Dramatic drop in cell resistance through induced dipoles and bipolar electrochemistry.

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SUMMARY

When conducting materials are immersed in an electrolyte, induced dipoles and bipolar electrochemistry processes change the electrochemical cell characteristics. Simple polarization effects or electric percolation had not been sufficient to explain those changes in suspensions, since those changes occur well below the electronic percolation limits. This work shows that a significant lower resistance of the cell and charge transfer effects are present even for a discrete number of non-mobile conducting pieces inserted unconnected in the blank electrolyte. Using macroscopic conducting immersed pieces, a physical mediation due to transport through the induced dipoles is observed and if redox species exist, is enhanced. The combination is considered a physicochemical mediation.

Induced Dipole evaluation for immersed conducting pieces.

An induced dipole is created between the borders of each of the conducting pieces in the electrolyte, when an external electric field is applied.
The existence of such dipole and the voltage contribution may be established by various semi-quantitative approaches.

Resistivity changes for electrolyte containing immersed conducting pieces (EIS)

The effect depends on the number of pieces, its size and shape, as well as the location within the electric field.

Cyclic voltammetry changes for redox species (POM)

If we choose the redox behavior of SiW12O40−4 (POM) anion, we do observe some changes.

CONCLUSIONS

- The Rs decreased when immersing discrete conducting pieces in the electrolyte, even without electronic percolation.
- The Rs effect depends on the number of pieces, its size and shape, as well as the location within the electric field.
- Physical polarization effects appear but also modifications in redox potentials, and capacitative effects, much before electronic percolation exists.
- Physical mediation, seen as a cascade effect, is envisaged through the formation of alternating dipoles, while chemical mediation exists at the new induced interfaces.

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References