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Structural Characterization of Complex Fluids in Nanopores by SANS: From Surfactant Solutions to Microemulsions

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Self-assembly of surfactants in confined geometries plays an important role in environmental, chemical and pharmaceutical technology. Adsorption of surfactants at metal oxide and other polar/charged surfaces depends primarily on the nature of their head groups: cationic surfactants exhibit high-affinity adsorption due to the interaction of the positively charged head groups with negative surface charges. Nonionic surfactants, on the other hand, exhibit low affinity adsorption isotherms due to the weak effective interaction between the hydrated head groups and hydrated surface. This difference in head group interaction with the surface causes a different evolution of surfactant aggregate morphologies at the surface. We are using small-angle neutron scattering (SANS) to study the influence of confinement on the aggregate structure of nonionic and cationic surfactants. Ordered mesoporous silica materials such as SBA-15 have favourable properties for such studies, due to the uniform size and shape of their primary pores. Studies of the aggregate morphologies of nonionic surfactants in SBA-15 have been published [1-3]. Here we will present results for the cationic surfactants DPCl and CPCl and discuss the similarities and differences in their aggregate morphologies in comparison to nonionic surfactants of the CnEm type.
The behavior of microemulsions in porous substrates is of relevance for a variety of processes, from tertiary oil recovery to soil decontamination. We will present preliminary results of a SANS study of droplet microemulsions imbibed in SBA-15, focussing on the questions if droplets of diameter greater than the pore size can enter the pores and to what extent the droplets become attached to the pore wall. Both kinds of information can be obtained by SANS measurements using a H2O/D2O solvent mixture that matches the scattering length density of the silica matrix, so that the microemulsion droplets appear against a uniform scattering background.

References

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