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Structural studies on gelation of 12-Hydroxystearic Acid Solution

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Introduction

Recently, numerous studies have been conducted on gelation of solutions of low molecular weight gelators in organic solvents. This group of chemical compound has an ability to make various kinds of organic solvents gel with a concentration of only a few percents due to formation of rigid fiber at nanoscales. Usually the gel is thermally reversible, i.e., gel is formed by cooling a mixture of gelator and solvent below the sol-to-gel transition temperature, while it transforms into sol by raising temperature. 12-hydroxystearic acid (HSA) are well-known as one of the low-molecular weight gelators. So far, although structures of the gel have been largely investigated, there are few studies on quench depth dependence on the gelation. In this study, we focus on the gel properties near the sol-to-gel transition temperature.

Results and Discussion

Small-angle X-ray scattering measurements were conducted to investigate the structure of the HSA gel with an apparatus at the beam line BL-9C. Firstly we investigated solvent effect on gelation of HSA solution. Observation was made at room temperature (ca. 25 ºC) and for solutions with concentration of 3 wt % HSA. The result is summarized in Table I.

Table I Solvent dependence of gel properties of HSA solution. THF: tetrahydrofuran, OG: opaque gel, TG: transparent gel, S: solution, I: insoluble.

dodecane	polybutadiene (M=3000)	phenyl methyl silicone	toluene
OG	OG	OG	TG
xylene	ethanol	THF	water
TG	S	S	I

As is clearly shown, HSA is soluble in solvents with polar groups such as ethanol or tetrahydrofuran, while HSA forms gel in hydrocarbon solvents. Especially, transparent gel was obtained for solvents with phenyl groups such as toluene and xylene, while turbid gel was obtained for usual hydrocarbon solvents such as hexane and dodecane. Thus, ability to form gel significantly depends upon solvent quality. Next we present the results of small-angle X-ray scattering measurements. Figure 1 shows quench depth dependence of the scattering profiles for the 10 wt % HSA gel in toluene. All the data were measured for the gel formed by quench from 49 ºC. There exists a scattering peak at q = 0.13 Å^{-1}, (001) reflection peak of HSA crystalline. Moreover, the scattering profiles have a similar shape at different quench depths, suggesting that the structure of the gel is not essentially affected by quench depth.

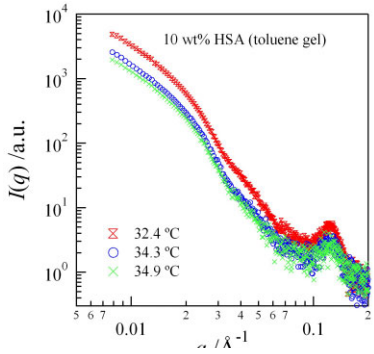

Fig. 1 Small-angle X-ray scattering profiles for the 10 wt% HSA gel in toluene at different quench depths.

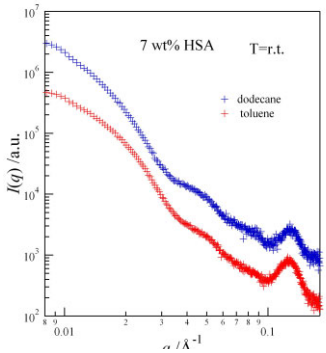

Fig. 2 Comparison between SAXS profiles for the toluene gel (transparent gel) and the dodecane gel (turbid gel) with a concentration of 7 wt% HSA.

Figure 2 presents comparison between a SAXS profile for the toluene gel (transparent gel) and that of the dodecane gel (turbid gel) with a concentration of 7 wt% HSA. The SAXS for the dodecane gel is larger than that of the toluene gel. The result indicates that the fibrillary network of the gel is denser for the former gel.

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