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过热度和电流密度对半石墨质阴极低温电解膨胀性能的影响

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摘 要： 采用改进型阴极电解膨胀率测试仪，研究低温电解质[K_3AlF_6/Na_3AlF_6]-AlF_3-Al_2O_3中电流密度和过热度对半石墨质阴极电解膨胀性能的影响，并对阴极的电解膨胀性能进行数值化表征。结果表明：金属K和Na由表及里渗透进入阴极内部；随着过热度和电流密度的增大，阴极电解膨胀率均呈增大趋势；当电解质过热度由10 ℃升高至50 ℃时，阴极电解膨胀率由1.41%增大至2.10%；随电流密度的增大阴极电解膨胀率呈现出不同的增幅；当电流密度小于0.4 A/cm^{2}或大于0.7 A/cm^{2}时，阴极电解膨胀率均明显增大；而当电流密度在0.4 A/cm^{2}到0.7 A/cm^{2}之间变化时，阴极电解膨胀率相对恒定、增幅最小；数学模型中引入的参数可用于表征阴极的电解膨胀及低温电解质中阴极抗K和Na渗透性能；低温电解时，降低熔体过热度、选择合适的阴极电流密度均可减小金属K和Na对阴极的破坏作用。

关键字： 铝电解；半石墨质阴极；电解膨胀；电流密度；过热度；低温电解

Effects of superheat and current density on electrolysis expansion performance of semi-graphitic cathode at low temperature

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Abstract: The effects of current density and superheat of potassium and sodium penetration in [K_3AlF_6/Na_3AlF_6]-AlF_3-Al_2O_3 on the electrolysis expansion of semi-graphitic cathode melts were studied with a modified laboratory Rapoport apparatus. A mathematical model was introduced to numerically character the electrolysis expansion performance of the semi-graphitic cathode. The results show that potassium and sodium penetrate into the semi-graphitic cathode from exterior to interior. The electrolysis expansion of semi-graphitic cathode increases with increasing current density and superheat. When the superheat increases from 10 ℃ to 50 ℃, the electrolysis expansion increases gradually from 1.41% to 2.10%. However, as the current density rises, the electrolysis expansion increases obviously before 0.4 A/cm^2, and after 0.7 A/cm^2

the electrolysis expansion increases obviously again. When the current density ranges in 0.4−0.7 A/cm^2, the electrolysis expansion keeps constant relatively, and its increase is the least. In addition, the parameters introduced in the mathematical model can reflect the same information with the curve of electrolysis expansion, and sequentially character the resistance performance to K and Na penetration accurately at low temperature. At low temperature the destructive effect resulted from potassium and sodium penetration can be reduced by reducing superheat and choosing proper current density.

Key words: aluminum electrolysis; semi-graphitic cathode; electrolysis expansion; current density; superheat; low temperature electrolysis