Diffusion in nanopores recorded by microscopic measuring techniques

C. Chmelik[1,2], D. Freude[1], J. Haase[1,2], S. Hwang[1], J. Kärger[1,2]*, R. Valiullin[1,2]

[1]Faculty for Physics and Earth Sciences, Leipzig University, Leipzig, Germany
[2]Saxon Academy of Sciences and Humanities in Leipzig, Leipzig, Germany
*kaerger@physik.uni-leipzig.de

Diffusion, i.e. the irregular movement of, notably, atoms and molecules as the elementary constituents of matter, is among the omnipresent phenomena in nature and, moreover, often among the decisive steps deciding about the functionality of the given system. This is in particular true for many technological processes, including those based on the application of microporous materials. As a consequence of the intimate contact of the "guest" molecules in such "host" materials with their internal surface, such systems serve as excellent media for matter upgrading by separation due to molecular sieving and by catalytic conversion. In all these applications, as a matter of course, the gain in value-added products can never be faster than allowed by the rate of mass transfer between the surrounding atmosphere and the interior of the nanoporous materials. The rate of this exchange may depend on quite a number of processes. Knowledge about their relevance for the overall process is, as a consequence, an important prerequisite for ensuring operation with these materials with highest possible performance [1].

The poster presents two measuring techniques which, by their very nature, can be focused on, exclusively, microscopic dimensions, including the interior of the individual particles (crystallites) of the material under study. Correspondingly, they are referred to as "microscopic measuring techniques". The examples presented refer, in particular, to the potentials of these techniques for investigating mass transfer in complex systems.

These are, notably, zeolites with hierarchically organized pore spaces where the genuine micropore space is permeated by "transport pores" [2]. Recent progress in combining conventional pulsed field gradient (PFG) NMR diffusion measurement with magic angle spinning (MAS) [3,4] has opened up novel potentials for attaining information about the various constituents of mass transfer in such materials which, so far, were only accessible by modelling approaches [5,6].

Microimaging via IR microscopy (IRM) and interference microscopy (IFM), as the second method(s) in the focus of this poster, have similar potentials – even though, on monitoring mass transfer in hierarchical pore spaces, they have so far been only applied in the fast-exchange regime. These potentials, however, have been demonstrated already with the in-depth observation of mass transfer in mixed-matrix membranes (MMMs), where the interface between the filler (MOF ZIF 8) and the embedding polymer medium could be identified as a region of enhanced guest concentration [7].

References

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