

Nanostructured carbon materials by soft-templating of resorcinol-formaldehyde gels: Towards a control of porosity

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Carbon gels are texture-tailored carbons that are prepared by drying, followed by pyrolysis of organic gels (Resorcinol-Formaldehyde aqueous gels for instance). These materials, prepared by polycondensation of a phenol (commonly, resorcinol) and formaldehyde in a solvent (water in most cases) are composed of microporous interconnected sphere-like nodules, formed during the gel synthesis *via* a microphase separation mechanism induced by polymer growth [1]. The size of these nodules is mainly regulated by the synthesis pH; as a result, the size of the voids between the nodules after drying and pyrolysis, and thus the meso- or macroporosity of the final carbon material, is also regulated: it depends on both the composition of the precursor solution (pH, mainly) and the drying procedure [2]. Finally, as the nodules are microporous, the pore size distribution of carbon gels is bimodal: they contain micropores (typically 0.2-0.3 cm³/g) and meso- or macropores (up to several cm³/g), the size of which can be tuned as desired.

Despite their higher cost than conventional activated carbons, carbon xerogels are interesting for specific applications: the accurate tailoring of the pore texture led to increasing significantly the performance of catalytic and electrocatalytic processes. In particular, choosing a correct meso- or macropore size significantly decreased mass transport limitations in gas phase catalysts [3] and fuel cell electrodes [4]. However, in carbons issued from RF gels, only the average size of the largest pores can be tuned so that the pore texture remains bimodal whatever the synthesis conditions. To widen the application window, it becomes desirable to elaborate carbon materials with a hierarchical pore texture, with individually controllable pore sizes and structures. This should be possible by macro- or mesostructuration of the carbon nodules. The most popular approach towards the textural control is the so-called “nanocasting” strategy, which remains quite tedious and costly since it implies the use of a sacrificial hard template (typically macro- or mesoporous silica) that is removed by HF etching, which precludes a safe and viable industrial production [5]. On the other hand, soft-templating has recently been proposed as an attractive alternative and ordered mesoporous carbons displaying various symmetries have been prepared *via* organic-organic self-assembly routes either by EISA or in aqueous conditions. These however often suffer from long processing times and morphology is most limited to films or powders [6].

Here we describe the control of porosity in RF-based carbon monoliths *via* the soft-templating route. In particular, we have investigated the effect of multiple parameters, including the nature of the non-ionic surfactants and the physico-chemical preparation conditions, such as reactant ratios and pH, on the final porous carbons. It is shown that the growth of the carbon polymer can successfully be oriented by fine-tuning the interactions between the precursors and the hydrophilic moieties of the surfactant.

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