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Kyoto University
The structure and molecular motion of polymer substances are studied using mainly scattering methods such as neutron, X-ray and light with intention 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.

Scope of Research

Publications


Presentations


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, or its constituent glucosamine monomers. In our body, glucosamine is a principal constituent of the arthrodial 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).

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 thickness was reported for polystyrene thin films, however the detailed mechanism is still missing. Glass transition is believed to be a 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 1. Dissolution temperature of aqueous chitosan as a function of ionic strength.](image1)

![Figure 2. Thickness dependence of \(T_g\) evaluated from ellipsometry and inelastic neutron scattering (INS).](image2)

![Figure 3. Schematic view of relaxation time map with the notion of CRR, which was used to explain our results.](image3)


Grants


Award