

Towards Understanding of the Influence of Pore Architecture and Atomic Construction of Carbon Materials in Adsorption Processes

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Nanoporous carbon materials play a crucial role in various fields like gas purification, energy storage, and catalysis. In all of them, adsorption phenomena on the carbon surface are among the most important steps. The adsorption properties of such materials are known to be a function of their pore architecture. Pore size, pore geometry, pore connectivity, and pore hierarchy determine important factors like mass transport and the strength of interaction with different guest species. Another powerful “regulation screw” to control the adsorption properties is the atomic construction. The controlled integration of heteroatoms (most often nitrogen) into porous sp^2 -based carbon networks can significantly change their physicochemical properties. This includes their acidity/basicity, oxidation resistance, electric conductivity, and surface polarity. In order fully use of these “doping effects” it is important that the heteroatoms are significant in number, uniformly distributed over the bulk of the material, and that the local atomic construction motives are as defined as possible. The synthesis of nitrogen-rich carbon materials by controlled condensation of well-defined nitrogen-rich molecular precursors is a particularly useful way to synthesize porous carbon materials with large concentrations and precisely incorporated heteroatoms.

The presentation will cover a selection of synthetic approaches to tailor the pore structure and the atomic construction of carbon materials by using templating methods and molecular precursors, respectively. Materials with hierarchical pore architectures as well as examples with high pyrazinic nitrogen content of up to 33 at% will be presented along with their structure-performance relationships in energy and environmentally relevant applications ranging from catalysis to electrochemical energy storage. A couple of unconventional adsorption techniques including Xe-NMR and thermal response measurements for the characterization of such materials will also be part of the presentation.