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S E M I N A R
aus
Halbleiterphysik und Nanotechnologie

Mo, 14.12.2020, 11:15 Uhr, (Seminar via Zoom)

"Adsorption-Induced Deformation in monolithic, hierarchically ordered nanoporous Materials with convex and non-convex mesoporosity"

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Deformation of porous solids due to vapor adsorption, or in brief "Adsorption-induced deformation" (AID), has been studied for close to 100 years[1]. Adsorption is by definition the enrichment of adsorbing molecules at the adsorbents interface[1], forming a liquid or liquid-like state. During adsorption the adsorbed molecules excert high pressures, up to several hundreds of atmospheres[1], on the porous solid, resulting in its deformation. Advances in the synthesis of hierarchically ordered nanoporous materials with well ordered mesoporosity[2–4] have allowed to investigate not only the physics of adsorption, but also AID. Using in-situ adsorption Small Neutron Angle Scattering (SANS) and in-situ adsorption dilatometry we investigate AID of novel monolithic, hierarchically ordered nanoporous silica[5] and carbon[6] materials as a function of relative pressure.

Here, the first materials we investigated with these techniques are monolithic, hierarchically ordered nanoporous silica samples, exhibiting 2D-hexagonally ordered cylindrical mesopores similar to SBA-15. We track the deformation of three samples with different thermal histories due to adsorption of water in-situ. Additionally, we apply a recently developed analytical model of AID[7] to describe radial strains on the mesoporous level, probed by SANS, and their transfer to the macroscopic level measured with dilatometry. The second materials investigated are monolithic, hierarchically ordered nanoporous carbons at three different stages of physical activation. In contrast to the silica samples previously investigated, the carbons mesostructure is a direct negative where a continuous, non-convex mesopore space is wedged between 2D-hexagonally ordered carbon nanorods. Using in-situ n-pentane adsorption SANS and dilatometry we find qualitatively and quantitatively different behavior in contrast to silica samples exhibiting convex mesoporosity. Our findings underline i) the importance of AID in the field of adsorption science as a reliant complimentary source of information on adsorption precesses and ii) the significant impact of mesopore structure on the AID of porous materials.

References

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