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PT-CATALYZED MEMBRANES FOR SOLID POLYMER ELECTROLYZERS

ENERGY EFFICIENCY

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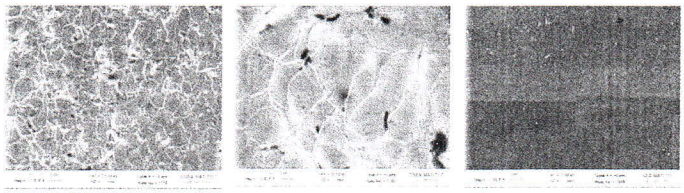
Abstract:

Solid polymer electrolyte (SPE) technology used in water electrolysis represents an extremely promising system for on-board production of pure oxygen in submarines and for energy storage purposes in spacecraft. Respect to the classical alkaline water electrolysis, these systems present many advantages: among them a greater safety, since no corrosive liquids are employed, a good reliability and a significant increase in operating cell efficiency up to several A cm-2 [1]. Moreover SPE electrolyzers are very compacts and characterized by a low weight. Above-described features are strictly connected with the presence of the Nafion membrane (acting as electrolyte) in SPE. In fact, this polymeric materials allows to achieve good performances, due to his excellent chemical and mechanical stability as well as high ionic conductivity and good gas impermeability. Anyway, to a large-scale SPEs production and diffusion it is necessary to overcome some drawbacks, which are so far mainly economic factors. The price of both Nafion membranes and of noble metal (e.g. platinum) based electrocatalysts used (necessary for their high acidic corrosion resistence) is nowadays still remaining somewhat high. Furthermore, because of the severe operating conditions (the electrode have to support either the strong acidity of the Nafion membrane either high mechanical tension during gas evolution), much attention must be posed on the electrode structure, in order to strengthen the bonding between electrocatalyst and polymeric membrane [2-4]. In this work Pt-catalyzed Nafion membranes have been prepared [5, 6] following an optimized procedure: the noble metal cationic species are chemically reduced directly within the solid polymer electrolyte, showing good results. The structure of the precipitates have been investigated by scanning electron microscopy (SEM) and electrochemical characterization has been carried out by electrochemical impedence spectroscopy (EIS) and by electrolysis measurements. By the electrochemical results summarized in Tab1, related to the tree samples M01, M07 and M08 prepared in different conditions, it is possible to observe that their behaviour is strictly related to many factors: materials employed, thickness and morphology of platinum deposit, preparation steps and so on. In particular, platinum distribution across the polymeric membrane and on its surface is a key parameter for the electrolysis performances. In fact, to realize an efficient SPE composites, the bonding of the electrocatalyst onto the polymeric membrane is critical.
Therefore, metal has to be located not too far inside the membrane to avoid shortening and low faradic yield due to gas diffusion through the membrane. Besides, metallic nanoparticles must be simultaneously present inside the membrane (acting as electrocatalyst) and on the uppermost membrane surface (as current collector). Furthermore, those two regions must be in contact, to ensure electron transport and good adherence of the electrode under high mechanical tension during gas evolution.

Pt-catalyzed membranes	HRF /Ω cm^{-2}	I @ 2 V /mA cm^{-2}
M01	0,95	47,0
M07	1,67	29,30
M08	1,04	24,58

Tab.1: EIS characterizations of SPE composits

Morphological studies seem to confirm completely these theoretical considerations and in addition clarify the influence of deposit structure on electrochemical performances (Fig.1).



a) *b)* *c)*

Fig.6: SEM images at 10KX: a) M01, b) M07 and c) M02.

The differences are extremely evident: M01 and M07 have a surface characterized by a lot of creeks and hole, while M02 shows a more homogeneous and compact surface, without breaks. Based on these considerations, electrochemical behaviour of these samples could be easy explained: when a not closed structure is present, a better reaction involved gases crossing is allowed, giving enhanced performances. On the contrary, a sensible resistance increase is measured, causing a noticeable worsening in electrolytic results. In conclusion, the SPE-electrocatalyst composits investigated in this work, are characterized by low noble metal loadings, excellent electrochemical properties and strong adhesion of the electrodes onto the polymeric membrane.

[1] S.A.Grigor'ev, V.I.Porembskii, "Electrolyzer with solid polymer electrolyte for getting special-purity gases", Chemical and Petroleum Engineering 40 (9-10) (2004).
[2] A.Katayama-Akamata et al., Electrochim. Acta, 28 (1983) 777.
[3] H.Kita et al., Electrochim. Acta, 29 (1984) 1721.
[4] H.Nakajima et al., Electrochim. Acta, 32 (1987) 791.
[5] P. Millet, R. Durand, M. Pineri, J. of Appl. Electrochem., 19 (1989) 162.
[6] P. Millet, R. Durand, T.Alleau, J. of Appl. Electrochem., 23 (1993) 322.

Biosketch

Alessia Cemmi is PhD student in Chemical, Material and Environment Engineering at La Sapienza University, Rome (Italy) with Prof. M. Pasquali. She is involved in hydrogen production by water electrolysis, in Solid Polymer Electrolyzer materials and in Polymer Electrolyte Fuel Cells and she works in collaboration with Dr.Alfonso Pozio from ENEA Research Centre, Casaccia (Rome).

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