

Mass-transfer of binary mixtures in DDR single crystals

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For the first time, micro imaging by interference microscopy (IFM) is applied for studying uptake and release of guest molecules in nanoporous host material for investigating the adsorption of gas mixtures and for correlating the thus observed behavior with corresponding single-component sorption experiments. Combining the advantages of high spatial and temporal resolution in the order of $0.45\ \mu\text{m}$ and 15 s, respectively, this promising approach results in time-dependent two-dimensional profiles of the intra-crystalline sorbate concentration of the single crystal under study [1, 2, 3]. However, with the lack of differentiation of different species present inside the microporous framework only certain types of experiments seems feasible, notably when the mixture consists of species with large differences in the rate of mass transport under the confinement of the channels, cages and windows of e.g. zeolite ZSM-58, which is well known from previous IFM studies [4].

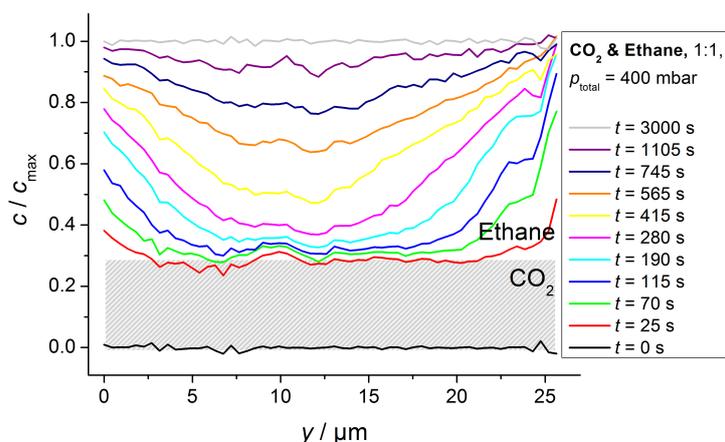


Figure 1: IFM mixture experiments are enabled by several orders of magnitude difference in the single-component diffusion rates of e.g. CO₂ and ethane leading to apparent instantaneous uptake of CO₂ and much a slower sorption process for ethane. When provided as a 1:1 gas mixture of $p_{\text{total}} = 400\ \text{mbar}$, CO₂ reaches a quasi-equilibrium at about 30% IFM signal (shaded area) followed by additional and much slower ethane adsorption. Hence, influences of the presence of CO₂ on the diffusivity of ethane can be examined.

We report the results obtained with the host-guest-system CO₂ and ethane in ZSM-58 together with their single-component equivalent. The experiments could be carried out as true mixture adsorption IFM measurements benefitting from the huge difference of the diffusion coefficients of the two species. The almost instantaneous increase of IFM signal equally distributed throughout the whole crystal can therefore be correlated with the very fast uptake of CO₂, see shaded area in Fig. 1, with the ethane adsorption starting shortly afterwards.

References

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