

DIRECT EXPERIMENTAL EVIDENCE OF CONFINED METHANE HYDRATE IN HYDROPHILIC AND HYDROPHOBIC MODEL CARBONS

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Methane hydrate (MH) is a topic in material science with scientific, geopolitical and environmental impact. With its elaborate clathrate structure, MH can theoretically store 163 m³ of methane in only 1 m³ of water. The utilization of this efficient natural energy storage concept in an energy storage system by artificially growing methane hydrate, however, has not been accomplished commercially so far, since MH formation kinetics are extremely slow.

A pioneering publication of Prof. Joaquin Silvestre-Albero and coworkers reported that porous carbons can drastically speed up this process by using the confined space of the carbons interior porosity. The scientific community, however, was skeptical as no experimental evidence could be made, that MH indeed grows inside the pores, leading to a long-running - still unresolved - debate. Neither, the origin of this tremendous increase in formation kinetic, nor the impact of the pore surface properties could be answered so far. In this contribution, we address these fundamental questions by utilizing model carbons with ordered and uniformly-sized pores in which surface functionality and polarity can be tailored to a hydrophobic or hydrophilic nature. In combination with an advanced *in situ* characterization setup we could follow the formation of MH directly inside the pores. This setup combines small- and wide-angle neutron scattering, synchrotron X-ray diffraction and volumetric high pressure gas adsorption techniques. Thereby, we could observe and prove MH nucleation and growth inside confined carbon environments. Additionally, we demonstrate how the carbon surface chemistry impacts the methane hydrate formation kinetics and storage capacity.