Cathode processes during the synthesis of the Al-Zr alloys in KF-AlF₃-Al₂O₃-ZrO₂ melt

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Abstract

An overview of the methods of electrochemical synthesis of aluminium with zirconium alloys, indicating the relevance of the search and development of new resource-saving methods for its preparation. The data on the kinetics of electro-reduction of zirconium and joint electrodeposition of zirconium with aluminium from halide melts and ionic liquids is provided. New energy efficient method, which concluded in preparation of such alloys by the electrolytic decomposition of aluminium and zirconium oxides in a low-melting melts on the basis of the system KF-AlF₃ is proposed.

Cyclic voltammetry method was used for the investigation of the cathode process kinetics in the KF-AlF₃-Al₂O₃ and KF-AlF₃-Al₂O₃-ZrO₂ melts on the glassy carbon substrate at the temperature of 750 °C. It is shown that in the KF-AlF₃-Al₂O₃ melt the only one peak on the voltammograms in the potential range -0.1...-0.2 V corresponding to the discharge of aluminium at the cathode is observed. Introduction of zirconium dioxide into the KF-AlF₃-Al₂O₃ melt leads a peak on the voltammograms at the potential range of 0.13-0.17 V corresponding to zirconium discharge to appear. The discharge current of both aluminium and zirconium increase with the rate, meanwhile potentials of current peaks shifted slightly. The obtained data was analyzed from the voltammetry diagnostic criteria point of view. In particular, the dependence of the current density peak from the square root of scan rate of potential (iP from v₁/2), which is linear in the range of studied sweep rates of the potential and crosses the beginning of the ordinates, was performed. This indicates that under the experimental conditions the recovery process of zirconium-containing ions from the KF-AlF₃-Al₂O₃-ZrO₂ melt is quasi-reversible and mainly controlled by the diffusion.

The number of electrons involved in the cathode recovery process of zirconium was calculated by the equation for the reversible process and equals to 4.

The results will be used for the determination and optimization of parameters for obtaining aluminium alloys with zirconium via the electrolysis of melts on the basis of the system KF-AlF₃-Al₂O₃-ZrO₂.

References


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