Structure Study on Amphiphilic Ideal Co-network Gel

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Amphiphilic network, composed of hydrophilic and hydrophobic units, is a unique material because of its affinity to both polar and non-polar environments. One of the most famous examples is contact lens. Basically, contact lens should be hydrophilic because the solvent is water. However, hydrophilic polymers do not pass oxygen so much compared to hydrophobic silicone polymers. Contact lens made of amphiphilic polymers satisfies these two antagonistic demands. Therefore, contact lens is a representative of amphiphilic polymer gels. Like this, amphiphilic network is promising material and their structural analysis is urgent business. However, it is difficult to determine its structure quantitatively because of inhomogeneity of networks.

To overcome this situation, our group made new amphiphilic network which is supposed to be homogeneous. Basic idea is modification of homogeneous gels called Tetra-PEG gels (T. Sakai et al., Design and fabrication of a high-strength hydrogel with ideally homogeneous network structure from tetrahedron-like macromonomers, Macromolecules, 2008, 41, 5379). Tetra-PEG gels are high performance polymer gels made of tetra-arm poly(ethylene glycol), developed by our group. The Tetra-PEG gels do not have noticeable defects in their network structure, such as loops, dangling chains, and trapped entanglements (T. Matsunaga et al., Structure Characterization of Tetra-PEG Gel by Small-Angle Neutron Scattering, Macromolecules, 2009, 42, 1344). Recently, we also succeeded in preparation of gels which are composed of active ester terminated Tetra-PEG and amine terminated linear poly(dimethylsiloxane) (PDMS). Each component is connected one after the other and we call these gels " PEG-PDMS gels ". When toluene solvent is substituted for water, each PDMS unit is expected to shrink homogeneously.

SANS results of water-substituted PEG-PDMS gels (measured in HANARO, Korea, 30/6/2013~5/7/2013) show some peaks, which correspond to the characteristic length of tens of nanometer. This peak is also observed by SAXS (measured in Spring-8, Japan, 1/7/2014~3/7/2014) although the position of peak is different from that of SANS. Fig. 1 shows the comparison of SANS profiles and SAXS profiles. We prepared different molecular weight samples and they show qualitative difference. These results strongly suggest that several PDMS components aggregate and microphase separation occurs.

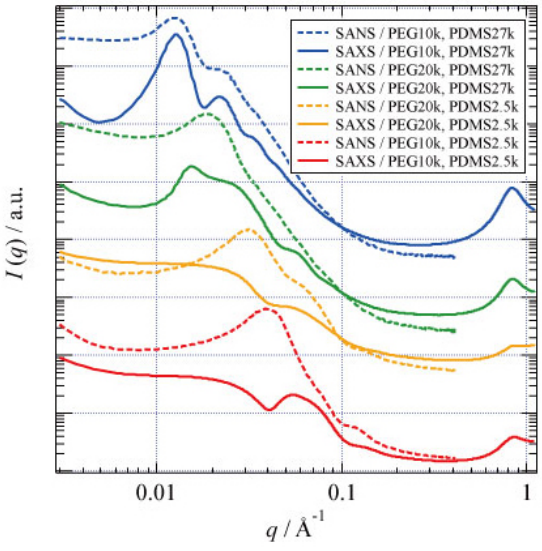

Fig. 1. Comparison of SANS and SAXS profiles obtained from PEG-PDM gels.