Aluminothermic production of silicon using different raw materials

K. Jakovljevic[1], *N. Simkhada*[2], *E. Emil-Kaya*[3], *M. Wallin*[4], *and G. Tranell*[5]

1. Researcher, Norwegian University of Science and Technology, Trondheim Norway 7034. Email: katarina.jakovljevic@ntnu.no
2. Research Engineer, Norwegian University of Science and Technology, Trondheim Norway 7034. Email: nishan.simkhada@ntnu.no
3. Postdoctoral Researcher, Norwegian University of Science and Technology, Trondheim Norway 7034. Email: elif.e.kaya@ntnu.no
4. Researcher, Norwegian University of Science and Technology, Trondheim Norway 7034. Email: maria.wallin@ntnu.no
5. Professor, Norwegian University of Science and Technology, Trondheim Norway 7034. Email: gabriella.tranell@ntnu.no

Keywords: silicon production, aluminothermic reduction

ABSTRACT

Silicon is a vital element in many products today, such as electronic components, solar devices, high-quality alloys, and many others. The growing global demand highlights the need for the development of sustainable production methods to meet this demand as an alternative to the current carbothermic reduction, submerged arc furnace (SAF) based process. An alternative to this is the aluminothermic reduction of quartz in a CaO-SiO_2 slag, which not only reduces direct carbon dioxide emissions but also promotes the utilization of secondary raw materials such as quartz fines, aluminium dross and scrap as well as secondary alumina (SA) from dross recycling.

In the current study, the effects of initial slag composition (slag basicity, CaF_2 additions, SA), SiO_2/reductant stoichiometry, as well as reaction temperature on the resulting metal composition and metal yield were explored. Results were compared with thermodynamic simulations using FACTSage 8.2.

Experimental results show that, in agreement with thermodynamic simulations, the silicon content of the alloy is increased, while the Ca is decreased for starting slags where CaO-SiO_2 is partly replaced by CaF_2. A lower reaction temperature also promotes a lower Ca content of the alloy. By reducing the reductant:SiO_2 ratio, a higher silicon content of the alloy is obtained. Addition of SA to the initial slag results in an alloy with a higher aluminium content.