

Blends of protic ionic liquids with different Brønsted-acidity for PEFC operating above 100 °C

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Polymer electrolyte membrane fuel cells (PEMFC) have emerged as promising candidates to combustion engines for automotive applications. However, the most widely accepted and commercialized membranes based on sulfonated fluoropolymers like NAFION[®], whose proton conduction relies on the presence of water, limits the operating temperature below 80 °C (ambient pressure). The operation of a PEMFC at elevated temperatures above 100 °C would allow a significantly simplified system setup for water and heat management. Operation temperatures of 100–120 °C require novel non-aqueous electrolytes. Protic ionic liquids (PIL) immobilised in a host polymer are considered as alternative membranes for future intermediate-temperature PEMFCs. [1] Ionic liquids consist of bulky organic cations and anions of superacids, resulting in a low melting point (< 25 °C). A large variety of combination of cations and anions gives the opportunity to design electrolytes with desired properties. The structure of the electrical double layer in ionic liquids is different to conventional aqueous solutions, consisting of alternating cation and anion layers. [2]

In this contribution, we present a study on the (total) conductivity, the onset potential and the limiting current density of blends consisting of PIL electrolytes [HA⁺][X⁻] with Brønsted-acidic cations [HA⁺] of various acidity. Results from former studies show that the first reduction step including the proton transfer to the (catalytic) active sites on the electrode is mainly determining the ORR rate in these type of electrolytes. [3] The presence of a potent proton donor, *i.e.* a sufficient acidic PIL cation [HA⁺] or water will limit the total rate. Thus, the onset potential of the ORR in a future IT-PEMFC will depend on both the concentration of residual water and the PIL cation acidity. However, in addition to the ORR kinetics, the O₂ solubility and diffusion are also important factors as they limit the maximum current density and thus the potential range under fuel cell operation. A high cation acidity of a PIL is often accompanied by a high hygroscopicity and viscosity and thus a low O₂ solubility and diffusion coefficient and *vice versa*. To overcome these limitations, we suggest blends of PILs, consisting of a high acidic PIL and a PIL with a high O₂ solubility and diffusion (but low acidity), which are able to achieve a higher ORR current density in the relevant potential range for fuel cell operation. [4]

References:

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