Determination of Double Layer Properties of Carbon Aerogels Electrodes using Probe Beam Deflection and AC Impedance

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The development of electrochemical double layer supercapacitors requires the availability as electrode materials of conductive materials of high electrochemical area.
Glassy Carbon aerogels produced by formation of gels of crosslinked resins, followed by supercritical drying and pyrolysis, could be used for that purpose because they combine high surface area with good mechanical properties and electrical conductivity.
While the applications of those materials have been described [1], the fundamental properties of the materials are less well known. Even from the technological point of view, it is necessary to know the properties of the materials to direct the design and/or modification. Additionally, the understanding of those properties could shed light on porous electrodes behavior and modeling of similar systems [3].
In the present communication, Probe Beam Deflection and AC Impedance are used to evaluate the properties of the electrochemical double layer formed on carbon aerogel electrodes in aqueous (acidic and neutral) and nonaqueous (propylene carbonate and acetonitrile) media.
Probe Beam Deflection technique is an optical technique which detects the ion flux from/to an electrode by the refraction of a laser probe beam travelling parallel to the electrode surface. The technique has been extensively used to evaluate the redox coupled ion exchange of electroactive layers (conducting polymers, redox oxides) with the bathing solution [2].
In the case of high surface electrodes, the change of ion population in the double layer, while the potential is stepped between two potentials, would cause ion flux from/to the electrode. The high surface area of the aerogel electrodes makes that small changes in ion population cause significant ion fluxes.
While qualitative data could be obtained by scanning slowly the electrode potential, the amount of flux depend on the difference between the starting potential and the potential of zero charge. On the other hand, a quantitative evaluation of the flux could be obtained by measuring of the deflection during pulse experiments at different potentials. In that way, is possible to estimating the ion population in the double layer and related parameters such as the potential of zero charge.
AC impedance spectra of carbon aerogel electrodes are measured in a specially designed cell. The results are analyzed using an equivalent circuit and the double layer capacitance of the electrode surface (including pores) is extracted from the data. The capacitance presents a minimum which could be related with the potential of zero charge
The parameters obtained using both techniques are compared for the different electrolyte studied.

References

1.- J. Wang, L. Angnes, H. Tobias, R.A. Roesner, K.C. Hong, R.S. Glass, F.M. Kong, R.W. Pekala, *Anal. Chem.*, 12(2000)1625 and refs therein.
2.- C. Barbero, M.C. Miras, R. Koetz, O. Haas, *J. Electrochem. Soc.*, 138(1991)669.
3.- M.G. Sullivan, B. Schnyder, M. Baertsch, D. Alliata, C. Barbero, R. Imhof, R. Koetz, *J. Electrochem. Soc.*, 147(2000)2636.