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Characterization of SrO samples produced at two different temperatures

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ABSTRACT

In this study, two strontium oxide (SrO) samples were produced at two different temperatures of 950 °C and 1000 °C, and the characterization of these samples was carried out using X-ray diffraction (XRD), Fourier transform infrared (FTIR) spectroscopy, and scanning electron microscopy (SEM). The as-obtained results were compared with both each other and the available data in the literature, and all the as-observed results were reported in more detail. It was found that the temperature of the heat treatment affected significantly the crystallite size and morphology and SrO samples can be easily prepared in high purity via a wet chemical method as a facile route.

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1. INTRODUCTION

As strontium reacts with oxygen, it forms strontium oxide, or strontia, SrO. Strontium oxide is formed when strontium is burned in air. It is also formed when strontium carbonate $SrCO_3$ decomposes [1]. Because of their limited availability, strontium compounds have not been commonly used until recently. Strontium-containing frits are now popular, particularly where brilliant glaze finishes and low thermal expansion are desired. Since it is non-hazardous and non-poisonous, strontium is essential. SrO is useful in combination with other fluxes at lower temperatures, despite its high melting point [1]. SrO has been widely used in various technological applications owing to its eminent optical, thermal, mechanical, magnetic and electrical properties, as well as its high oxidation resistance and chemical inertness [2]. In the work of [1] the role of strontium oxide as modifier in silicate-based bioactivate classes have been studied. It was obtained a fixed 10 mol% of CaO was replaced with MgO or SrO or fifty-fifty MgO-SrO and obtained ad a good mechanical performance. There is no comprehensive theoretical or experimental work on the title complexes in the literature as far as we know, and we have provided two strontium oxide samples at two separate temperatures of 950 °C and 1000 °C in this work. X-ray diffraction (XRD), Fourier transform infrared (FTIR) spectroscopy, and scanning electron microscopy were used to characterize these samples in detail.

2. MATERIALS AND METHOD

Strontium nitrate ($Sr(NO_3)_2$) was purchased from Merck and used without any further purification. Two of 0.1 M $Sr(NO_3)_2$ solutions were prepared in two different flasks with volumes of 100 mL using the distilled water as the solvent. These solutions were mixed in a multi-position magnetic stirrer at 75 ºC for 3 h and then dried in an oven at 120 ºC for 23 h. Finally, the samples were heat-treated at various temperatures of 950 ºC and 1000 ºC for the same time of 3h.

X-ray diffraction (XRD) data of the as-produced SrO samples were collected by using a Rigaku RadB-DMAX II model diffractometer with a step size of 0.02° using Cu Kα radiation. Fourier transform infrared (FTIR) data in the

mid-infrared range (400-4000 cm^{-1}) were recorded by a PerkinElmer Spectrum One spectrophotometer using the KBr pellet method. The morphological investigations were carried out by using a LEO EVO 40xVP model scanning electron microscope equipped with an EDX detector (Röntech xflash).

3. RESULTS AND DISCUSSION

3.1. XRD results

X-ray diffraction (XRD) analysis results of the samples are shown in Fig. 1. Both spectra are perfectly matched with the standard data for SrO (JCPDS pdf no: 48-1477) having the cubic crystal structure. For two samples, the diffraction peaks of (111), (200), (220), (311), and (400) were observed. No any notable shift in the peak positions due to the heat treatment temperature was observed, but some changes in the intensities of these peaks were seen.

The crystallite size (t), lattice parameter (a) and unit cell volume (V) of the samples having a cubic crystal system were calculated using the following relations, respectively [3]:

$$D_S = \frac{0.9\lambda}{\beta \cos\theta} \quad (1)$$

$$\frac{1}{d^2} = \frac{h^2 + k^2 + l^2}{a^2} \quad (2)$$

$$V = a^3 \quad (3)$$

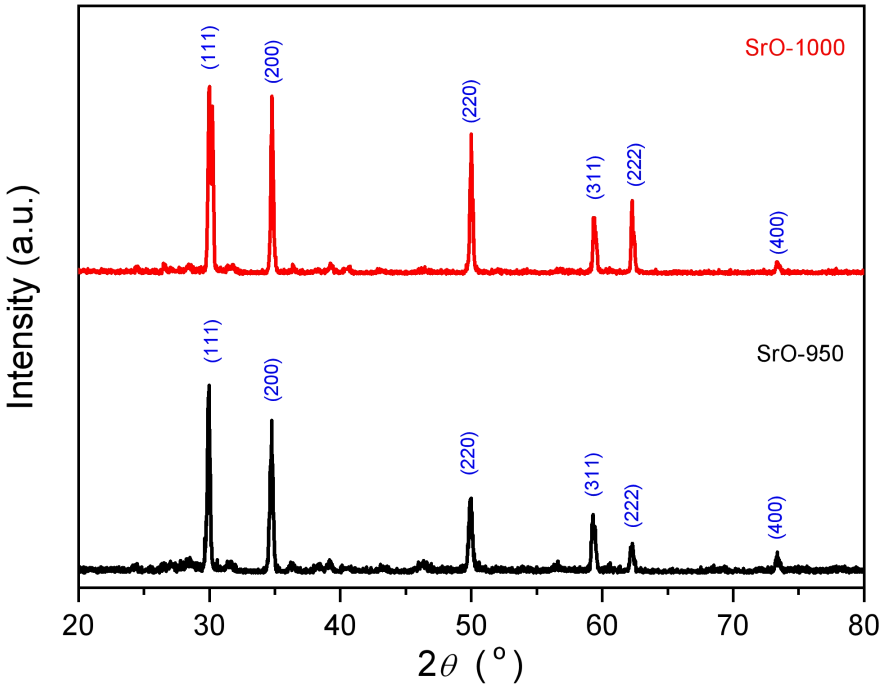

Fig. 1. XRD patterns of both SrO samples produced at various temperatures

Table 1. The as-computed values of the crystallite size (t), lattice parameter (a) and unit cell volume (V) of the samples compared with the standard data for SrO structure

Sample	a (nm)	V (nm^3)	t (nm)
SrO (JCPDS 48-1477)	0.5160	0.1374	-
SrO-950	0.5161	0.1375	32.88
SrO-1000	0.5157	0.1372	36.10

For both samples, the as-calculated values of these parameters are listed in Table 1. As can be seen from Table 1, the lattice parameters and unit cell volume values of both samples are very close to those of the standard values belonging to SrO. The crystallite size was found high for the Sr-1000 produced at 1000 ºC in comparison to the Sr-950 produced at 950 ºC. This is due to the expansion of the samples as expected theoretically at the high temperatures compared to the lower temperatures [4].

3.2. FTIR results

Fourier transform infrared (FTIR) spectra of the samples are given in Fig. 2. The bands at 601, 904, 1033, and 1445 cm^{-1} are associated with the vibrational mode of the Sr-O bond indicating the formation of SrO for both

samples [5-8]. The bands of 3476, 3614, and 3682 cm^{-1} are assigned to the hydroxyl and water-related groups, which are possibly adsorbed moisture from the atmosphere [2,9,10]. The as-observed band at 1056 cm^{-1} is related to the vibration mode of the C-O bond, which is possibly adsorbed from air atmosphere [11]. The as-detected band at 2975 cm^{-1} is due to the C-H bond related vibrational modes of CH_2 and/or CH_3 [12,13].

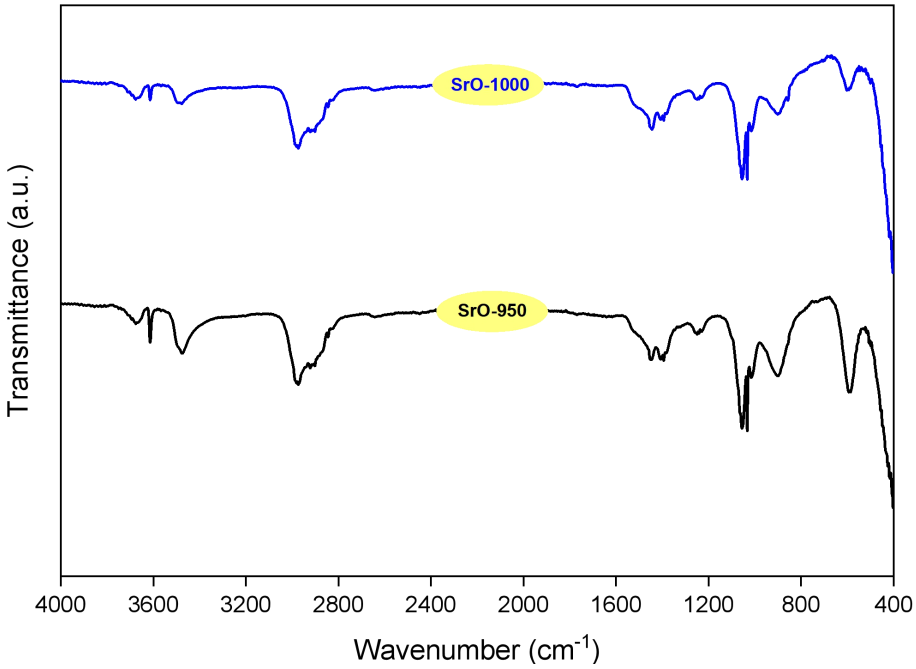

Fig. 2. FTIR results of both SrO samples

3.3. SEM investigations

The morphological investigation results of both SrO samples are shown in Fig. 3. Both samples are composed of the randomly stacked particles with the cubic shapes. In comparison to the SrO-950 sample, the SrO-1000 has got the bigger particles verifying the expansion at the higher temperature. The EDX results showed that each SrO sample contained only the elements of Sr and O, as expected. For both, the atomic percent of Sr and O is close to each other.

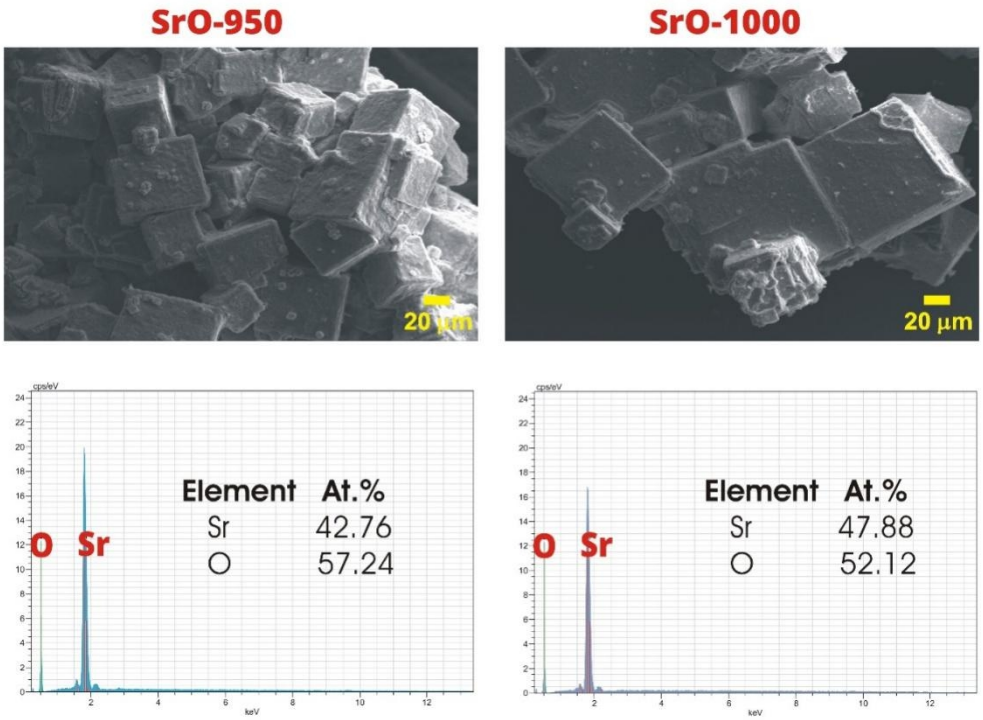

Fig. 3. Morphological analysis of both SrO samples

4. Conclusions

In this study, it was aimed to investigate the effects of the production temperature of SrO on its structural and morphological properties. In this context, two SrO samples were produced at different temperatures of 950 °C and 1000 °C by using a facile wet chemical route, and these samples were characterized by using the X-ray diffraction (XRD), Fourier transform infrared (FTIR) spectroscopy, and scanning electron microscopy (SEM) techniques. As can be seen from the XRD and SEM results, the higher temperature caused an increase in the crystallite size and grain size of the SrO structure. The XRD and FTIR results also confirmed the formation of SrO structure for each sample. No impurity was detected in both XRD and SEM investigations of the samples. Briefly, all the as-investigated properties were affected by the production temperature.

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