Interactions between conducting additives and redox couples dispersed in flow cell electrolytes

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The use of nanocarbons as dispersed conducting additives can bring interesting advantages in the electrolyte of electrochemical storage devices as this material can ensure a high conductivity and area. Moreover, the introduction of multiredox nanosized oxides (redox couples) dispersed in the electrolyte can also lead to remarkable improvements, as seen in Li/air batteries [1,2]. These oxides can act both as redox mediators and catalysts for the oxygen reduction or evolution reactions (ORR, OER) that take place during the battery cycling. Polyoxometalate clusters or other nanoparticles such as FeOx and IrOx are already known by their catalytic activity in O_2 reduction and reoxidation processes [3].
Herein, the influence of different types of carbon and multiredox nanosized oxides in aqueous alkaline and organic media has been studied for Zn/O_2 flow cell electrolytes. Graphene, graphene oxide, carbon black and carbon nanotubes have been used as conducting additives whereas polyoxometalates and IrOx have been used as multiredox nanosized oxides. Furthermore, hybrids between carbons and the nanosized oxides have also been tested, as a significantly enhanced catalytic activity is expected being the oxides coupled to the carbons. In several cases we do observe a synergy between the redox and the conducting species giving rise to enhanced currents and lower overpotentials. The relevant parameters and hypothesis for a mechanism will be discussed.

References

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Figures

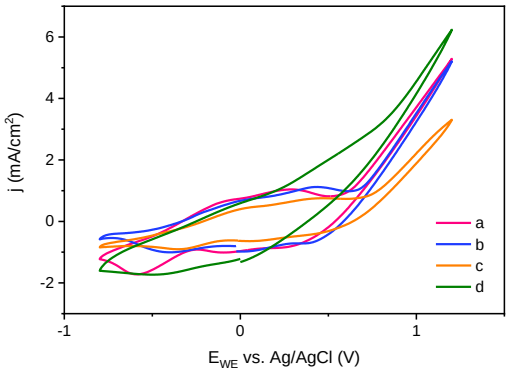

Figure 1: Cyclic voltammetries at 50 mV/s of OER and ORR on IrOx electrodes in a) K_2CO_3 0.1 M (aq) and with addition of b) IrOx solution, c) carbon nanotubes and d) IrOx and carbon nanotubes.
As observed in figure 1, the addition of both carbon nanotubes and IrOx in an aqueous alkaline media results in a synergy that leads in a more favorable OER, whereas no large effect compared to the blank is seen when only adding neither carbon nanotubes nor IrOx.