

Electro-deposition and re-oxidation of carbon in carbonate containing molten salts

Abstract

The electrochemical deposition and re-oxidation of solid carbon were studied in CO_3^{2-} ion-containing molten salts (e.g. $\text{CaCl}_2\text{-CaCO}_3\text{-LiCl-KCl}$ and $\text{Li}_2\text{CO}_3\text{-K}_2\text{CO}_3$) at temperatures between 500 and 800 °C under Ar, CO_2 or $\text{N}_2\text{-CO}_2$ atmospheres. The electrode reactions were investigated by thermodynamic analysis, cyclic voltammetry and chronopotentiometry in a three-electrode cell under various conditions. The findings suggest that the electro-reduction of CO_3^{2-} is dominated by carbon deposition on all three tested working electrodes (Ni, Pt and mild steel), but partial reduction to CO can also occur. Electro-re-oxidation of the deposited carbon in the same molten salts was investigated for potential applications in, for example, direct carbon fuel cells. A brief energy and cost analysis is given based on results from constant voltage electrolysis in a two-electrode cell.