Temperature-responsive Anion-exchange Membranes Prepared by Graft Polymerization of N-isopropylacrylamide and Poly(vinyl alcohol)

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Summary

We describe design and preparation of temperature responsive anion-exchange membranes, which can control the permselectivity between anions with same sign and same valence in response to temperature changes.

A temperature-responsive polymer was prepared by *in situ* polymerization of N-isopropylacrylamide in poly (vinyl alcohol) (PVA). Poly(NIPAAm) chains in the membranes give the membranes high water content at temperatures below their lower critical solution temperature (LCST) (32 ˚C), and low water content at temperatures above the LCST. A mixture of dimethyl sulfoxide solution of the polymer obtained, poly(allylamine) (PAAm) and PVA was cast on teflon plate. The membrane obtained was crosslinked in an aqueous solution of glutaraldehyde at 25 ˚C for 24 h. The water content was obtained from the weights in the dry state and in the wet state. The charge density at various temperatures was estimated by measuring membrane potential across the membrane. Permeation experiments at 15 and 50 ˚C were performed, using an acrylic plastic cell of two parts separated by the membrane to investigate the permselectivity between fluoride and nitrate ions.

The water content of the membrane decreases with increasing temperature because the hydrophilicity of the poly(NIPAAm) chains decreases. The water content decreases with poly(NIPAAm) content, C_{NIPA}, at 15 ˚C and increases at 50 ˚C. The charge density at 50 ˚C is larger than that at 15 ˚C because the water content at 50 ^{o}C is lower than that at 15 ^{o}C. The ratio of the partition coefficient between nitrate and fluoride ions (K_{NO3}/K_F) decreases with C_{NIPA} at 10 ˚C and increases at 50 ˚C. The permselectivity, which is defined as the division of permeation coefficient of NO_3^- ion to that of F^- ion, increases at 50 ˚C, but decreases at 15 ˚C with increasing poly(NIPAAm) content because of the change of the membrane hydrophilicity. This indicates that the permselectivity between the ions through the membrane can be controlled by changing the temperature and the poly(NIPAAm) content. The membranes have permselectivity for fluoride ions under the conditions at temperatures below the LCST and C_{PVA} = 85 wt %, and for nitrate ions under the other conditions. These results indicate that the permselectivity between anions with same sign and same valence through the temperature-responsive anion-exchange membranes can be controlled by changing the hydrophilicity of the membrane.