Impact of the Solidification Rate on the Chemical Composition of Frozen Cryolite Bath

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Abstract

Solidification of cryolite-based bath takes place at different rates along the sideledge, around alumina rafts and new anodes. The solidification rate has a significant impact on the structure and the chemical composition that determine the thermal conductivity and thus the thickness of sideledge or the duration of the existence of the temporary frozen bath layers in other cases. Unfortunately, samples that can be collected in industrial cells are formed under unknown, spatially and temporally varying conditions. For this reason, frozen bath samples were created under different heat flux conditions in well-controlled laboratory environment using the so-called cold finger technique. The samples were analyzed by X-ray Diffractometer (XRD) and Scanning Electron Microscope (MEB) in Back Scattering (BS) mode in order to obtain spatial distribution of chemical composition. Results were correlated with structural analysis. XRD confirmed our earlier hypothesis of recrystallization of cryolite to chiolite under medium heat flux regime. Lower α-alumina, and higher γ-alumina content in the samples obtained with very high heating rate suggest that fast cooling reduces γ–α conversion. In accordance with the expectation, SEM-BS revealed significant variation of Na/Al ratio in the transient sample.

Keywords: Aluminum electrolysis; frozen ledge; cold-finger; chemical composition; cooling rate.