Modeling the Electric Double Layer in Finite Electrolyte Solutions

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Abstract

While electric double layers play a crucial role in many biophysical processes involving charged molecular species (such as proteins and DNA), they are often a limiting factor in technological applications where charged conductors are brought in contact with electrolyte solutions. Charges in the conductor's surface layer attract oppositely charged ionic species (thus creating the "double layer"), which in turn modify the electrostatic field generated by the charged conductor alone. Multiple theories of increasing complexity have been proposed to model the associated electrostatic potential in solution, which is generally obtained by solving the Poisson-Boltzmann (PB) equation. Even the most advanced analytic solutions of the PB equation, however, use approximations that limit their applicability for many applications, such as when higher electric potentials or finite solution volumes (as encountered in microfluidic cells) are involved. In this contribution, we will present our work on modeling the electric double layer in such situations using COMSOL Multiphysics® software.