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Issue 5, 2022

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Physical Chemistry Chemical Physics

Ions, adsorption and electric response of a ferrofluid cell

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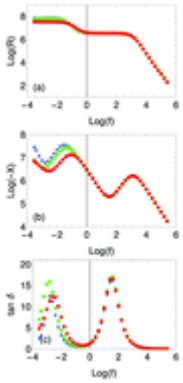
Abstract

We show that the electric response of a cell in the shape of a slab containing a ferrofluid (magnetic particles in kerosene) can be interpreted by means of a model based on the adsorption of ions from limiting surfaces. We report on three samples, identical in all aspects, but limited by electrodes in gold, platinum and titanium. For frequency larger than 1 kHz, the spectra of the real and imaginary parts of the total electrical impedance of the cells are identical. From this result it follows that in this frequency range the response of the cell is independent of the electrodes, which can be considered as blocking. In the low frequency region, up to 0.3 mHz, the response of the cells depends on the electrodes, as discussed recently by Batalioto *et al.*, *Phys. Chem. Chem. Phys.*, 2021, **23**, 2819. A simple generalization of the PNP model with ohmic boundary conditions works well only up to 10 mHz. For frequencies smaller than this value the reactance of the cells tends to increase again, indicating a capacity behaviour that could be related to the adsorption effect of the electrodes. A generalization of the ohmic PNP model containing surface capacitance in series is able to fit the data. From the value of the surface capacitance, the thickness of the surface layer is estimated to be on the molecular scale. From this result, we conclude that the adsorption phenomenon could be important for the description of the electrical properties of these systems. A simple generalization of the PNP model with boundary conditions derived by the Langmuir model is in reasonable agreement with our experimental data. The

analysis is performed at the impedance level, taking into account a test based on the tangent of the loss angle of the system.



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Article information

https://doi.org/10.1039/D1CP04724H

Article type
Paper

Submitted

15 Oct 2021

Accepted

19 Dec 2021

First published

13 Jan 2022

Citation

Phys. Chem. Chem. Phys., 2022, **24**, 3400-3409

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