Introducing proton conductivity to an azobenzene side-chain liquid crystalline polymer and photoalignment

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Recent investigations have reported the anisotropic ionic conductivity[1] and enhanced ionic conductivity[2] in liquid crystalline (LC) electrolytes. Our research group demonstrated the out-of-plane and in-plane photoalignment method for side-chain liquid crystal (SCLC) polymer thin films.[3] In this study, we designed the proton conductive LC copolymers with azobenzene (Az) mesogen and acryl acid (AA) (P(Az_{1-x}-*co*-AA_x), Fig.1) and attempted to control proton conductive anisotropy in P(Az_{1-x}-co-AA_x) thin films by in-plane photoalignment of LC nanostructure.

P(Az_{1-x}-co-AA_x) were synthesized by free radical polymerization. Differential scanning calorimetry, polarized optical microscopy revealed that the copolymers exhibited LC phases. X-ray scattering (XRS) measurement profiles for (P(Az_{1-x}-*co*-AA_x)s at r.t. are shown in Fig. 2. We observed the scattering peaks corresponding to lamellar structure in the small-angle region, indicating that the homopolymer and copolymers exhibited a smectic phase at r.t. The first-order smectic lamellar peak positions of the polymers sifted from 3.6° (d = 3.6 nm) to 1.9° (d = 4.6 nm) with the increase of the composition of AA. The first-order peak was much weaker than the second-order peak at more than x = 0.5. These indicate that Az mesogen and AA side-chains are nano-segregated through the main chain and form the alternating lamellar structure with smectic LC Az and proton conductive AA layers in the copolymer (hetero lamellar structure). Furthermore, the copolymers exhibited a sharp peak derived from smectic B phase around 20°. We will discuss the in-plane photoalignment of P($Az_{0.5}$-*co*-$AA_{0.5}$) thin film and the proton conductivity anisotropy in the aligned film.

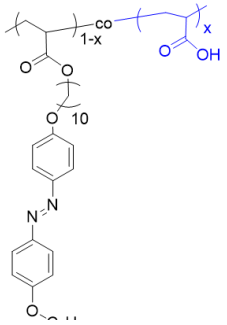

Fig.1 Chemical Structure of P(Az_{1-x}-*co*-AA_x).

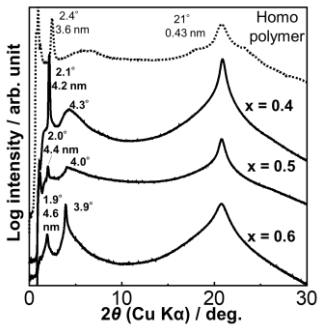

Fig.2 XRS profiles of P(Az_{1-x}-*co*-AA_x)s at r.t. for x = 0 (doted), 0.4, 0.5, 0.6 (solid).

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