

Investigation of Direct Electrolytic Reduction of Solid SiO_2 to Si with High Purity

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Abstract: A new way using optical fiber wastes as raw material for the preparation of electrolytic reduction of solid SiO_2 to Si in molten chlorides was proposed to be a considerable technology to prepare solar grade silicon (SOG-Si). It has some advantages such as low cost and energy consumption, environmental protection, simple production flow and ultra-high purity product. The formed Si was confirmed by Raman spectroscopy.

Key words: solar grade silicon; optical fiber wastes; SiO_2 ; electrolytic reduction

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With the development of PV industry the traditional supply falls short of the demand, a new technology is needed to prepare SOG-Si with abundant feedstock supply and low cost and energy consumption.

Recently Yasuda^[1-3] found electrolytic reduction of SiO_2 to Si is feasible in molten chlorides such as CaCl_2 . High purity silicon will be prepared just removing oxygen from high purity SiO_2 by this method. In this paper, author investigated a new way to recycle silica optical fiber wastes for feedstock supply of solar grade silicon on the basis of direct electrolytic reduction of solid SiO_2 to Si in molten chlorides. A new method and production flow sheet of SOG-Si was proposed. And Si had been prepared via direct electrolytic reduction of fiber optic rods used which are made of ultra-high purity silica glass.

1 A new way to prepare SOG-Si

A new simple production flow proposed by authors combination recycling of wastes with preparation of high purity of silicon directly for feedstock supply of SOG-Si was shown in Fig 1, which suggests that silicon with high purity at low cost and energy consumption could be realized via remelt method process. This new method was proposed to be a new technology to prepare SOG-Si. For this way, there are some advantages:

(1) The feedstock supply can be easily acquired from a large number of optical fiber wastes which are

generating every year. As a new efficient way for recycling optical fibers wastes, it can protect environments and avoid wasting high-purity silica resource and potential high-energy.

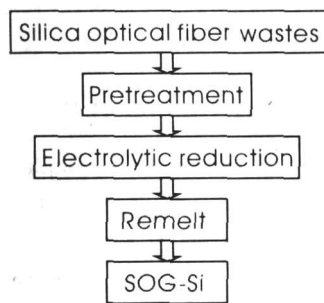


Fig 1 New production flow

(2) The energy consumption and the cost of the method are low.

(3) The preparation method is simple and the product purity is high.

2 Experimental

Optic fiber rods used which are made of ultra-high purity silica glass was washed in distilled water. And using them made up of contacting electrode. A SiO_2 contacting electrode was prepared by equally winding a Mo wire and copper wire as a current lead, about thirty times around a quartz glass rod. The counter electrode

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was a graphite rod 1000 g anhydrous calcium chloride (reagent grade) was contained in a sealed stainless steel reactor after pretreatment. And the temperature of reaction is 850°C .

Samples were prepared by potentiostatic electrolysis at 1.10 V vs Ca^{2+}/Ca for 1 h and analyzed after washing in distilled water and removing the Mo wire. Samples were analyzed by Raman spectroscopy (Argon ion 514.5 nm, Renishaw Corp.)

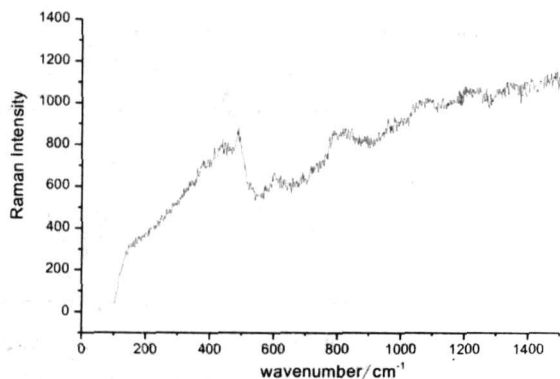


Fig 2 Raman spectra of sample after electrolysis at 1.10 V for 1 hour in the molten CaCl_2 at 850°C

3 Results and discussions

The Raman spectrum of the sample are showed in Fig 2 for different measure prints in the same sample. From the Raman spectrum of sample we can observe a peak between 400 and 550 cm^{-1} of Raman shift. The peak consisted of two peaks, one is around 475 cm^{-1} related to amorphous Si which has a peak around 480 cm^{-1} , and the other is related to crystal silicon which has a peak around 520 cm^{-1} ^[5]. SiO_2 reduction to Si had been confirmed.

4 Conclusions

(1) A new technique to preparation of SOG-Si was proposed, which has some advantages such as low cost and energy consumption, product meeting the required quality for SOG-Si and simple production flow sheet.

(2) Si has been prepared via direct electrolytic reduction of fiber optic rods used which are made of ultra-high purity silica glass. The formed Si was confirmed by Raman spectroscopy.

(3) As a new efficient way for recycling optical fibers wastes, it can protect environment and recycle waste high purity silica resource and potential high energy.

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直接电解还原二氧化硅制备高纯硅的研究

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摘要: 提出了以废弃石英光纤为原料, 利用熔盐直接电解还原 SiO_2 来制备太阳能级硅的新思路设计, 该设计具有低成本、低能耗、环保、工艺流程简单以及产品纯度高等优点。利用激光拉曼检测证明了硅的生成。

关键词: 太阳能级硅; 石英光纤废料; SiO_2 ; 电解还原;

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