Functionalization by plasma polymerization of carbon monolith with submicrometric hierarchical pores

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The functionalization of materials by plasma polymerization is a useful process for adjusting the properties of materials to a targeted application by deposing a thin layer of appropriate polymer on the surface. This process is mainly used with non-porous substrates or in a lower extend with porous materials but with lack of evidence that internal surface of the material is functionalized. Moreover, the influence of the electrical conductive nature of the substrate (e.g. insulating Si (or SiO2) versus conductive carbon material) on plasma polymerization mechanisms is hardly investigated. Therefore, functionalization of porous monoliths by this process appears as a challenge. Critical parameters such as pore size and electrical conductivity of substrate need to be addressed for fully understanding plasma polymerization mechanism within such materials. In our case, carbon materials with controlled pore size and electrical conductivity were used to investigate the diffusion of plasmagenic species and growth mechanism of the polymer within the porous and conductive nature of the material. A focus is given on the pore range that can be functionalized.

Our strategy is to develop carbon monoliths with hierarchical and controlled porosity. Materials with an average macropore size ranging from 50 nm to 250 nm were prepared by the sol-gel process combining phenolic resin formation with spinodal decomposition.[1] The xerogel was carbonized up to 950°C before surface functionalization by plasma polymerization. Perfluorooctyl acrylate (PFAC) was chosen as polymer precursor due to the ease of fluorine detection by spectroscopy techniques (EDX for instance). The deposition process was carried in an inductively coupled RF plasma reactor, operating at low pressure (typically at 0.2 mbar), in pulsed and continuous mode. Fluorine content, related to the polymer deposition, was followed with mapping techniques such as SEM-EDX as a function of the characteristic size of the porosity of the monolith. In addition, comparison of the polymer deposition on carbon monoliths and model planar substrates, either with insulating (Si wafers) or conducting (pyrolytic graphite sheets) properties, was investigated and discussed.

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1. A. C. Juhl, C.-P. Elverfeldt, F. Hoffmann, et M. Fröba, , *Microporous Mesoporous Mater.*, vol. 255, p. 271-280, janv. 2018, doi: 10.1016/j.micromeso.2017.07.040.