In this Supplemental Material, we provide the volume fractions of the cation, anion, and water, taking into account the strong electrostatic correlation. The results are considered an extension of Fig. 10 (a) in the main text for larger values of the surface charge density. Accordingly, the calculation detail and the model parameters are consistent with those in Sec. II-C. Water molecules are significantly adsorbed onto the charged surface on the right when the surface charge density $\sigma$ is increased [Fig. S1 (a) and (b)].

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FIG. S1: Volume fractions of the cation, anion, and water. $\lambda_{IL} = 1.0$, $\lambda_w = 0.001$, $\varepsilon_w > \varepsilon_{IL}$, $\Delta v = v_w - v_{IL}$, and $\Delta \tilde{p} = \tilde{p}_w - \tilde{p}_{IL}$. The surface charge density is increased from (a) to (b).
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