disordered polymer materials including low-energy excitation, glass transition and local segmental motions; formation processes and structure of polymer gels; the structure and molecular motion of polyelectrolyte solutions.

## Research Activities (Year 2009)

### Publications

Hayashi Y, Matsuba G, Zhao Y, Nishida K, Kanaya T: Precursor of Shish-kebab in Isotactic Polystyrene under Shear Flow, *Polymer*, **50**, 2095-2103 (2009).

Ogawa H, Kanaya T, Nishida K, Matsuba G, Majewski P. J, Watkins E: Time-resolved Specular and Off-specular Neutron Reflectivity Measurements on Deuterated Polystyrene and Poly(vinylmethylether)blend Thin Films during Dewetting Process, *J. Chem. Phys.*, **131**, [104907-1]-[104907-7] (2009).

### Presentations

Shear Induced Mesomorphic Phase Formation of Isotactic Polystyrene, Zhao Y, Matsuba G, Nishida K, Kanaya T, Annual Meeting, The Society of Fiber Science and Technology, Tokyo, 12 June 2009.

Distribution of Glass Transition Temperature in Polystyrene Multi-layered Thin Film, Kawashima K, Inoue R,

Matsuba G, Nishida K, Kanaya T, Annual Meeting, The Society of Fiber Science and Technology, Tokyo, 12 June 2009.

Gelation and Phase Separation of Methylcellulose Aqueous Solutions, Morita H, Tanaka K, Nishida K, Matsuba G, Kanaya T, The 55th Meeting of Polymer Science, Kobe, 17 July 2009.

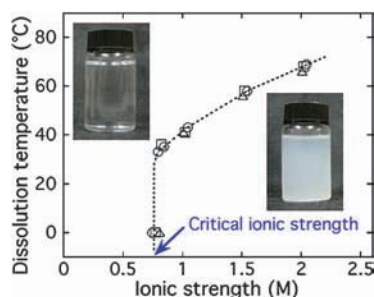
Study of Crystallization and Mesomorphic Phase of Poly(Butylene-2,6-Naphthalate), Matsumoto N, Okada K, Nishida K, Kanaya T, The 55th Meeting of Polymer Science, Kobe, 17 July 2009.

Inelastic Neutron Scattering of Ultra-Thin Polymer Films, Kanaya T, Inoue R, Kawashima K, Matsuba G, Nishida K, IDMRSC 2009, Rome, 2 September 2009.

Fast Time-Resolved WAXD and SAXS Measurement of Mesomorphic Phase Formation of Isotactic Polypropylene, Nishida K, Okada K, Matsuba G, Ito K, Kanaya T, XIV International Conference on Small-Angle Scattering,

## Critical Dissolution Ionic Strength of Chitosan Solution

Chitosan is derived from chitin, which is a major component of the shells of crustaceans, by the partial *N*-deacetylation, of its constituent glucosamine monomers. In our body, glucosamine is a principal constituent of the artrodial cartilage and as a consequence therefore chitosan is widely used as a health food supplement for the prevention and treatment of arthritic complaints. However, clarification of the fundamental properties of chitosan has been behind its applications. Here we have studied the formation and dissolution property of aggregates of chitosan in aqueous solution, with and without added salt using wide-dynamical range light transmittance measurements. A large hysteresis loop was found for both the formation of aggregates during cooling and the dissolution thereof during heating. In spite of the existence of the hysteresis, and regardless of the precise aggregation state and heating rate, the temperature at which the aggregates dissolved (namely the dissolution temperature) was uniquely determined for any given concentration of chitosan and NaCl. Further a critical dissolution ionic strength, below which no aggregation was detected, was established from the variation of dissolution temperature with ionic strength (Figure 1).



**Figure 1.** Dissolution temperature of aqueous chitosan as a function of ionic strength.

Oxford, UK, 17 September 2009.

Crystallization of Isotactic Polypropylene from Mesomorphic Phase during Heating with Constant Rates, Asakawa H, Nishida K, Okada K, Matsuba G, Kanaya T, Ogawa H, The 58th SPSJ Discussion (Autumn) Meeting, Kumamoto, 17 September 2009.

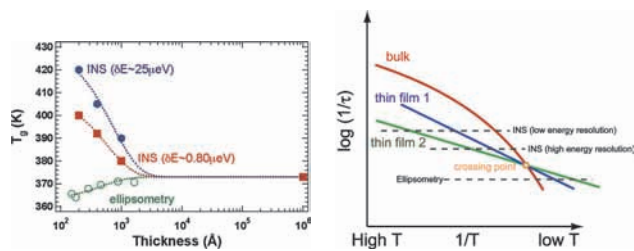
Crystallization Mechanism and Morphology of Polyamide-6, Kawabata J, Matsuba G, Nishida K, Kanaya T, The 58th SPSJ Discussion (Autumn) Meeting, Kumamoto, 17 September 2009.

## Grants

Kanaya T, Higher Order Structure Formation in Induction Period of PLA Crystallization and External Fields,

## Glass Transition of Polymer Thin Film

It is well known that physical properties of polymer thin films are quite different from those of bulk. One of the most fascinating topics is the thickness dependence of glass transition temperature ( $T_g$ ) among them. The decrease of  $T_g$  with film thickness was reported for polystyrene thin films, however the detailed mechanism is still missing. Glass transition is believed to be dynamical transition, hence dynamical studies on polymer thin film give us some clues to the understanding of glass transition of polymer thin films. Therefore, we have studied the dynamics of polymer thin films by inelastic neutron scattering (INS) as a probe of dynamics. Figure 2 indicates the thickness dependence of  $T_g$  by INS with different energy resolutions and ellipsometry. We observed the decrease of  $T_g$  with thickness from ellipsometry, however the increase of  $T_g$  with the reduction of thickness was observed by INS although sample condition is same. In order to understand the contradiction, we used relaxation time map, which is based on the cooperatively rearranging region (CRR) concept, as shown in Figure 3. With this figure, we succeeded to explain contradiction reasonably.



**Figure 2.** Thickness dependence of  $T_g$  evaluated from ellipsometry and inelastic neutron scattering (INS).

**Figure 3.** Schematic view of relaxation time map with the notion of CRR, which was used to explain our results.

Collaboration Research with Toyota Motor Corporation and Toyota CRDL., INC, 15 January 2003–30 September 2009.

Kanaya T, Polymer Crystallization and Control of Higher Order Structure Control through Non-equilibrium Intermediate States, Grant-in-Aid for Scientific Research (A), 1 April 2008–31 March 2011.

## Award

Nishida K, The Award of the Society of Fiber Science and Technology, Japan, "In Situ Observation of Structure Formation in Fibers and Films", The Society of Fiber Science and Technology, Japan, 10 June 2009.