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Analysis of Phase Separated Structures of Poly(dimethyl siloxane)-co-poly(dimethyl acrylamide) Network Gel by Small Angle X-ray Scattering

Katsuhiro Yamamoto[1,*] Yuka Mori, and Isamu Akiba[2]
[1] Nagoya Institute of Technology, Nagoya, Aichi 466-8555 Japan
[2] The University of Kitakyushu, Kitakyushu, 808-0135 Japan

1 Introduction

The amphiphilic PDMS-*co*-PDMAA gel is swollen by water and methanol. Then unique phenomenon that hydrophobic PDMS domain cannot be swollen to strong polar solvent was observed. So it is assumed that if the gel is swollen into water and methanol, solvent molecules localize in only hydrophilic domain. By using such phenomenon, electron density of only hydrophilic domain can be changed, and structure analysis with contrast variation can be performed. In this research, water, methanol, and mix solvents were used as strong polar solvent.

2 Experiment

PDMS-DA, DMAA, and HMPPO as a photoinitiator were mixed with a vial. Then, mixture was poured into PP cell (thickness of 0.2~2mm, diameter of 20mm) and polymerized by irradiation of UV(365nm). PDMS-*co*-PDMAA gel was swollen into water, methanol and mix solvent (water/methanol) for 1 day. Diameter of samples were measured before and after swelling. The SAXS measurement was performed to dry and swollen samples.

3 Results and Discussion

Phase separated structure induced by radical copolymerization of poly(dimethyl siloxane)-α,ω-diacrylate) (PDMS-DA 60wt.%) and hydrophilic dimethyl acrylamide (DMAA 40wt.%) was investigated by small angle X-ray scattering. The polymerized gel of PDMS-*co*-PDMAA was transparent and had a bicontinuous and periodic structure in nanometres scale [1, 2]. In present work, the structure of the gel containing solvents (water/methanol) was analysed by SAXS using X-ray contrast variation method. The hydrophilic domain in the gel was swollen selectively by absorbing the solvents. Figure 1 show SAXS profiles of the gel containing solvents with different amounts of methanol. The scattering intensity decreases and the scattering pattern changes with an increase in methanol content. This can be interpreted by consideration that the electron density profile and nano structure varies with an incorporation of the solvents into the gel. The electron density of the hydrophilic domain decreases with an increase in methanol contents.

To analyze the intensity variation in detail, the theoretical scattering intensity can be calculated with using two (PDMS, PDMAA/solvent) or three (PDMS, pure PDMAA, PDMAA/solvent) component models. The experimental scattering intensity (invariant) was also obtained from the SAXS profile and those were compared with theoretical values of scattering intensity (Figure.2). From Figure 2, the experimental scattering intensity was almost fitted well with using the three component model. This tendency is also found at compound ratios of PDMS/DMAA = 90:10, 80:20, and 40:60 wt. %. We also try to calculate the theoretical scattering profiles.

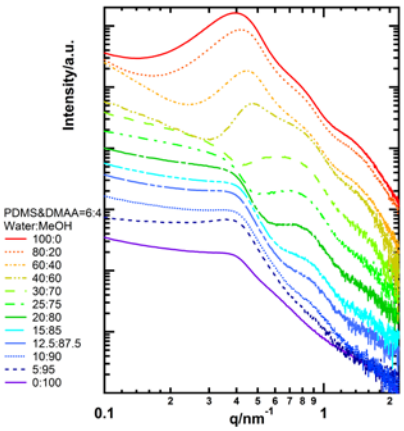

Figure.1 SAXS profiles of the gels in dry state and in solvents.

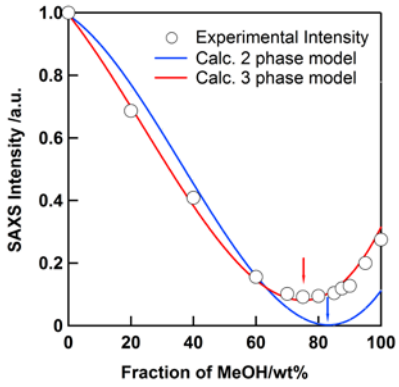

Figure.2 The relative SAXS intensity with methanol fraction at PDMS/DMAA=60:40 wt.%.

References

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* yamamoto.katsuhiro@nitech.ac.jp