Behavior of a molten magnesium-aluminosilicate at elevated potentials

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Abstract

Molten oxides represent a new medium to carry out electrolysis at very high temperature, typically above 1450◦C. In molten state, electrochemical decomposition of refractory oxides can be studied by application of an electrical potential between electrodes.
An experimental device capable to perform this technique was designed in ArcelorMittal, allowing stable electrochemical measurements and the quantification of oxygen gas, produced by the faradaic reactions. In this study a magnesium aluminosilicate composition with varying iron oxide contents was put under an electrical tension of up to 6 V. To interpret the acquired charge transfer an ohmic drop correction was performed using the cell geometry and the molten oxide's electrical conductivity.

The presented results illustrate the electrochemical response of the molten glass to the applied electrical potential in dependence of iron oxide concentration. The corrected measurements show a diffusional mass transfer limitation in correlation with the varying iron oxide content. Further increase of the applied voltage then led to the decomposition of the aluminosilicate into oxygen gas, a liquid Fe-Si-Al alloy and a solid MgAl2O4 spinel. The latter was formed due to the depletion of Fe- and Si- ions from the melt in the vicinity of the cathode. Ongoing application of the electrical potential finally resulted in the passivation of the electrode by the spinel phase and the termination of charge transfer.

Keywords: Molten oxide electrolysis, Molten silicates, Crystallization phenomena, Metal extraction, Electrochemistry

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