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Measurement of the impedance of aqueous solutions of KCl: An analysis using an extension of the Poisson-Nernst-Planck model

Appl. Phys. Lett. **105**, 022901 (2014); <https://doi.org/10.1063/1.4890386>A. R. Duarte¹, F. Batalioto¹, G. Barbero^{2,3}, and A. M. Figueiredo Neto¹[View Affiliations](#)[View Contributors](#) PDF

ABSTRACT

We investigate the frequency dependence of the real and imaginary parts of the electric impedance of a cell with titanium electrodes, filled with aqueous solution of KCl in different concentrations. Our experimental data are interpreted by means of an extension of the Poisson-Nernst-Planck model, assuming that the electrodes are not blocking and well described by Ohmic boundary conditions, and that two groups of ions are responsible for the electric conduction. One group is due to the dissociation of KCl in water (majority carriers), the other to the impurities dissolved in water or present in KCl (minority carriers), whose bulk density is very small with respect to first group. The agreement between the experimental data and the theoretical predictions is good, taking into account the small number of free parameters entering in the model. In particular, the diffusion coefficient for the potassium and chloride ions well comparer with those reported in literature. According to our analysis, the role of the carriers related to the impurities present in the solution play a fundamental role in the fit of the experimental data in the low frequency region. The presented model where two groups of ions are present, with the assumption of equal mobilities for positive and negative charges in a group, is motivated by the experimental evidence that in aqueous solution of KCl, K^+ , and Cl^- have approximately the same mobilities. Since the PNP model for an electrolytic solution of the case considered by us predicts an electric response similar to that of an electrolytic solution where the positive and negative ions have different mobility, a comparison with the results reported recently by Macdonald is presented [J. R. Macdonald, *Electrochim. Acta*, **123**, 535 (2014)]. Alternative



NON-BLOCKING ELECTRODES IS ALSO DISCUSSED.

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