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Synthesis and characterization of strontium carbonate nanostructures via simple and fast microwave approach

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ABSTRACT

Strontium carbonate ($SrCO_3$) nanostructures were synthesized successfully via simple microwaveapproach by $Sr(NO_3)_2$, carbonate powder and sodium hydroxide (NaOH) as reagents. The effects of microwave time and power were investigated on product size and morphology. The productswere characterized with X-ray diffraction pattern (XRD), scanning electron microscopy (SEM).

KEYWORDS

Strontium carbonate;
Microwave;
Nanostructures.

INTRODUCTION

In the past few decades, the nanostructures materials have shown increasing research interest due to their unique physical and chemical properties. These properties are greatly affected by the morphology, size, shape and crystallography of nanomaterials[1,2]. Strontium carbonate ($SrCO_3$) and barium carbonate ($BaCO_3$) are very important materials for a number of industries. $SrCO_3$ is used as a constituent of ferrite magnets for small direct current motors, an additive in the production of glass for color television tubes, modern electric industries, and for the production of iridescent and special glasses, pigments, driers, paints, pyrotechnics, strontium metals and other strontium compounds[3, 4]. A variety of processes for the preparation of $SrCO_3$ have been reported[5, 6]. So far, SrCO3 particles with different morphologies have been produced, such as nanowires[7], flowerlike nanostructures[3] and hexahedral ellipsoids[8]. Furthermore, strontium carbonate has only one crystal-phase, so it has been widely studied as a model system for bio-crystallization[6]. Various processes for the preparation of $SrCO_3$ including, hydrothermal method[3], self-assembled monolayers[5], ball milling of celestite[9], microemulsion, mediated solvothermal method[10], sonochemical method[11] homogeneous precipitation by enzyme-catalyzed reaction[12], biological synthesis[13] and solvothermal methods[14] have been reported. Recently, microwave method has attracted wide interest in material science which helps to increase the nucleation rate, reduce the synthesis time and provide the small particles with narrow size distribution and high purity. Hence, it is quite promising and easy to use for industrial applications[15, 16]. In this experimental work, $SrCO_3$ nanostructures were synthesized via a smile microwave approach. Different parameters such as microwave time and power were investigated on the product size and morphology. Optical properties of the product were studied. Different analysis such as XRD, SEM, TEM

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and PL were used to characterization of the synthesized products.

EXPERIMENTAL

Materials and physical measurements

All the chemical's reagents used in experiments such as $Sr(NO_3)_2$, carbonate powder and NaOH were of analytical grade and used as received without further purification. For characterization of the products XRD patterns were recorded by a Rigaku D-max C III, X-ray diffractometer using Nifiltered Cu Ka radiation. SEM images were obtained by scanning electron microscope (SEM) (Philips XL-30ESM).

Synthesis of $SrCO_3$ nanostructures

In a typical experimental procedure equal mole of $Sr(NO_3)_2$ and carbonate powder were dissolved in water, separately and then two solutions were mixed together. Then certain amount of NaOH was dissolved in final solution to adjust pH of the solution. After that the solution was transferred to beaker and exposed to microwave irradiation for different times and powers. After thatobtained powders were centrifuged and washed several time with water and absolute ethanol for removing probably by products. Finally, the productswere dried at 80 for 10 h. Experimental conditions of $SrCO_3$ formation was shown in TABLE 1.

RESULT AND DISCUSSION

Figure 1 shows XRD pattern of sample No. 5. As shown in this figure, the main diffraction peaks were observed at 25.2°, 26°, 37°, 44.5°, 48°, 50.5°in the XRD pattern of the $SrCO_3$ which confirm the formation of $SrCO_3$with orthorhombicstructure (JCPDS No. 71-2393). Also lattice constants of the product were a= 5.0900 Ap , b= 8.3580 Ap and c=5.9970 Ap .

Figure 2 (a-c)shows SEM images of S1-S3, respectively. As shown in this figure, microwave power has important role in determination of prod-

TABLE 1 : Samples preparation conditions

Sample No	Microwave Time (min)	Microwave Power (W)
1	5	600
2	5	750
3	10	600
4	10	750

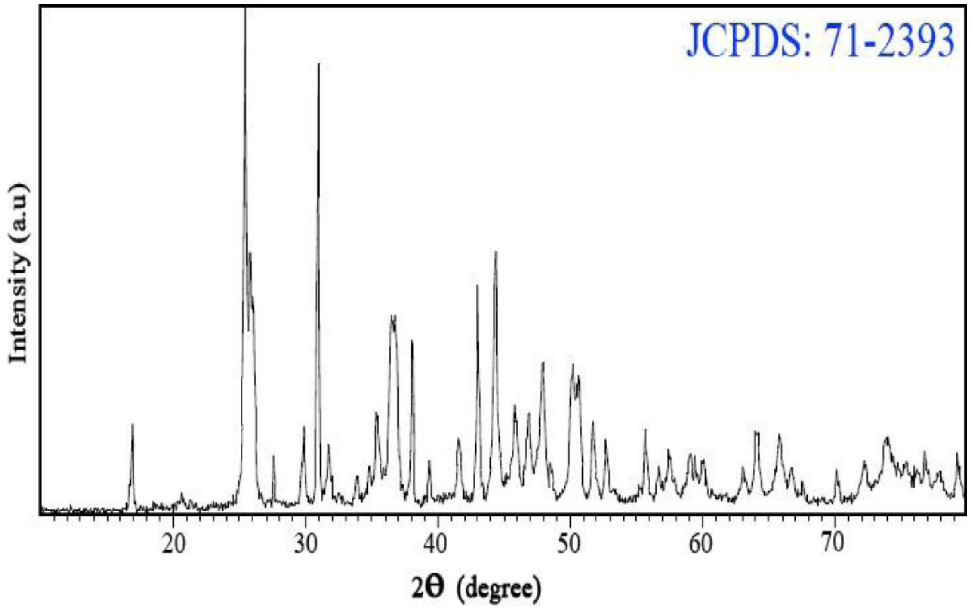


Figure 1 : XRD pattern of sample No. 5

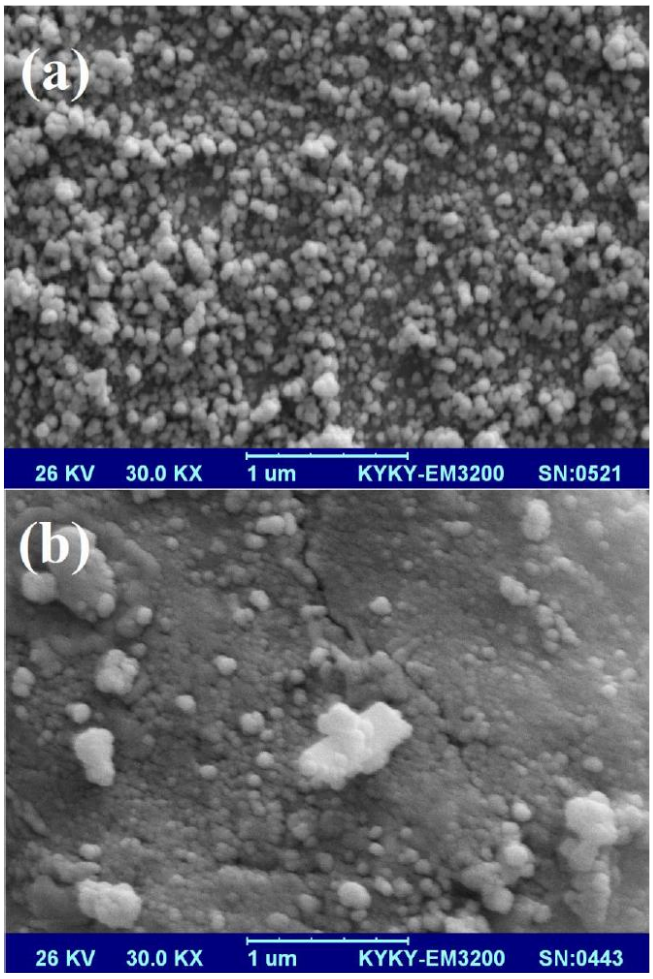


Figure 2 (a-c) : SEM images of S1 – S2, respectively

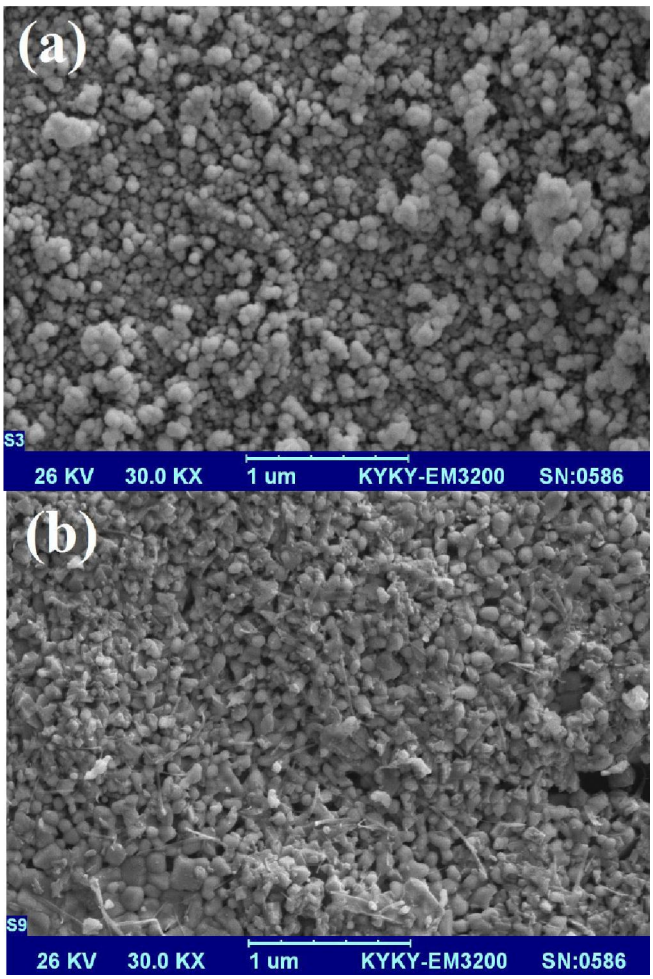


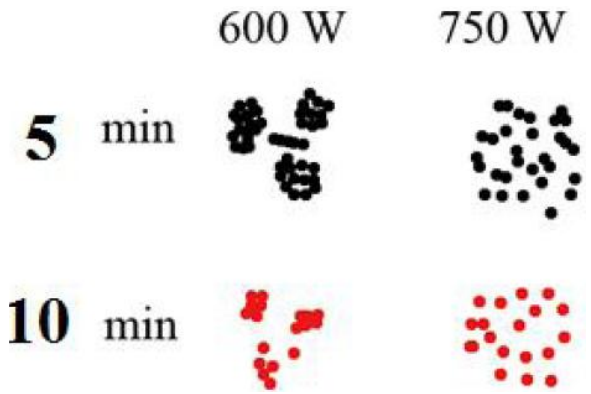
Figure 3 (a-c) : SEM images of S3 – S4, respectively

uct size and morphology. When the reaction was done at 600 W, aggregated particles were obtained that can be attributed to low produce energy of the microwave in this power (Figure 2a). In fact, at 600 W microwave can't prepare require energy for synthesis of separate tiny particles. By increasing microwave power to 750 W, required energy is prepared and very tiny particles are created (Figure 2b).

SEM images of samples prepared at 6min in different powers are shown in Figure 3. It can be seen that at 600W microwave power (Figure 3a) aggregated particles are obtained that by increasing microwave power to 750W these particles are separated and very tiny particles are achieved (Figure 3b). So microwave power in this time has also significant effect on product size and morphology and by choosing the best microwave time, it is capable to synthesizing very tiny particles.

Figure 4(a-c)shows SEM images of S6–S9 respectively. The effect of microwave power on product size and morphology in this time is similar to previous times. At initial power of microwave for preparation of the product, lump-like and bulk structure with some tiny particles are synthesized that indicate 600W power at this time cant prepare required energy for creation of separated nanoparticles. By increasing microwave power to 750 W, aggregated particles are appeared that shown in this time 750 W prepared more energy than other times and subsequently lump-like structure formed from very small particles are achieved.

The effect of microwave time on product size and morphology is similar to microwave power effect. Figure 2a, 3a and 4a show the effect of microwave time on product size and morphology at 600W microwave power. It can be seen that at 4 min microwave irradiation (Figure 2a), aggregated particles are obtained that by increasing time to 6 min (Figure



Schem 1 : Schematic of the influence of microwave power and time on product size and morphology.

3a), the particles become separated and nanoparticles are synthesized. In fact in 6 min microwave can prepared required energy for synthesizing of small and separated particles. When microwave time was selected to 8 min, more energy of microwave was prepared that led to aggregation of particles and so bulk and lump-like structure was obtained (Figure 4a). It can be concluded that in this power, 6min irradiation is optimum microwave time for creation very small particles.

The effect of microwave time at 750 W power is shown in Figure 2band3b. The observation in this power is similar to 600W microwave power. As shown in Figure 2b, using microwave irradiation at 750W for 4 min prepares tiny particles that some of them are aggregated together. By increasing microwave time to 6min (Figure 3b), separated and tiny particles are achieved that can be attributed to more produce energy of the microwave at 6 min irradiation.

The influence of microwave timSe ion product size and morphology at 900W power was investigated. Schem. 1 shows the influence of microwave power and time on product size and morphology.

Aggregated particles and show lower band gap respect with sample No. 5. It can be concluded that particle size and morphology has important role in optical properties of the samples.

CONCLUSION

It can be concluded that microwave time and morphology have significant effect on product size and morphology and by choosing the best microwave time and power we can obtain very tiny particles. Each microwave powers have optimum time and each microwave times have optimum microwave power that can produce sufficient and appropriate microwave energy for creation of separation and tiny nanostructures. Also it was found that synthesis condition affect on optical properties of the samples.

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