Corrosion of Ni-30Cr alloy in silicate melts: electrochemical measurements

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Abstract

Contact between a metal and a molten silicate occurs in many industrial applications. For example, soda-lime silicates can be encountered in the glass fibering industry and boro-silicates are used in the vitrification process of nuclear wastes. Chromia-forming Ni-based superalloys are often used in these applications as they exhibit good mechanical properties and a high resistance to corrosion by molten silicates.
Considering the ionic conductivity of molten silicates, electrochemical methods are perfectly adapted for:

- the characterization of the medium (electroactive domain, potential measurements)

- the determination of physico-chemical properties of multivalent species (diffusion coefficient, standard potential)

- the study of corrosion of metal (active or passive state)

In this work, simplified systems are investigated to evaluate the influence of several parameters (e.g. basicity, viscosity) of the medium on the corrosion of materials. These systems are binary soda silicates Na2O-SiO2, ternary soda-lime silicates Na2O-CaO-SiO2 and boro silicates Na2O-B2O3-SiO2.
A classical three electrodes design has been adapted to high temperature conditions. The reference electrode is made of Yttria-Stabilized-Zirconia (YSZ), and the counter electrode is a platinum plate. Two kinds of working electrodes can be used: (i) the characterization of the properties of the silicate melt and of the dissolved species requires a platinum working electrode, and (ii) corrosion studies require a working electrode consisting of the considered alloy. With the latter type of electrode, I vs. E plots can highlight the existence of a passive domain of the alloy, and thus give access to the passivation current. Consequently, the active or passive state of the alloy can be given by a simple potential measurement, which can thus evidence the depassivation of the alloy vs. temperature or time.

Keywords: corrosion, electrochemisty, nickel base alloys, molten silicates

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