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Impact of double-layer charging dynamics on induced-charge electro-osmotic flows KEVIN T. CHU, YUXING BEN, MARTIN Z. BAZANT, Department of Mathematics, MIT — Induced charge electro-osmotic (ICEO) flows depend crucially on a combination of diffuse layer charge build up and a non-trivial tangential electric field at the electrode surface. Moreover, since time-dependent fields are commonly used to drive ICEO flows, charging dynamics play a critical role in determining the magnitude and direction of the resulting fluid flow. Unfortunately, at strong applied fields, the traditional model of the electrochemical cell as a linear RC circuit breaks down and the impact of bulk diffusion on the charging cannot be ignored. To gain a deeper understanding of the dynamics of diffuse layer charging, we consider the following simple problem: What is the response of a metallic sphere in an electrolyte solution to a suddenly applied uniform electric field. Even in the weak-field limit, we find that there is a non-trivial temporal and spatial dependence to the charge build up at the surface of the sphere, which may impact transient fluid flows. At strong fields, we find that surface conduction begins to be important as the diffuse layer builds up sufficient charge to induce surface diffusion and electromigration.

Marin Bazant
MIT

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