Seksjon for komplekse materialer

New Models for Electric Double Layer Capacities

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Background

Recent advances in the development of electro-chemical energy devices such as fuel cells, batteries and super-capacitors, have led to a renewed interest in electro-kinetic flow phenomena in micro- and nanopores.

In particular, the formation of the electric double layer (EDL) at the interface between an electrolyte and an electrode or a charged surface is still not fully understood. Yet, it is one of the key processes in electro-chemical energy devices.

Project Summary - Methodology

This project will investigate the electric double layer at thermodynamic equilibrium by use of modified mean-field theory. In particular, we will employ modified Poisson-Nernst-Planck equations to study system properties and compute charge density, permittivity and electric potential profiles. Most importantly, the EDL capacity will be investigated and how it compares to experimental findings.

The first step will be to conduct a literature review of what has already been done in this field so as to become familiar with the problem.

Making use of symmetry in the system, we will then simplify the rather complex, governing equations, yielding a much more manageable set of ODEs (ordinary differential equations). Subsequently, these will be solved numerically in Matlab or another programming language that suits the student.

This work may include a collaboration with the Weierstrass Institute in Berlin, Germany. Further details can be discussed with the project supervisor, Peter Berg, at any time.

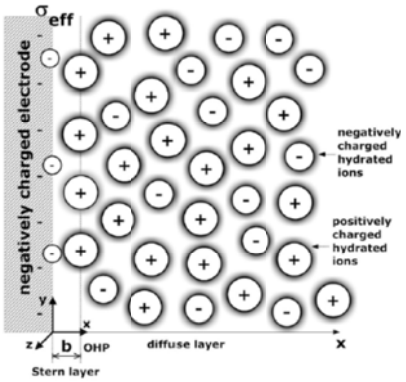

Figure 1: Model of the electric double layer (from [4]):
negative and positive ions near a charged wall.
Water molecules are not drawn explicitly.

References

[1] Bazant *et al.*, *Adv. Colloid & Interface Sci.*, **152,** pp. 48-88 (2009)
[2] Berg and Findlay, *Proc. Roy. Soc. A*, **467**, pp. 3157-3169 (2011)
[3] Borukhov, Andelman and Orland, *Electrochim. Acta*, **46**, pp. 221-229 (2000)
[4] Gongadze *et al.*, *Gen. Physiol. Biophys.*, **30,** pp. 130-137 (2011)