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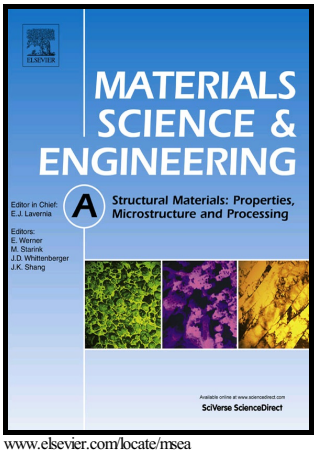

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High-resolution TEM microscopy study of the creep behaviour of carbon-based cathode materials

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Abstract

Creep is in close relationship with the materials deterioration and deformation of the cathodes in aluminum reduction cells. The purpose of this work is to obtain the creep mechanism of the carbon cathode for aluminum electrolysis. A modified Rapoport equipment was used for measuring the creep strain of the semi-graphitic cathodes during aluminum electrolysis with CR=2.5 and at temperature of 945 ℃. The arrangement of carbon atom has been studied after hexagonal graphite converting into rhombohedral graphite during aluminum electrolysis by XRD and high-resolution transmission electron microscopy (HRTEM). The creep deformation of the carbon cathode has a close relationship with the mobile dislocation walls. These results will be helpful in controlling the cathode quality and its performance in aluminum reduction cells.

Keywords Aluminium; Carbon cathode; Creep mechanism; Crystallization transformation; Kink bands

1. Introduction

At present, commercial primary aluminum is produced mainly by Hall-Héroult process, whereby alumina is dissolved in a molten electrolyte and electrolyzed. In general, the lifetime of a aluminum reduction cell used for the production of aluminum is about 3–5 years. Although obtaining much progress in the cell design over time, there are still many shortcomings such as high overall production cost, great carbon expenditure, serious environmental pollution and unstable production as well. Therefore, improving the cell life, which could solve completely or incompletely these problems, has become a hot topic. The operating condition of the carbon cathodes is found in close relationship with the cell life [1, 2]. For the carbon cathodes, sodium expansion and creep deformation are widely considered as the main cause for cathode deterioration [3, 4]. The creep behaviour of carbon cathodes has already been addressed by investigators [5-7]. A. Zolochevsky et al. has developed a constitutive model for creep deformation of carbon cathodes to reproduce the relationship between the creep strain, external pressure and time through the use of uniaxial compression