Inhomogeneity Effect on Nano-Structure in Dehydrated NIPA/SA Gel

Kazuhiro HARA\(^{a,1}\), Yusuke SUEYOSHI\(^1\), Takao TANIGAWA\(^1\), Satoru YOSHIOKA\(^1\), Toshihiro OKAJIMA\(^1,2\), Masaaki SUGIYAMA\(^3\) and Toshiharu FUKUNAGA\(^3\)
\(^1\)Kyushu University, Motooka, Fukuoka 819-0395, Japan
\(^2\)SAGA-LS, Yayoigaoka, Tosu 841-0005, Japan
\(^3\)KURRI, Kumorito, Osaka 590-0494 Japan

Introduction

States and properties of the gels are considerably influenced by interaction changes between solvent and polymer-network with environmental conditions. For example, there is a small and continuous change in volume in the NIPA gel at 36°C with the hydrophilic-to-hydrophobic change of its isopropyl group, while, in the case that the network-polymer has additional ionized groups inside such as the NIPA/Ac copolymer gel, the volume change becomes more drastic with the effect of the Donan potential [1]. Such a drastic volume change is referred as a volume phase transition [1,2]. In addition to this macroscopic feature, there also occurs a nanostructural change by introducing the ionized group in the gel: an emergence of a prominent peak in a SANS profile indicating realization of the micro-phase transition [3].

Emergence of A Distinct SAXS Peak by Dehydration

Such a competition of the internal forces will occur in a condition other than the volume phase transition. As such a phenomenon, the authors have been investigating property change of the hydro-gels by dehydroization, which is still interesting because the dehydroization is one of the most general phenomena by which the gels show a drastic volume change. Besides, by dehydroization, there occur property changes indicating that some gels becomes glass-like substances [4], which have been confirmed by viscoelastic measurements [5,6], Raman scattering [7] and inelastic neutron scattering experiments [8]. Moreover, by our SAXS study, a distinct nanostructure has been also found in a dehydrated N-isopropylacrylamide/sodium acrylate (NIPA/SA) gel, which is a common hydrogel of the NIPA/Ac gel, indicating occurrence of the micro-phase separation by the dehydroization [9]. By our succeeding nano-structural observations of the dehydrated NIPA/SA gel, it was found that the distinct SAXS and SANS peaks can be only observed in a restricted parameter region [10]. This feature indicates that the characteristic structure in the dehydrated NIPA/SA gel can be realized on a delicate balance of related interactions [11].

Effect of Inhomogeneity on the SAXS Profile

Therefore, in the present study we have observed the cross-link concentration dependence of SAXS profile of dehydrated NIPA/SA gel with changing the cross-linker concentration. By the observation, we have found a considerable change in the SAXS profile as shown in Fig.1: considerable change occurs in peak-position and intensity around a certain cross-linker concentration where the gel becomes opaque.

\[\text{Intensity (a.u.)} \] 

\[q (\text{Å}^{-1})\]

Fig.1 Change in the SAXS profile of dehydrated NIPA/SA gel with cross-linker (BIS) concentration. This gel (before dehydroization) becomes opaque with the cross-linker concentration of 1.5%.

References


*haratap@mbox.nc.kyushu-u.ac.jp