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Efficient Synthesis and Characterization of Highly Pure Nanosilica from Sand

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ABSTRACT

This study aims to extract pure silica nanoparticles from sand dunes by using an economical and simple extraction method. The chemical analyses by XRF and FTIR of the synthesized silica confirm the high purity of the silica (~98% SiO_2), while the XRD pattern shows an amorphous structure of the synthesized silica. However, the microstructural analysis displays that the extracted silica particles size is in the range of nanometers. These results confirm the formation of silica nanoparticles and support the use of the new product for advanced material applications.

Introduction

In recent years, due to their excellent physical properties, silica nanoparticles have attracted great interest in several applications such as separation, catalysis, optics, and biomedicine [1–4]. Basically, sodium silicate and tetraethyl orthosilicate (TEOS) are the main precursors for the silicaproduction. However, the high price of these precursors stimulated the researchers to find substitute natural and low-cost resources for Nanosilica and also its extraction process [5]. Silica sand is one of the alternative sources that are very abundant in Sahara and very rich in SiO_2. This work aims to extract and characterize highly pure nano- silica through a facile chemical method from Algeria sandas a low-cost silica source.

Experimental Study

The sand sample was collected from the North-East of Algerian Sahara, which contained 75wt% of quartz (Fig.1-a). The synthesis of silica nanoparticles was carried out bythree stages. First, the sand sample was stirred in HCl at room temperature and was washed with distilled water to remove the impurities. In order to obtain the sodium silicates, a mixture of sodium hydroxide and silica sand was mixed and was heated at 300 °C. The obtained productwas diluted with distilled water and stirred with a hot platestirrer, and then followed by titration of the solution with HCl to form a clean white gel. The final silica gel was washed, dried at 100°C, and then ground. The produced silica was characterized using several techniques as X-Ray Fluorescence (XRF), Fourier transforms infrared (FTIR), X-ray diffraction (XRD), and scanning electron microscopy (SEM).

Results and Discussion

The chemical analysis by X-ray fluorescence spectroscopy(XRF) and Fourier transform infrared (FTIR) indicate thatthe new obtained product consisted of highly pure silica particles (~98% SiO_2). The XRD pattern confirms theamorphous structure of the synthesized silica (Fig1-b). Moreover, the scanning

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electron microscopy (SEM) analysis reveals that the extracted silica particles' size is in the range of the nanometers. These results corroborate that high purity silica nanoparticles were successfully prepared from sand dunes by using a cost-effective method. Hence, the extracted nanoparticles of silica might be used for nanotechnology applications.

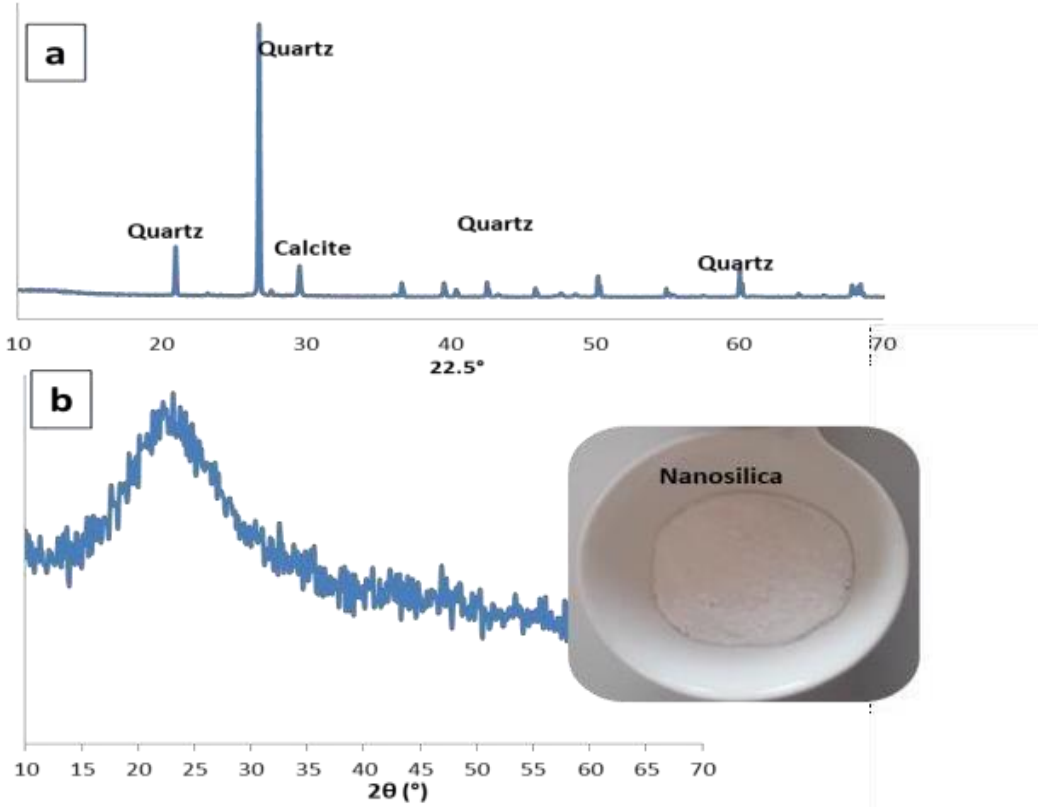

Fig.1: XRD spectra of (a) the silica sand and (b) of the prepared nano-silica.

Conclusion

Silica nanoparticles were extracted from Sand dunes usinga simple and low-cost method. The results show that the extracted silica particles from sand have high purity. XRD analysis confirms the amorphous nature of the prepared silica. However, the SEM micrograph confirms the nanometers size of the prepared silica particles.

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