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Neutron scattering study on the structure-property relationship of polymer electrolyte membranes

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Polymer electrolyte membranes (PEMs) are of great interest as solid electrolytes for applications such as fuel cells, water treatment and electronic devices. Typically, PEMs are composed of the hydrophobic polymer matrix, hydrophilic polymer chains with ionic groups. Upon hydration, ionic groups absorb water resulting in the formation of ion channels that phase-separated from the hydrophobic polymer matrix. The properties of PEMs are controlled by not only the density of the ionic groups but also the morphology and connectivity of ion channels. In this talk, we quantitatively elucidate the structure-property relationships of radiation grafted PEMs using small-angle neutron scattering (SANS) technique. Particularly, we develop the partial scattering function (PSF) analysis through contrast variation SANS, which gives the concrete structure information of individual components with locations in the membrane. PSF was for the first time used to understand the detailed structure of the benchmark material Nafion and compared to that of radiation grafted PEMs. This work provides a mechanistic insight into membrane conductivity and structure correlations. In particular, the structural guidelines at the molecular level are significant and relevant for establishing superior design rules for fuel cell membranes. This work is currently published in *Macromolecules* 54, 4128 (2021) and 55, 7100 (2022).

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