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Operando Neutron Radiography Analysis of High-Temperature Proton Exchange Membrane Fuel Cell Based on Phosphoric Acid Doped PBI membrane by Using Hydrogen-Deuterium Contrast Method

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The energy shortage and environment pollution are two of the most important challenges for human race. With the advantage of zero-emission and high energy conversion efficiency, proton exchange membrane fuel cell (PEMFC) is recognized as an alternative solution for future energy conversion technology, and has been gained great development in recent years. The classical PEMFC which is based on PFSA-type membranes (e.g. the well-known Nafion) and operated between 60-90℃, still has some issues such as low carbon monoxide tolerance of the catalyst and complex water management. To overcome the disadvantages, high-temperature PEMFCs which are based on phosphoric acid doped PBI membranes, operated between 140-180℃, are in the focus of the current research.

In order to characterize high-temperature PEMFCs in-operando, the neutron radiography method can be used. This neutron imaging in combination with the deuterium contrast method was used to analyze the hydrogen distribution and exchange processes in a high-temperature PEMFC in-operando. The cell was operated at different steady state conditions (different current densities and stoichiometries). At each condition neutron images of the active area of the cell were taken and the data were used to analyze the changeovers of the fuel switched between hydrogen (H2) and deuterium (D2). We will demonstrate that local exchange between H and D (and vice versa) is influenced by the overall exchange dynamics and the current distribution within the cell. A change from H-to-D is different from a change from D-to-H. We found a faster proton-to-deuteron exchange when switching from H2 to D2 gas supply than for a change from D2 to H2 gas.

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