Performance and Polarization Studies of the Magnesium–Antimony Liquid Metal Battery With the Use of *In-Situ* Reference Electrode

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ABSTRACT

This work presents the performance and polarization studies of a magnesium–antimony liquid metal battery with the use of an *in-situ* pseudo reference electrode at high operating temperature (*ca.* 700 °C). Due to the immiscibility of the contiguous salt and metal phases, the battery appears as three distinct layers: (1) positive electrode, (2) electrolyte and (3) negative electrode layers. The configuration of the *in-situ* reference electrode within the three floating liquid layers is described and is to avoid direct electrical contact/short circuit with the other electrodes. Electrochemical tests, including linear sweep voltammetry, impedance spectroscopy and galvanostatic cycling, evaluate the performance of a magnesium–antimony battery under a range of operating temperatures and current densities. Through the polarization studies, the area resistance of the negative and positive electrodes and the overall battery are found to be*ca.* 0.55, 0.65 and 1.20 Ω cm^{-2}, respectively. In a typical 1 h charge/discharge per cycle experiment, average voltage efficiencies of *ca.* 64% are obtained at 60 mA cm^{-2} with a slight deterioration after subsequent cycles. In these tests, the half-cell measurements also indicate that the sprayed layer of boron nitride at the reference electrode is chemically stable and shown to be an effective electrical insulator for prolonged operation at high temperature (*ca.* 700 °C).

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