

Structural Analysis of Polyurethane Resin by Small-angle Neutron Scattering

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Polyurethane resin is one of the most familiar materials consisting of polyisocyanate and polyol groups. Due to the good mechanical properties like adherence and durability, polyurethane resin is widely used as industrial materials in the wide ranges such as adhesives, fabrics, paints, and inks. Polyurethane resin including isocyanurate groups, which is formed by a trimerization reaction of isocyanate groups, provides better thermal stability and rigidity than that composed of linear urethane bonding because of more functional groups and of stiffer hard segments in the former one.

As for the effect of the stoichiometric ratio, $[NCO] / [OH]$, into the network structure of polyurethane resin, various studies have been carried out so far. Redman reported the effect of the $[NCO] / [OH]$ ratio on molecular weight and on the rheological, thermal, and mechanical properties of two series of ester-based polyurethanes.[1] Nierzwicki and Wysocka also studied the effect of the $[NCO] / [OH]$ ratio on the micro-phase separation of ester-based polyurethanes, which can be induced by the soft segments and hard segments, by thermo-mechanical analysis (TMA).[2]

In this paper, we discuss the gelation kinetics and the microstructure of polyurethane gels by focusing on the network concentration and the stoichiometric ratio of isocyanate to hydroxyl groups, $[NCO] / [OH]$. The purpose of this study is to clarify the following matters, i.e., the effect of the total concentration and $[NCO] / [OH]$ on the microscopic inhomogeneities of the network. We used acryl-polyol as a soft segment component and polyisocyanate as a hard segment component.

Fig.1 shows the intensity profiles of polyurethane resin having different total

concentration(wt%) and $[NCO] / [OH]$. In the case of 12.8 wt%, the $[NCO] / [OH]$ dependence is so little and the intensity is low. This is due to the fact that at 12.8 wt%, the system was at liquid state while the sample became gel-like state by further increasing the total concentration. It should be noted that at 17.1 wt%, the intensity became the maximum. At more than 17.1 wt%, the intensity decreased with the total concentration due to the decrease of the concentration fluctuation of the polymer network. These experimental results were also in good agreement with our previous work by dynamic light scattering.[3] At 54 wt%, the intensity profiles were flat due to the strong incoherent scattering of the concentrated polymers.

References

- [1]Redman RP. Developments in Polyurethanes. London: Applied Science Publishers, 1978.
- [2]Nierzwicki W and Wysocka E. J. App. Polym. Sci. 1980;25:739-746.
- [3]T. Suzuki, M. Shibayama, K. Hatano, and M. Ishii. Polymer, in press.

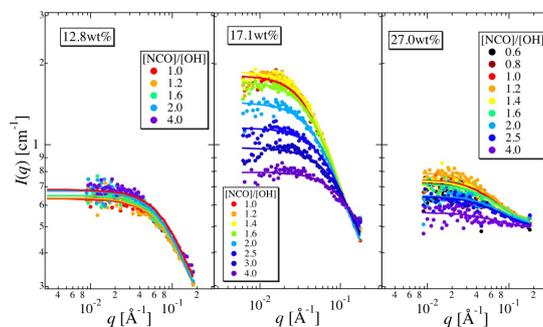


Fig. 1. Intensity profiles of polyurethane resin.