

Project: “Quartz raw-material for metallurgical production of FeSi and Si-metal”



Image 1: Furnace no. 1 at Elkem Thamshavn (Photo: Elkem ASA, Silicon Division)

Project overview

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The Project period is scheduled to June 1st, 2003 to May 31st, 2007 and financing is through a University scholarship at NTNU with Elkem ASA, Silicon Division as a partial sponsor for the project, through project expenses.

The project is integrated in the SUP financed by the Norwegian Research Council (NFR) “The value chain from deposit to beneficiated product with emphasis on quartz”.

Project – outline

The main focus is on the development of knowledge concerning quartz used as a raw material for the metallurgical production of ferrosilicon and silicon metal. The main objective for this PhD project is:

- *by using systematic investigations and modern analytical equipment*
- *to obtain a basic knowledge about the properties of quartz raw material that are important for the production of silicon*
- *and further, develop methods to test these properties*

The work will mainly be carried out on typical quartz used for FeSi and Si-production.

Quartz properties

The raw materials for Si for the metallurgical production of ferrosilicon and silicon metal, are Quartz and Quartzites. These are in operational terms separated into two types: Rock quartz and Gravel quartz, which are blasted rock and non-blasted, sedimentary deposited materials respectively.

The high purity of the products and the nature of the production process necessitate the need of some requirements to the specifications for the raw materials. The most important property requirements for quartz/quartzite, are:

- purity (pollution and inclusion)
- mechanical strength
- thermal strength
- softening properties

Because of Elkems involvement in the project, the focus will mainly be related to problems and challenges described by Elkem:

- What causes too much fines to be generated from the raw-material?
- Which properties make the quartz decrepitate when shock heated in the furnace?
- Which properties are important for the melting- (softening) properties of the quartz resulting in a certain melting progress?

Earlier work

Little published research has been carried out on the properties of quartz related to the metallurgical production of ferrosilicon and silicon metal prior to this project. However, it appears that company-internal research has been more frequent, unfortunately results from such work is difficult, if not impossible, to reach. Operational experience and none scientific tests seem to have been the working method in most (Fe)Si plants.

Analytical techniques in the project

Several analytical techniques will be evaluated in this project. Examples of techniques which are more or less known and understood, for application on quartz for (Fe)Si production is listed below:

Optical microscopy investigations

- Polarization microscopy
 - Mineralogy
 - Texture (e.g. grain size)
- Fluorescence microscopy
 - Porosity
 - Grain boundaries
- Linkam TS1500 High Temperature System
 - Microscopic technique
 - In situ heating effects (up to 1500 °C)
 - Causes of these effects

Scanning Electron Microscope (SEM) techniques:

- Cathodoluminescence (CL)

- classify different generations
- internal zoning in minerals
- distribution of trace minerals
- Micro cracks
- Electron Backscatter Diffraction (EBSD)
 - Crystal structure
 - Orientation map
- Energy-dispersive x-ray Spectrometry (EDS)
 - Semi quantitative in situ element analysis

Microprobe

- quantitative in situ element analysis

XRD

- Mineralogy (crystal structure)

DTA

- Mineralogy
- Phase transitions

Dilatometry and Segercone

- Softening properties (melting properties)

And other techniques relevant for testing mechanical and thermal properties of quartz.