Proton Transport in Mesoporous Silica SBA-16 Thin Films with Three-Dimensional Cubic Structures

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Restoration of electric potential barriers by deprotonation reaction

To elucidate the effect of surface charge density of mesopores on I - V curves, the I - V curves were measured by changing the soaking duration of a nanofluidic device in deionized (DI) water (18.2 M Ω ·cm). Figure S1 shows the measured I - V curves for four different soaking durations. Following the measurement of the I - V curve of 1 M HCl aqueous solution, a nanofluidic device was immersed in DI water for several days to restore silanol groups in the pore surface. The I - V curve of 10^{-7} M HCl aqueous solution was measured every 24 h. Despite the extremely low concentration, the measured I - V curve was almost linear at 1 day, since the silanol groups were not yet fully restored from the previous protonation. Eventually, however, the measured I - V curve became nonlinear because the silanol groups were restored by deprotonation, and the electric potential barriers increased. After 4 days, the silanol groups were fully restored and the I - V curve agreed with the measured one. These results suggest that the I - V curve of HCl aqueous solutions was sensitive to the surface state of mesopores, and control of the surface state was crucial to elucidate the characteristics of I - V curves.

Figure S1. Effect of soaking duration of a nanofluidic device in DI water on current vs. electric potential bias (I - V) curves.