ABSTRACT

Inert anode for aluminum electrolysis can greatly reduce production cost, cut down energy consumption, increase the production capacity and is environmentally friendly, its development and application will bring about a revolution in aluminum industry. Yet so far this technology has not achieved a success, and the problems are concentrated on the material's physical property and corrosion resistance. Funded by the State Key Project of Fundamental Research (973 project) and National High Technology Research and Development Project (863 project), and with the aim of developing satisfactory inert anode material, the current work investigated in details the cermets of Ni-Cu-$NiFe_2O_4$-NiO with the respect to the ceramic phase and metal phase. On the basis of preparing inert anode samples by "cold pressing- sintering" process, charaterisation techniques such as SEM, XRD, optical microscopy, AAS (atomic absorption spectroscopy), XRF (X-Ray fluorometry), and experimental apparatuses such as high temperature electric resistance determination equipment and bench-scale cells were adopted to study the effects of NiO content in ceramic phase of cermets and different metal phases, i.e. Ni, Cu, and Cu-Ni on the corrosion behavior, density, and electric conductivity of the cermets, moreover, the corrosion and electric conductivity mechanisms were also discussed.

The main onclusions and findings can be summarized as follows:

a) Increasing NiO content in ceramic phase is harmful to the densification of $NiFe_2O_4$-NiO ceramic during sintering. However, the addition of 5 wt% Ni as a metal phase and sintering under controlled atmosphere improves the cermet relative density dramatically, e.g. the average apparent density of 5Ni-9.5NiO-$NiFe_2O_4$ group is 5.57 $g \cdot cm^{-3}$, with the relative density 98.11%; and the electric conductivity under 1000℃ is 39.61 $S \cdot cm^{-1}$.

b) The increase of NiO content in ceramic phase reduces the Fe concentration in electrolyte from 0.01857 wt% to 0.006836 wt%~ 0.009574 wt%, yet has little effect on the Ni concentration. Considering

the sintering property and corrosion resistance, the excessive content of NiO in ceramic phase is determined to be 10 wt%.

c) With metal phase varying from Cu, Ni, to 85Cu-15Ni (mixed powders), the densities of these cermets inert anodes differ little, while the high-temperature electric conductivity of 17Cu+ 5324 is the best, i.e. 81.17 $S \cdot cm^{-1}$ at 960℃. Furthermore, the "unpolarized" and "polarized" corrosion experiments also fail to differentiate effectively these cermets, which results from the fact that the difficult and complexity of high-temperature molten salt experiment lead to great deviation of the obtained experimental data, thus this part is still subject to a great amount of future research.

d) Experimental results show that the cermet components corroded into the Na_3AlF_6-Al_2O_3 melts do not distribute evenly, but follow Boltzmann distribution with respect to distance from inert anode. Such distribution may result from the impurity ion gathering near cathode by electric force under polarization condition. This uneven distribution together with different algorithms has great effect on the estimation of inert anode corrosion rate. It is urgent to set up a scientific and reasonable examination and evaluation mechanism of corrosion rate for inert anodes.

KEY WORDS Inert anode for aluminum electrolysis, Cu-Ni-NiO-$NiFe_2O_4$ cermets, cryolite-alumina melts, corrosion resistance, impurity ion distribution