PHISICO-CHEMICAL INVESTIGATION ON NOVEL MATERIALS FOR DMFC

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Direct Methanol Fuel Cells (DMFCs) are of considerable practical interest as power source for a range of applications, including electric vehicles and portable electronics. Up to now, perfluorosulfonic acid polymer membranes have been widely used, as proton conducting electrolyte, for their good electrochemical properties and chemical resistance, in spite of some critical drawbacks, such as high methanol permeability and strong dependence of ionic conductivity on water content.

In this work we present an acid absorbed-composite membrane based on a polymer-ceramic added matrix. By mixing a hydrophobic polymer (poly-vinylidene fluoride, PVdF) with a hydrophilic component (poly-acrylonitrile, PAN), we can modulate the water affinity of the membrane. The further addition of a ceramic filler (Al_2O_3) into the matrix improves the morphology and increase the retention of the acidic solution absorbed. The resulting membrane shows high conductivity ($\sigma = 10^{-1}$ Scm^{-1}, room T) [1], which appears not critically affected by the relative humidity of the atmosphere (Fig.1).

A vibrational spectroscopy analysis (IR and Raman), carried out to understand the molecular interactions of the polymer matrix and the acidic solution, has clearly evidenced the roles of PAN and Al_2O_3 in favouring the acid uptake and, therefore, the high conductivity of the composite membranes.

Thus, the stable PVdF-PAN- Al_2O_3 matrix has been further studied and also used in the preparation of novel acidic membranes, obtained by the dispersion of a strong heteropolyacid (phosphotungstic acid, PWA) [2] in the polymer matrix. The direct addition of PWA powder during the synthesis of the membrane can assure entrapping and retention of the protonic component. A preliminary investigation on these new systems has shown good thermal stability (Fig.2) and interesting conductivity values ($\sigma = 10^{-3}$ Scm^{-1}, room T).

In this presentation we report a complete characterization of the membranes and discuss the possibility of their application as polymer electrolytes in DMFC.

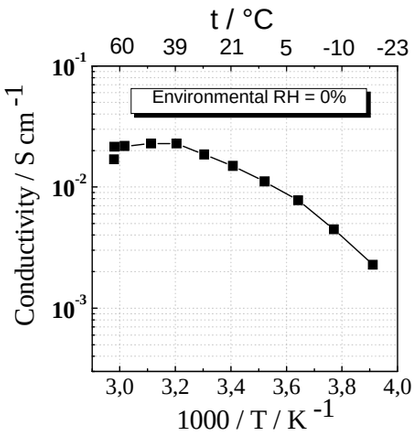

Fig.1: Arrhenius plot of a PVdF-PAN- Al_2O_3 membrane soaked in 6M H_2SO_4 solution.

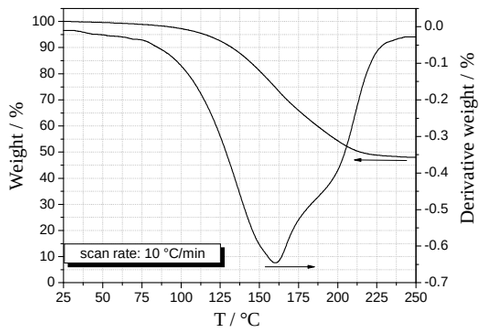

Fig.2: TGA response of a PVdF-PAN- Al_2O_3-10%PWA membrane.

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References:
[1] M.A. Navarra, S. Panero, B. Scrosati, *J. Sol. St. Electrochem.*, in press.
[2] Z.-G. Shao, P. Joghee, I-M. Hsing, *J. Memb. Sci.*, 229 (2004) 43-51.