XXXVII
Reunión del Grupo de Electroquímica
Alicante, 17-20 Julio 2016

Toward enhanced supercapacitors by mutually adapting electrolytes and nanoporous carbons

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Electric double-layer capacitors (EDLCs) or supercapacitors are electrochemical energy storage systems that can provide high power density (15 kW kg^{-1}) and possess long cycle life due to their charge storage mechanism based on ion electrosorption. The most extensively used materials for supercapacitors are high-surface-area microporous carbons, but some mesoporosity is usually desired for enhanced rate capability.

On the one hand, using phenolic-resin-derived micro/mesoporous carbons, which only differ in the mesopore shape, we have rigorously proven the beneficial effect of mesopore shape and order on the enhanced rate capability in aqueous electrolytes (Fig. 1A) [1].

On the other hand, using a series of microporous biomass-derived carbons, we have concluded that the areal capacitance of both electrodes is similar for carbons with different and disperse micropore size distribution. This is due to the linear increase of effective dielectric permittivity with the pore size [2] (Fig. 1B), which counterbalances the effect of the smaller charge separation in the narrow pores and does so independently of the electrolyte used. We have also evidenced that the rate capability of separate electrodes is different. In organic electrolyte (1.5M $TEA^+BF_4^-$/AN), the gravimetric capacitance of the negative electrode is higher as the current density increases, with a progressively growing difference for wider pores. The opposite trend is observed in alkaline aqueous electrolyte, for which the capacitance of the positive electrode is higher than that of the negative with the increasing current density.

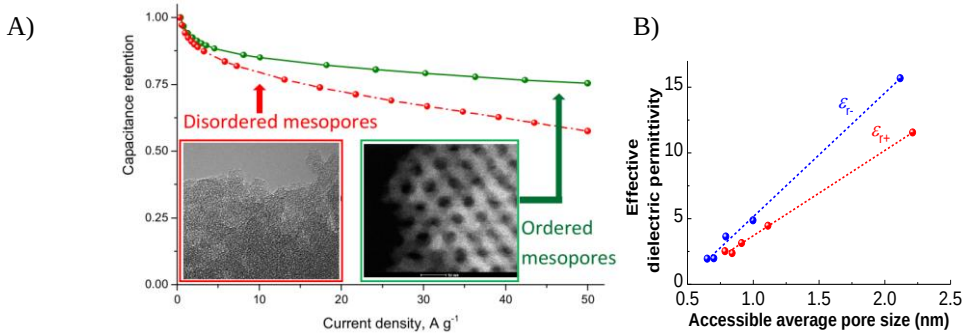

Fig. 1: A) Rate capability vs mesopore shape; B) Dielectric permittivity vs average pore size.

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