

SEMINAR

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Halbleiterphysik und Nanotechnologie

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“Adsorption and Transport in Multiscale Porous Media”

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Hierarchical porous materials such as hierarchical zeolites, which combine several porosity scales, are widely used in industry (adsorption, separation, catalysis) to overcome slow diffusion in microporous solids (< 2 nm) and enhance access to their large surface area. Available modeling approaches for adsorption and transport in such multiscale porous media are limited to empirical parameters which cannot be derived from molecular coefficients. In particular, existing approaches do not offer the ground for a bottom up model of adsorption/transport in multiscale materials as (1) they describe empirically the adsorption/transport interplay and (2) they do not account for the breakdown of hydrodynamics at the nm scale.

In this talk, I will present a multiscale model of adsorption and transport in hierarchical materials obtained by adding mesopores (\sim few nm) and macropores (> 10 nm) to existing microporous crystals [1]. I will first show how adsorption, permeance, and transport in such media can be described without having to rely on macroscopic concepts such as hydrodynamics [2]. Using fundamental parameters and coefficients available to simple experiments, we will see how transport coefficients can be rigorously obtained from simple models in the framework of Statistical Mechanics. Then, I will present a multiscale model of adsorption and transport in hierarchical materials [3]. This approach consists of upscaling accurate molecular simulations in a lattice model. Thanks to the use of atom-scale simulations, which capture the different adsorption and transport regimes upon varying the temperature, pore size, pressure, etc. this bottom-up model does not rely on hydrodynamics and, hence, does not require assuming a given adsorption or flow type. I will also discuss NMR experimental results on transport in hierarchical zeolites [4].

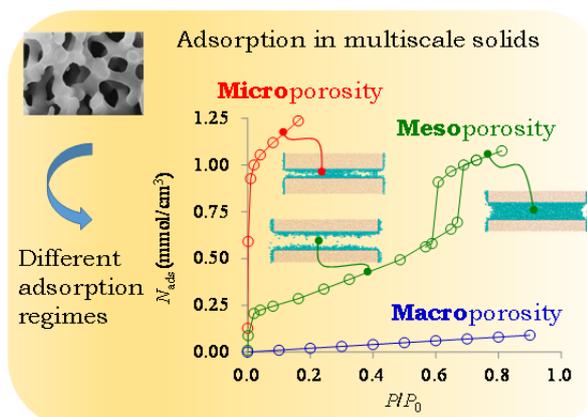


Fig. 1. Adsorption in multiscale solids involves reversible filling in micropores and irreversible and discontinuous filling in mesopores. In the latter case, for a pore size D , the pore is partially filled by an adsorbed film for $P < P_c$ and completely filled by the liquid for $P > P_c$.

- [1] B. Coasne et al., Langmuir 29, 7864 (2013).
[2] K. Falk et al. Nature Comm. 6, 6949 (2015).
[3] A. Botan et al. Phys. Rev. E 91, 032133 (2015).
[4] A. Galarneau et al., J. Phys. Chem. C 120, 1562 (2016).