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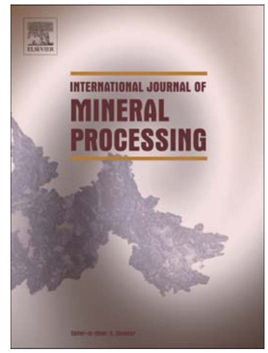

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Processing of quartz lumps rejected by silicon industry to obtain a raw material for silica glass

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Abstract

This work aimed at analyzing quartz lumps rejected from a major metallurgical grade silicon producer and at studying the effect of several processing techniques over its purification. The final objective was to enable the use this lumps as raw material for silica glass production. Chemical analyses using ICP-MS technique were conducted to understand the nature of the chemical impurities in the rejected lumps, aiming to identify rather if the impurity was inside or outside the quartz lattice. The processing procedures were divided in two steps, the first consisting of only a physical treatment and the second one consisting of a chemical treatment. The physical treatment consisted of washing, milling (and separating the material by its particle size) and magnetic separation. This treatment reduced most of the impurities present in quartz, purifying over 90% of the Fe contamination and over 60% of the Al contaminations, but it was incapable of producing a powder with similar chemistry to commercial raw materials. The chemical treatment was conducted using two different acid mixtures (dilute HCl and dilute HCl + HF). Interesting results were obtained using the HF containing mixtures. These mixtures were able to produce a powder with commercial purity (with Al impurities lower than 50 ppm). This treatment was also able to reduce lattice impurities.

Key words: Silica sand, silica purification, trace elements in quartz, iron removal, acid leaching

1. Introduction

Natural quartz is a key raw material to produce fused silica, which is an important material for several high technology applications. Such applications include, for example, the manufacturing of crucibles used to produce solar grade silicon [Minami et al., 2011, Kodama et al., 2010, Yamahara et al., 2000] and the production of transparent bulbs for UV light-induced water purification [Macaluso et al., 2009, Barkhudarov et al., 2008]. However, in order to be employed in such applications, silica glass needs to have adequate properties, such chemical purity, optical transparency and radiation resistance. Several studies as Dhamrin et al. (2009), Kvande et al. (2009), and Yamahara et al. (2001), reveal that crucibles made of less purer fused silica compromise the efficiency of solar silicon processing. Other works as Griscom (2011), Schreiber et al. (2005) and Kuzuu et al. (2003) show that impurities such as Al, Fe, Ge and Ti, as well as alkali metals are able to reduce its transparency in UV region and its radiation resistance, presenting reduced performance when used as light bulbs.

These impurities are presented in quartz and are introduced to the silica glass during fusion. Although there are several processing methods to reduce impurity levels in quartz, the characteristics of the ore are extremely important for obtaining a good processed quartz powder, able to be transformed into high-quality fused silica. Some of the processing methods include acid leaching [Du et al., 2011], electrochemical treatment [Dal Martello et al., 2011], and biological leaching [Arslan et Bayat, 2009]). Studies reveal that some of the impurities, as Al, Li and Ge, are preferentially located in the quartz crystal lattice itself, and not in other minerals present among quartz as inclusions or adsorbed material [Rakov, 2006, Götze, 2009]. Such