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Nano-structure Analysis of Poly(acrylamide-co-maleic acid) Gels by SAXS

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1 Introduction

Polymer gels have been paid many attentions in various industrial and technological fields. Composed of cross-linked polymer chain (known as polymer network) and solvent, they were proven as a promising candidate for heavy- and rare-metal ion adsorbents: it has been demonstrated that acrylamide-co-sodium acrylate (AAm/SA) gels show considerably high weight ratio of captured metal to absorbent; and, in the ion-capturing process, it was understood that the carboxyl group of sodium acrylate acts as a complexing agent for the metal ions. The absorbing ability is naturally considered to be higher if more carboxyl groups are introduced in the polymer network; and, in this sense, introduced maleic acid (MA) containing plural carboxyl groups as the complexing agent instead of sodium acrylate. However, under certain synthesis conditions, the AAm/MA gels were found to be turbid indicating existence of inhomogeneity in the gels, which has been known to be undesirable for metal ion adsorption. Therefore, it was necessary to elucidate the synthesis conditions that cause the cloudiness in the AAm/MA gel and the corresponding inhomogeneous structure in order to develop the high-performance metal ion capturing gels. The objects of this study is to quantify the opaqueness of the AAm/MA gels, to make clear the conditions where to opaqueness occurs and to investigate the nanostructures of the turbid AAm/MA gels.

2 Experiment

Synthesized were the AAm/MA gels with various ingredients composition, 0.7, 1.4, 2.1 M in (AAm + MA) concentration, 6:1, 5:2, 4:3 in AAm/MA molar ratio and 12, 25, 37 mM in BIS (N, N'-methelynebisacryamide; cross-linker) concentration.

Nano-structures of the gels were investigated by the small angel X-ray Scattering (SAXS) performed at the BL40B2 in SPring-8. Scattering Patterns were measured at room temperature by using Imaging plate (Rigaku R-AXIS VII). The camera length was settled about 2 m with the X-ray wavelength λ of 1.5 Å.

3 Results and Discussion

Figure 1 shows the SAXS profiles of the AAm/MA gels, in which one can observe the scattered X-ray intensities in the low scattering-vector region are stronger as is the concentration of cross-linker increased. The gyration radii estimated by the Guinier plots are listed on Table I, The turbidities of the AAm/MA gels were found to increase (namely, the transmissivity decrease) with the cross-linker concentrations by utilizing a spectrophotometer at 600 nm. It is indicated that the gyration radii have a positive correlation with the turbidities of the gels.

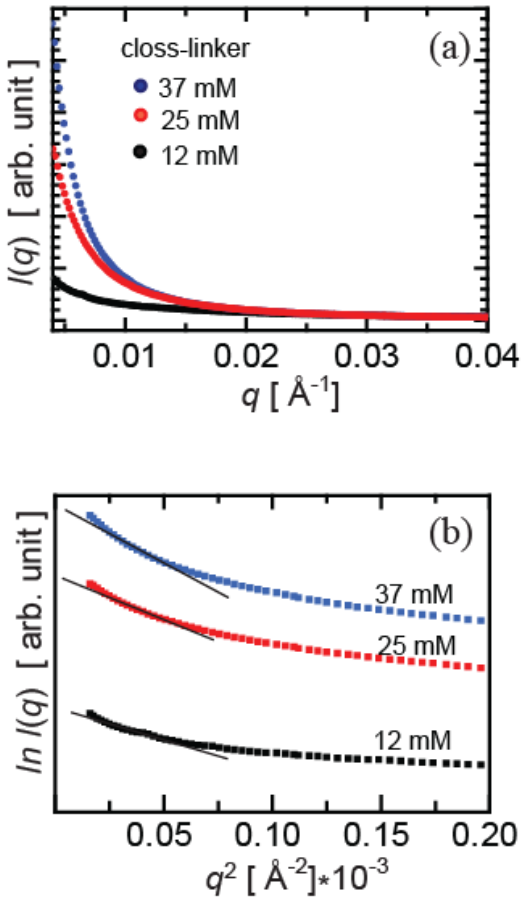

Fig. 1: SAXS profiles of AAm/MA gels at different cross-linker concentration. Total monomer concentrations and MA molar ratios were 1.4 M and AAm : MA = 5:2, respectively.

Table I: The gyration radii estimated by the Guinier plots.

Concentration of cross-linker [mM]	12	25	37
Gyration radii [Å]	130	160	190

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