NANOSTRUCTURED CARBON MATERIALS BY SURFACTANT-TEMPLATING OF RESORCINOL-FORMALDEHYDE GELS: TOWARDS A CONTROL OF POROSITY FOR ENERGY STORAGE APPLICATIONS

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In the aim of developing high performance C-based anode materials for Li-ion batteries, carbon xerogels (hard carbons) are promising candidates since their specific capacities widely exceed that of conventional graphitic structures. Nevertheless, in order to reduce the commonly observed irreversible capacity losses and to improve the cycling performances, it is important to control the structural and textural characteristics of such materials. The polymerization and pyrolysis of aqueous Resorcinol-Formaldehyde gels leads to bimodal carbon materials composed of microporous nodules delimiting meso-or macroporous voids, the average size of which depend on both the composition of the precursor solution (pH, mainly) and the drying procedure.[1]

Despite these interesting characteristics, for application as anode components for instance, the chemical diffusion of lithium ions within a bulk electrode material is often a rate-limiting step and optimized transport pathways could be provided by creating large mesopores or even macropores within the microporous carbon structure.[2, 3] Here, we report on the control of the textural characteristics of meso-microporous RF xerogels prepared by simple solvent evaporation by addition of a block-copolymer non-ionic surfactant (Pluronic F127) to the RF precursor solution prepared with different Resorcinol/Na-Carbonate (R/C) molar ratios.

The structural features of the final pyrolized carbons remained unchanged. From the textural point of view, the microporous volume as determined by N_2 adsorption remained in a constant range of about 0.3 cm^3/g, a value similar to that found for carbon xerogels prepared by evaporative drying. However, in the domain of the large mesopores, the addition of F127 leads to an increase in pore sizes (from ~35nm to ~50 nm for R/C=1000 and from ~10 to ~14 nm for R/C=500) and specific surface area. The volume of pores >7.5 nm, determined by Hg intrusion porosimetry, is also enlarged with values up to 1.8 cm^3/g and 0.75 cm^3/g for carbons prepared with R/C=1000 and 500 respectively. The former value is near that found for cryogels and aerogels. In accordance with these observations, the bulk density, as determined from Hg pycnometry is decreased in comparison to xerogels prepared under same conditions without surfactant. It is worth mentioning that all of these features are maintained when the synthesis is scaled-up to 15g of final porous carbon material.

These preliminary results show that the block copolymer surfactant acts in the control of the growth and stacking of the microporous carbon nodules. Though there is no real nanostructuration in the sense of "templating", this procedure is useful to increase the accessibility of the microporous network to lithium-containing electrolytes in Li-ion batteries.

References:

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