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MULTISCALE POROUS CARBONS: FROM DESIGN TO APPLICATION

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Porous materials displaying a multiscale and interconnected porosity are of critical interest for a wide range of applications involving mass transfer such as heterogeneous catalysis, supported catalysis, adsorption and energy storage. In the last decades, much effort has been given to prepare such materials with porosity on different length scales, so-called hierarchical porous materials, that combine the structural advantages of macropores (i.e. pore diameter ø>50 nm), mesopores (i.e. 2<ø<50 nm) and micropores (i.e. ø<2 nm). While macropores can improve mass transport and accessibility through the whole pore network, micro- and mesopores provide high specific surface area. In our group, we develop various innovative approaches (e.g. emulsion, spinodal decomposition, gelation/drying, solvothermal treatment, silica-based sacrificial template) to synthesize hierarchical porous carbons and composites from lignocellulosic biomass (e.g. saccharides, polysaccharides, lignocellulosic agrowastes). Those approaches allow a fine control over textural and morphological properties and yield porous functional carbons with promising properties as adsorbents, (bio) catalytic supports, electrocatalysts or additives for lithium-ion battery electrodes. Besides textural and morphological control, we are interested in the preparation of monolithic porous carbons. Those monolithic carbons display tuneable macroporosity (from 3 to 40 μm), bimodal mesoporosity and high specific surface area (>1000 m2g-1). They can be integrated in flow through devices for catalysis and adsorption. In particular, flow through biocatalytic reactors were recently developed for the production of formate from carbon dioxide via the co-immobilization of two enzymes within those hierarchical porous carbon monoliths. We could produce four mmol formate per mg of enzyme during three days, which is the highest formate productivity reported to date regarding biocatalytic processes.

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