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Time- and Spatially-Resolved Study of Methanol Sorption in Ferrierite Crystals using Interference and IR Microscopy

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1. Introduction

The present work is devoted to the study of sorption kinetics of methanol in the Ferrierite crystals using the Interference Microscopy (IFM) and the IR Microscopy (IRM) techniques. These techniques provide a possibility to image the adsorbate distribution within a single crystal during the sorption process: Transient intracrystalline profiles reflect the distribution of molecular concentration inside the crystal at a certain time. The integration of such profiles over the entire crystal dimension results in the sorption rates. The determination of the relevant information on the system under study from the data on sorption kinetics has already been thoroughly discussed in the literature. In the present work, we show that the spatially resolved kind of experiments provide additional information about the sorption process.

2. Experimental

The two-dimensional concentration profiles inside the Ferrierite crystal (fig.1a) with a high spatial resolution (of about 0.5 μm) were measured using IFM [1]. Gaseous methanol was used as an adsorbate, which at different vapour pressures was brought into contact with the Ferrierite crystals. The data for more than twenty single Ferrierite crystals (similar to that in fig. 1a) were obtained and used for the data analysis [2]. It is worth noting that the local concentration of adsorbate molecules in the crystal can also be measured using IR microscopy [3].

3. Results and Conclusion

Adsorption/desorption concentration profiles and kinetics were analyzed in the frame of three theoretical models: the surface resistance model, the diffusion resistance model and the surface and diffusion resistance model [4]. It was found that the data on sorption kinetics (Fig.1b) can be well described by either model within the experimental precision. At the same time, the spatially resolved data (the concentration profiles in Fig.1c) are satisfactorily described only within the surface and diffusion resistance model. The diffusion coefficient D of methanol in 8-ring channels of the Ferrierite crystals and the surface mass-transfer coefficient α were determined according to this model.

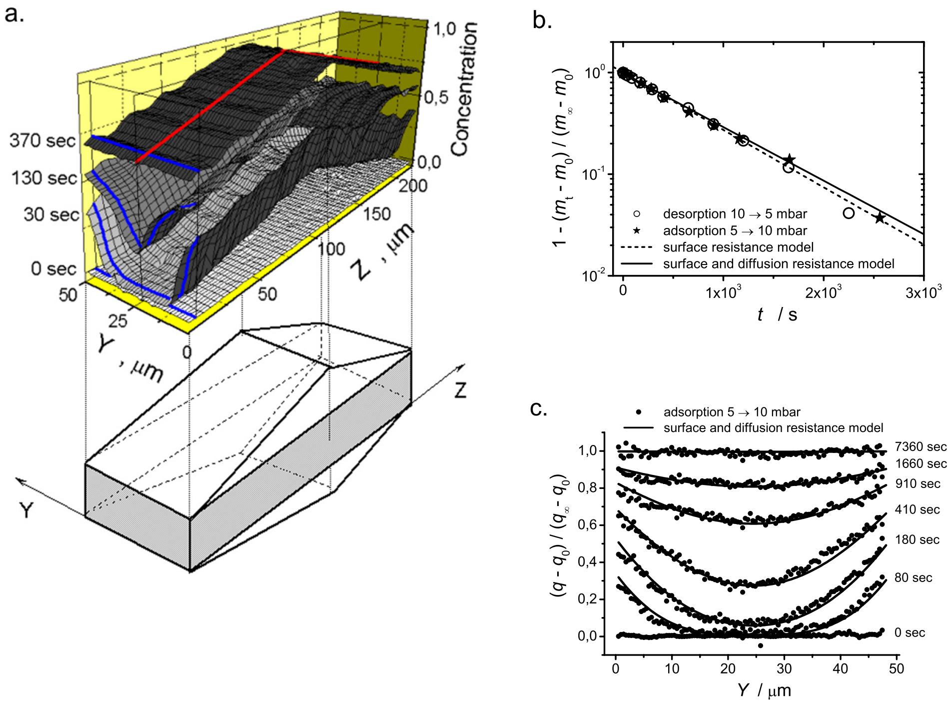

Fig. 1. Shape of the ferrierite crystal and 2D-concentration profiles for the entire crystal for the large pressure step (0→80 mbar) (a), experimental adsorption and desorption curves plotted in semi-logarithmic scales (b) and adsorption concentration profiles in the y-direction (c) near the edge of the crystal (z = 2 µm) for the pressure steps 5 → 10 and 10 → 5 mbar at certain times measured by interference microscopy. Also the theoretical curves calculated using the surface resistance model and the surface and diffusion resistance model are shown.

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