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Probing the micro- and meso-structure of activated carbons with SANS

Activated carbons are among the most widely employed materials in catalysis, either as supports or as catalysts on their own. The reasons of their success are mainly their low cost and their elevated specific surface area (SSA), which is enlarged by the activation process (i.e., the treatment of a char precursor at high temperature in the presence of either a chemical agent, e.g. phosphoric acid, or steam), resulting in the development of a complex porosity. The morphology of these micro- and mesopores, together with their spatial organization, is crucial to understand the catalytic properties of activated carbons.

Despite several studies have addressed the issue of pore shape of activated carbons, contradictory results were obtained. As reported by Kurig et al.,1 not only the widely accepted slit model is suited for describing their pores, as spherical or cylindrical shapes can show better agreement with experimental data. Defining the shape of the carbon platelets entails similar issues. Despite the idea of activated carbons as a collection of graphitic platelets of variable extension has been widely accepted for a long time, the relevance of fullerenic carbon domains has significantly increased in the last years.2,3 Finally, even though plenty of papers can be found addressing the pore shape in activated carbons, very few works are addressing the problem of the three-dimensional organization of the pores in space. The heterogeneity and defective character exhibited especially by industrially activated carbons implies that determining the hierarchical organization of the pores is a challenging task.

In the past years, our team has investigated the structural and surface properties of many activated carbons exploiting an unusually high amount of different techniqyes.2,4–6 By coupling together insights from this multitude of methodologies, we were able to shed light on composition, identity and amount of functional groups, size and shape of carbon domains, etc. The only piece we miss to complete the puzzle is the knowledge about the size and shape of the pores together with their organization on the mesoscale. This contribution is intended to present the first steps moved by our team in the characterization of porosity in activated carbons employing SANS.

This work focuses on two activated carbons of wood origin: CwA is physically activated with steam, while CCh is chemically activated with phosphoric acid. Previously collected data pointed out that the two samples differ in both structure and surface properties.

SANS patterns of the same two samples were collected during a preliminary experiment on D11. The two patterns exhibit clear differences, suggesting that they feature two distinct morphologies on the micro and mesoscale as well as possible different hierarchical organization of pores. Further experiment and advanced modeling will be required to assess these points.

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