Production of Al-Sc alloy by electrolysis in cryolite melt using Sc_2O_3 feed

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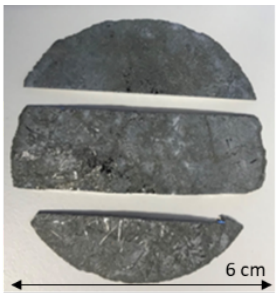
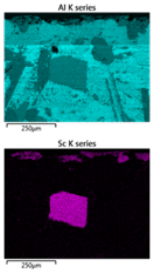
Al-Sc alloys are produced by mixing Sc with overheated liquid Al and subsequent melt crystallization. There are several drawbacks in this method, i.e. high production costs, high price of pure Sc, high losses during alloy preparation, and difficulties in controlling the cooling process parameters to obtain a uniform alloy crystallization. Therefore, innovative reduction technologies for Sc-Al master alloy production are sought. In this way, savings in process steps with respect to the current process, and the subsequent economic savings could be achieved.

In the frame of the SCALE project, SINTEF is investigating the possibility of modifying the industrially established process for reduction of alumina to aluminium, the so-called Hall-Heroult process, and then apply it for the direct production of Al-Sc alloys.

Electrolysis experiments at galvanostatic mode were carried out using a cryolitic melt with NaF/AlF_3 molar ratio CR=2.2 containing some Sc_2O_3 at 980 °C. The trials were run until anode effect was achieved, i.e., current blockage at the anode due to the depletion of oxide species at the surface





The metal product obtained was analysed by ICP-MS, showing a Sc content of ca. 2.6wt%. SEM analysis of the bulk metal showed the presence of the intermetallic Al-Sc compound, Al_3Sc, precipitated all over the Al bulk metal product.

Thermodynamic calculations showed that the following spontaneous chemical reaction takes place:

$$Sc_2O_3(diss) + 2AlF_3(diss) \leftrightarrows Al_2O_3(diss) + 2ScF_3(diss)$$

This was investigated experimentally by analysis of bath samples taken after addition of successive amounts of Sc_2O_3 into cryolite melts of different CR. The oxygen content was determined by inert gas fusion technique (TC-436 DR LECO Corp. USA) and quantitative determination of the different phases was carried out by Rietveld refinement of XRD diffractograms. The results confirmed that the above reaction is very much shifted to the right.

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