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Nanoporous Inorganic Materials: Synthesis and Applications

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Porous materials play a key role for the capture of gases such as CO_2, air filtration for clean air, and the development of novel catalysts. Mobile and stationary energy storage applications fueled by batteries and supercapacitors are important system technologies to promote the use of renewable energies and environmentally friendly electric vehicles. The presentation highlights diverse applications and recent developments in the field of porous materials such as MOFs, COFs, and carbons. The ability to adsorb huge amounts of gases renders such materials in particular useful for gas storage and the separation of gases.
Metal-Organic Frameworks (MOFs) synthesized in Dresden (named DUT-n) reach specific surface areas up to 7800 m^2/g.[1] They are promising materials for natural gas storage but also reveal fundamentally interesting novel phenomena.[2] The most intriguing phenomena were recently discovered in MOFs showing distinct structural transitions causing counterintuitive adsorption phenomena such as “negative gas adsorption” (NGA).[3]
Another ability of porous materials is to store ions in solution or encapsulate redox active molecules for energy storage. Hierarchical porous carbons are more robust and their high electrical conductivity renders them as highly useful components in the area of supercapacitors, batteries and electrocatalysts.[4] Especially lithium sulfur batteries require materials with a high specific pore volume for sulfur loading.[5] Lithium sulfur batteries are considered as highly promising next generation batteries because of the high theoretical capacity. An increase of energy density >400 Wh/kg is within reach. However, an interdisciplinary approach is needed to resolve remaining challenges of cycling stability due to the subtle interplay of anode, cathode, electrolyte and separator technologies. Supercapacitors store ions inside their pores and are commonly used for rapid charging processes needed for example in the recuperation of brake-energy. A fascinating new application of supercapacitors is the electrically driven adsorption of bioactive ions in porous carbons and the design of iontronic devices.
In summary, the presentation provides insights into tailor made porous materials and highlight their functionality with respect to gas storage, separation, ion storage and applications in batteries.

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