

Quantitative and Qualitative Analysis of Silicon extracted from Godavari river sand, Kandakurthi, Telangana, India.

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Abstract— Silicon is one of the most abundant materials on the earth available in the form of sand at banks of rivers and oceans. This project focused on quality and quantification of silicon extracted from Godavari river sand. The wet shiny sand collected from Godavari River at Kandakurthi, Nizamabad district, Telangana State, India. The collected wet sand washed with distilled water and dried in hot air oven at 200°C for 2 hours. The washed sample mixed with magnesium ribbon in 1:2 ratio, heated up to 1000°C for 30 minutes, cooled down to room temperature and then treated with concentrated hydrochloric acid. The grey colored Silicon (Si) is observed in the crucible. The grey colored sample collected, rinsed with distilled water and dried in hot oven at 100°C for 30 minutes. EDS and XRD results showed that the grey colored sample was 97% pure silicon, morphology and purity of the silicon is examined by FESEM and XRD.

Keywords—Silicon; Godavari river; EDX; XRD;

I. INTRODUCTION

Silicon is a second most abundant element on the surface of the earth, after oxygen. It is the mildest of metals. Silicon found as silica (quartz, sand) or as silicates (feldspar, kaolinite) in the nature. Silicon is frequently used in manufacturing computer chips, transistors and integrated circuits, solar cells and automotive industries. Silicon is extracted from sand by using different burning agents. Most of the silicon is made by reduction of SiO₂ with C in the electric furnace and extraction of silicon can be done on supplying sufficient amount of heat to removal of the Oxygen from silica sand [1, 3]. Magnesium used as reducing agent to extract silicon from sand [1]. Alumino thermal reaction carried out in Synthesis and purification of silicon obtained from Iran's domestic micronized sand [2]. Successfully extracted the silica from rice husk by using organic layer method [4]. Zinc reduction of SiCl₄ and potential routes via SiCl₄ and Si₂Cl₄ [5]. Silicon and Magnesium in the ratio of 1:1 is used [6]. In the present study, estimated the quality and quantity of Si extracted from Godavari river sand by using of magnesium as a burning agent following by treatment with HCl. The prepared samples were characterized by scanning electron microscopy (SEM), X-ray diffraction (XRD), and the purity of the sample was tested by energy dispersive X-ray spectroscopy (EDX).

II. EXPERIMENTAL PROCEDURE

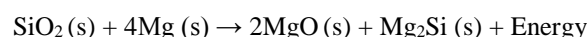
A. Sample collection

The wet sand was collected from Godavari River, kandakurthi, Nizamabad, Telangana State, India. The samples are allowed to dry for 1 hour in presence of sun light and weight of the each sample is measured using electronic weighing machine. The impurities and visible dust particles are washed out with distilled water and dried in electric hot air oven at 150°C for 1 hour. Sand samples are separated and extra contaminates are removed with the help of hand meshing. Sand particles which are taken by 30μ mesh has the more glassy like structures than 20μ mesh, so used for experiment by making them into powder. The weight loss of the samples is calculated and final weights of the powder are noted down and observed that each sample has lost 10% of their weight.

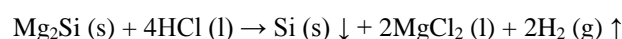
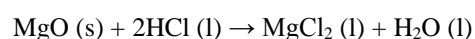
B. Treatment

Metallurgical grade silicon can be obtained from sand (SiO₂) when it has burn until the oxygen is removed from sand. For this silica powder, magnesium ribbon cut into small size with scissor and the ratios followed between the silica powder and magnesium ribbon are 1:2 (2grams:4grams). Both the samples are collected in graphite crucible and placed in electric muffle furnace at 1000°C for 30 minutes. Normalizing of sample was done by cooling them in presence of air after heat treatment.

During heat treatment,



When Silica was heated in presence of Mg ribbons the resultant product with a combination of MgO and MgSi is formed. This Solid material was treated with Concentrated HCl solution. And acid solution is taken on the basis of, for 1 gram Mg 50ml HCl. After adding HCl, the MgO and MgSi converts into MgCl₂ and it is an exothermic reaction. Reactions occurred in solution are following



Mixture of silica, silicon and magnesium are precipitate at the bottom of the beaker. Distilled water is used to remove the magnesium salts to get pure silicon. Drying of grey colored silicon is carried out in the electric hot air oven at above 100°C for 1 hour. Dried silicon particles are made into fine powder for testing silicon purity presence in the obtained mixture by EDX and XRD analysis.

C. Characterisation

The crystal structure of the extracted silicon was determined by X-ray diffractometer (D8 Discover, Bruker AXS Co. Ltd, Germany) with Cu- K α radiation $\lambda= 1.54056$ Å. The particle size and morphology was derived from field emission gun scanning electron microscope (Carlzeiss Co. Ltd., Germany) and the elemental composition was obtained from energy dispersive X-ray diffraction attached to FESEM (EDX INCA, OXFORD Instruments.).

III. RESULTS AND DISCUSSION

A. EDX Analysis

The elemental composition of Godavari River sand before processing was determined by Energy dispersive X-ray spectroscopy (EDX INCA, OXFORD Instruments) as has shown in Fig.1 & Table I, indicating the 85.4% silica present in the sample.

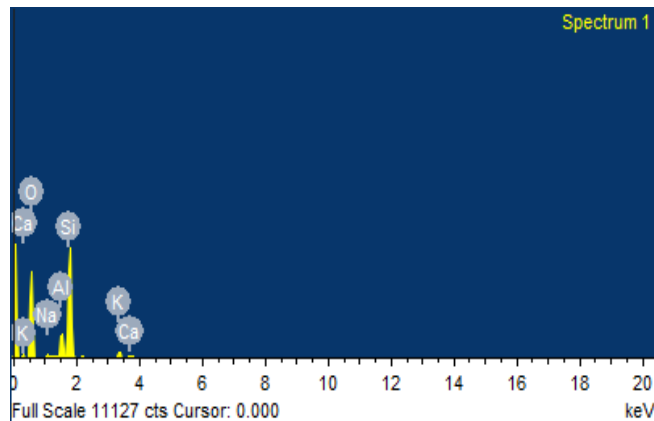


Fig. 1 EDX of Godavari river sand

Table 1. Elemental composition of Godavari river sand

| Element | Weight % |
|--------------|------------|
| O K | 55.40 |
| Na K | 1.08 |
| Al K | 5.43 |
| Si K | 30.86 |
| K K | 3.40 |
| Ca K | 1.78 |
| Fe K | 2.05 |
| Total | 100 |

After the process of extraction of silicon from Godavari river sand the product was analyzed again by EDX (fig 2). The elemental composition clearly shows 97% of Silicon along with minor percentages of Mg and oxygen as shown in table. 2. The oxygen may be a constituent in the form of MgO or SiO₂ which is to be identified in XRD.

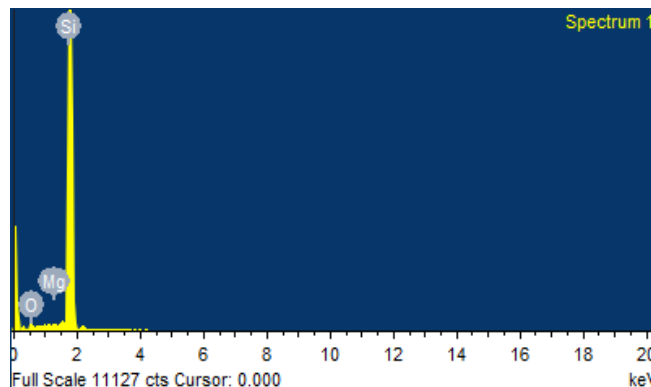


Fig. 2 EDX of extracted silicon from river sand

Table 2. Elemental composition of silicon obtained from Godavari River sand

| Element | Weight % |
|---------|----------|
| O K | 3.1 |
| Mg K | 0.2 |
| Si K | 96.7 |
| Total | 100 |

B. XRD Analysis

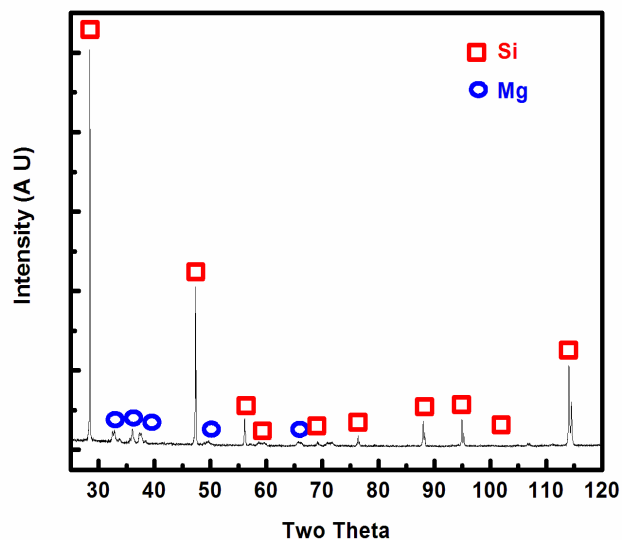


Fig. 3 XRD pattern of extracted Silicon from Godavari River sand

The X-ray diffraction patterns of mixture of silicon and Magnesium shown in Fig. 3 which is well matched with **pdf 01-075-0590** from the data base and indexed to the FCC Cubic structured Si. The unidentified peaks were matched with pure Mg and not matched with MgO. The oxygen percentage shown in EDX may be due negligible percentage of silica present in the product.

C. Morphology

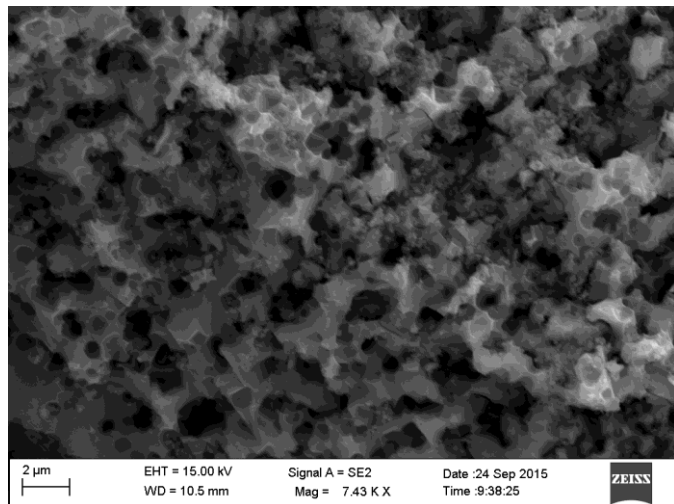


Fig. 4 SEM image of silicon

Fig. 4 illustrates the SEM image of Silicon obtained from Godavari River sand. The image clearly reveals that obtained Silicon exhibits the well-defined porous silicon morphology. The pore diameter size ranges between 400 to 600 nm. These pores can be utilized in several applications as a host material in holding guest nanoparticles as well as used as a filter in waste water management.

CONCLUSIONS

In summary, $\approx 97\%$ pure Silicon extracted from Godavari river sand. The purity of the sample examined by both EDX and XRD. Extracted silicon indexed to cubic FCC structure.

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