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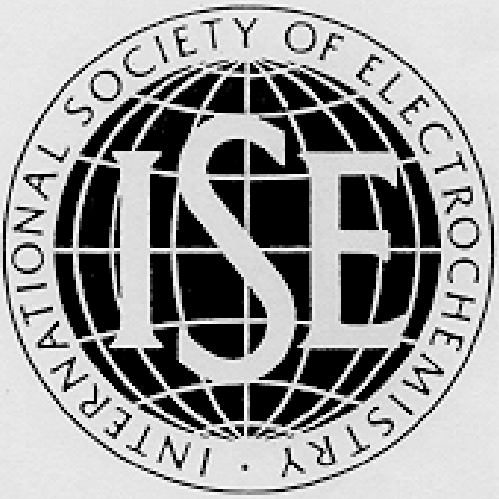

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EFFECT OF THE HEAT TREATMENT ON THE ELECTROCHEMICAL PROPERTIES OF LOW Pt LOADING CATHODES FOR PEFCS

L.Giorgi[1], A.Pozio[1], E. Antolini[1], C. Bracchini[1], R. Giorgi[2], S. Turtù[2], P. Ascarelli[3], E. Passalacqua[4]
[1] ERG-TEA-ECHI, [2] INN-NUMA-TECMA
ENEA C.R.E. Casaccia, ERG-TEA-ECHI, Via Anguillarese 301,
00060 Santa Maria di Galeria (Roma) Italy, E-mail: giorgil@casaccia.enea.it
[3] CNR-IMAI, Via Salaria km 29.300, 00016 Monterotondo S. (Roma), Italy
[4] CNR-TAE, Via Salita S. Lucia 5, 98126 S. Lucia (Messina), Italy

In this paper we investigated the influence of the heat treatment of the catalyst layer on the performance and agening of three layers cathodes for PEFC. The diffusion layer was composed by 20 wt% PTFE and 80 wt% carbon (1). To prepare the catalyst layer, a homogeneous suspension was formed from the Pt/C catalyst, glycerol and the Nafion solution with ethanol/isopropanol mixture as solvent. The resulting ink was deposited onto the composite diffusion layer of the electrode by a brushing procedure. Platinum loading was 0.11 mg Pt cm^{-2} (2). Finally, the samples were thermal treated at 70°C in air for 0.5 h (TT70 samples). To evaluate the effect of the heat treatment, some of these electrodes were also thermal treated in air at 110°C for 4 h (TT110 samples). From SEM examination it can be denoted that in TT110 electrode the voids between diffusion and catalyst layers disappear, resulting in a better adhesion of the layers.

The electrodes were operated, in 1M H_2SO_4 electrolyte at room temperature, at a constant current density of 0.1 A cm^{-2}. From the galvanostatic steady-state polarization plots, it can be seen that after 56 h of operating conditions the oxygen reduction overpotentials of the TT70 electrode increased; instead the plots of TT110 electrode showed a decrease. To gain more details on this behaviour, impedance spectra have been recorded at 0.1 A cm^{-2}. The observed behaviour of the impedance response results from the combination of conductivity, charge transfer and mass-transport limitations within the catalyst layer. Both oxygen and protons must be available at the catalyst site for the oxygen reduction reaction to occur. Restriction of access of either decreases the observed rate of the reaction, causing an increase of overall impedance. The impedance of the TT110 electrode decreased with time, while that of TT70 electrode increased, as a result of poorer kinetics for the oxygen reduction reaction. The better performance of the TT110 electrode can be also attributed to a improved adhesion between catalyst and diffusion layers.

As electrode performances are influenced by the nature of all components, whose chemical, physical and structural surface properties should be understood, some XPS spectral features have been studied, in order to obtain useful correlation between system operation and physical and chemical characteristics of materials. In particular, the variation of the intrinsic asymmetry of the Pt $4f_{7/2}$ peak, the energetic shifts of the photoemission lines and the evolution of the relative intensities have been investigated, before and after heat treatments and galvanostatic measurements. These aspects have been analysed to check possible variations in electronic properties of Pt nanoparticles due, for example, to size effect and/or cluster-support interactions and changes in the catalyst layer chemical composition.

References

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