Numerical Study of Membrane Polarization for a Network of Connected Pores

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Abstract

Spectral Induced Polarization (SIP) is a geophysical technique that measures the frequency dependence of the electrical conductivity of a material. The potential of using SIP to predict the hydraulic conductivity of the ground has been investigated since 1950s. However, the dependency of existing models on porosity and the geometry of the pore space makes the prediction of hydraulic conductivity challenging as these quantities are difficult to measure accurately in a field setting. Facing these challenges, it is necessary to develop numerical models, simulating the effect of the pore space geometry at the microscopic scale.
In this work the simulation software COMSOL Multiphysics® has been used to numerically solve the governing equations of charge transport for more realistic geometries such as a 3-D network of interconnected pores. The governing equations are defined using the Partial Differential Equations (PDEs) interface and solved in frequency domain. As a result, the electric current is determined to obtain information about amplitude and phase of the complex resistivity. Several simulations could justify the effect of pore-size distributions on the spectral behavior of ion fluxes within the network. The numerical study of the pore networks can be considered as a major tool for further simulation of explicit pore space structures and exploring the relationship between hydraulic and electrical parameters, which is not with other existing similar models possible.

Figures used in the abstract

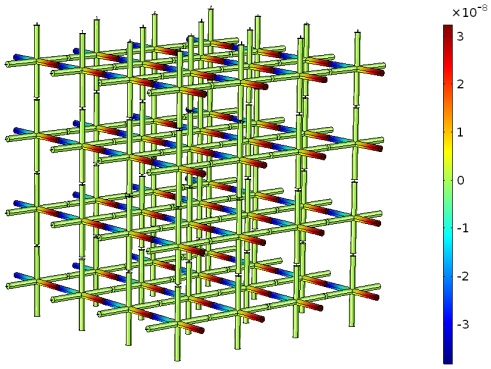

Figure 1: Concentration gradient of anions in the pore network.