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Realizing Ideal Interfacial Structure using Highly-oxygen-permeable-ionomer Thin Films for Advanced PEFC Catalyst Layers

The performance of catalyst layers in polymer electrolyte fuel cells has been improved by using highly oxygen permeable ionomer (HOPI), a polymer electrolyte with a bulky backbone, instead of the conventional Teflon-like polymer Nafion. To determine the origin of this performance enhancement, we used improved neutron reflectometry (NR) to study the nanostructure of polymer thin films that model the ionomer coating on platinum/carbon particles within the catalyst layer. Through simultaneous NR and impedance measurements, we discovered that the increase in film thickness caused by water absorption is a descriptor for the enhancement of proton conductivity in HOPI, similar to Nafion. Furthermore, the use of double contrast NR with H2O/D2O showed that HOPI does not form a dense lamellar layer on the Pt surface, unlike Nafion. This difference in interfacial structure is the main factor affecting the oxygen transfer resistance in the catalyst layer. Consequently, for HOPI, the prevention of dense layer formation at the interface and its sufficient thickness increase by water absorption contributes to the high oxygen permeability without compromising the proton conductivity. These results highlight the influence of the main chain chemical structure on interfacial alignment and molecular mobility.

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Thin films and interfaces in soft matter and materials science

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