SPEEK-based Hybrid Membranes for Polymer Electrolyte Membrane Fuel Cells.

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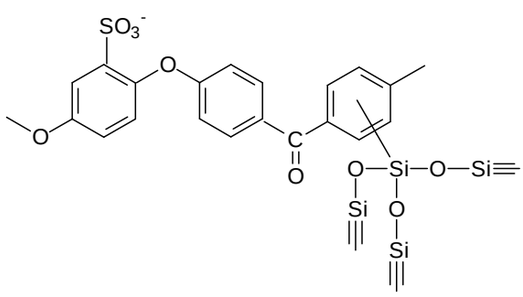
The proton conducting membrane is one of the key components of Polymer Electrolyte Membrane Fuel Cells (PEMFCs). Requirements to be met are high proton conductivity, high hydrolytic stability and low permeability to methanol to avoid alcohol crossover in DMFCs.[1] These properties are related to the hydrophobic nature of the polymer backbone and the hydrophilic nature of the acid side chain groups. The ratio between hydrophilic and hydrophobic groups the conductivity and mechanical properties of polymeric electrolyte membranes.

Much research efforts are devoted to the development of new electrolytes. Composite membranes where inorganic fillers are dispersed in a polymeric matrix are very promising for fuel cell applications. These composites are very interesting because of the possibility of combining the properties of organic and inorganic components in a single material.[2,3] It is however hard to achieve homogeneity at a molecular level, a target that can be reached developing hybrids where the inorganic component is covalently bound to the organic one.[4]

The properties of such covalent hybrids can be modulated by modifying the ratio between organic and inorganic groups and the nature of the chemical components.

We have focused our attention on PolyEtherEtherKetone (PEEK) as the organic backbone, which is a fully aromatic semicrystalline polymer and shows good thermal stability and excellent mechanical properties. Proton conductivity can be achieved by sulfonation, however, while SPEEK conductivity increases with degree of sulfonation, its mechanical properties show a parallel progressive deterioration.[5,6]

Organic/inorganic hybrids were synthesized by reaction of sulfonated PEEK with silicon tetrachloride, followed by hydrolysis. Further amounts of inorganic component were added by sol-gel reaction with tetraethylorthosilicate (TEOS) to modulate mechanical properties and electrical performance.



Materials were characterized by means of multinuclear NMR (Nuclear Magnetic Resonance) spectroscopy (^{1}H, ^{13}C, ^{29}Si), Thermogravimetric and Differential Thermal Analysis (TG/DTA), Differential Scanning Calorimetry (DSC), Fourier Transform Infra-red Spectroscopy (ATR-FTIR) and Electrochemical Impedance Spectroscopy (EIS).

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