Colloids and Surfaces A: Physicochem. Eng. Aspects 415 (2012) 343–348

Contents lists available at SciVerse ScienceDirect

Colloids and Surfaces A: Physicochemical and Engineering Aspects

journal homepage: www.elsevier.com/locate/colsurfa

Facile preparation of hierarchical porous carbons with tailored pore size obtained using a cationic polyelectrolyte as a soft template

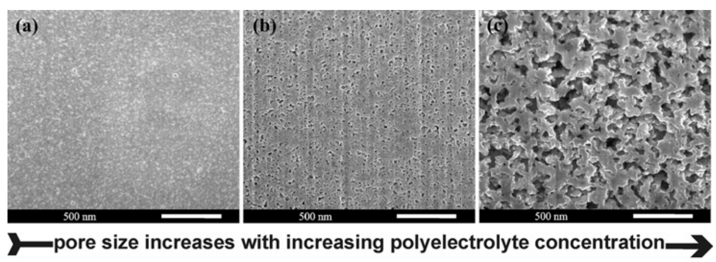
Juan Balach[a,*], Luciano Tamborini[a], Karim Sapag[b], Diego F. Acevedo[a], César A. Barbero[a]

[a] *Programa de Materiales Avanzados, Universidad Nacional de Río Cuarto, Agencia Postal No. 3, 5800 Río Cuarto, Argentina*
[b] *Laboratorio de Sólidos Porosos. Instituto de Física Aplicada (INFAP), CONICET, Departamento de Física, Universidad Nacional de San Luis, San Luis 5700, Argentina*

HIGHLIGHTS

- ► Hierarchical porous carbons (HPCs) are obtained.
- ► Cationic polyelectrolyte as a soft template is used in the synthesis of porous gel.
- ► The presence of the polyelectrolyte avoids the collapse of the wet gel during drying.
- ► HPC has a specific capacitance of 140 F/g and high areal capacitance of 0.1 F/cm^2.
- ► HPC surface remains accessible at 200 mV/s with retention of the capacitance of 72%.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 26 August 2012
Received in revised form 3 October 2012
Accepted 4 October 2012
Available online 13 October 2012

Keywords:
Cationic polyelectrolyte
Hierarchical
porous carbon
Resorcinol-formaldehyde
Soft template
Supercapacitor

ABSTRACT

Hierarchical porous carbons (HPCs) were obtained by carbonization of resorcinol-formaldehyde (RF) gels prepared in the presence of a cationic polyelectrolyte as a soft template. The porosity of the gels is maintained during air drying due to the stabilizing effect of a cationic polyelectrolyte on the sol–gel nanostructure. The proposed method greatly simplifies the production of porous carbon by making it unnecessary to use complex drying procedures, cumbersome solvent exchanges, and long curing times. Additionally, pore size of the HPCs can be tailored (from mesoporous to macroporous range) by controlling the amount of polyelectrolyte in the initial stage of RF polymerization. The HPCs have a high specific surface area (up to 675 m^2/g), large specific capacitance (up to 140 F/g) and areal capacitance (up to 0.1 F/cm^2), in acidic media. Significantly retention of the specific and areal capacitances of 72% are observed at high scan rates of 200 mV/s, making it suitable as an active material for fast supercapacitor applications.

1. Introduction

As a consequence of advance on new electronic technological devices, many efforts are being made in order to produce smaller and more efficient energy store devices. Electrochemical double layer capacitors (EDLC), also known as supercapacitors, are of particular interest due to their high power output and high energy density, which fills the gap between the high power densities offered by conventional dielectric capacitors (i.e. fast energy discharge rates) and energy densities of traditional batteries (i.e. greater energy storage). The capacitance, and hence the energy, comes mainly from the electrical double layer which is generated at the electrode-material/electrolyte interface.

Hierarchical porous carbon materials have widely been explored as supercapacitors due their properties as high specific surface area and narrow pore size (1–50 nm). These pore size involve whole micropores and mesopores. The micropores (pore size less than 2 nm) provide high surface area in carbon materials, and hence high

* Corresponding author. Tel.: +54 358 4676233; fax: +54 358 4676233.
E-mail address: jbalach@exa.unrc.edu.ar (J. Balach).

0927-7757/$ – see front matter
http://dx.doi.org/10.1016/j.colsurfa.2012.10.016