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The Effect of Atomic Diameter in the Particle Size of Nano Powder of $CaSnO_3$ and $MgSnO_3$ Prepared by Single Stage Solid State Synthesis Method

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ABSTRACT

Nano particles of CaSnO3 and MgSnO3 ,because of their thermal stability and chemical and physical reactions in the air have attract many researchers and find various applications in various application In many areas such as making sensors, ceramic dielectrics and battery electrodes.in this article the nano SnO2 powders are prepared by Solid state one stage synthesis method firstly and then the physical and cristla properties of Nano powders are examined in various temperatures. The powder which was a mixture of MCl2,M(OH)2 with SNCl4.5 H20 (M=Mg & Ca) with Sn/M weight ratio of 1:1, in particle sizes of 6 to 44 nano meter were prepared and were heated in temperatures of 200,400 and 800 siliceous degrees. In the first stage ,the above mentioned powder materials are combined in room temperature and after grinding, the prepared powder is centrifuged in 30 minutes and finally is decanted for investigation of heat effect, the prepared nano powders are annealed for 4 hours. As far as the goal was to consider the effect of the atomic diameter on the particle size, two elements from second group of periodic table is selected and the above mentioned stages are done for each of them separately.
Using XRD and SEM analysis ,the size of particles was determined to be between 6 and 44 Nanometers and the effect of atomic diameter in particles size is clearly obvious.
KEYWORDS: $CaSnO_3$, $MgSnO_3$, single stage Solid state

1. INTRODUCTION

The entrance of humans to the Nano world and The use of nano structures, gives the ability to him to make far more stronger and lighter materials and structures, with excellent electric conductivity, magnetic properties, thermal insulation and abrasion resistance. For any nono powder, the specifications such as particle size, average size, the distribution of movement ,chemical nature, structure, shape and morphology, Phases kind, cristaline content are very important and determinant.[1]some above mentioned factors can be managed by exact controlling of preparation process . Nano particles of CaSnO3 and MgSnO3 ,because of their thermal stability and chemical and physical reactions in the air have attract many researchers and find various applications in various application In many areas such as making sensors, ceramic dielectrics and battery electrodes. Calcium Stanate is more used in dampness sensors and ceramic accumulators. [2]

Various methods such as Sol-Gel, PVD,… are used for making Nono particles with their peculiar advantages and disadvantages and have their own challenges. We used a method which is simple and economically efficient as well.

In addition to making Calcium Stanate nano powder, investigating the effect of atomic diameter was also intended .so ,Magnesium from the second group is selected and it's nano powder of Magnesium Stanate is also prepared and examined.

MATERIALS AND METHODS

After making the initial powders according to table 1, Sncl2.5H2O is mixed with MCl2 and are grinded for 30 minutes to make sure that the combination is done. Then M(OH)2 is added to the powder in the mill and is grinded for another 30 minutes. The emerge of water on the upper walls of the grinding apparatus after adding M(OH)2 shows that the combination is happened .So by adding distillated water to the powder and primary centrifuging the

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product in 8000 RPM for 10 minutes in room temperature and decanting it according to reaction 1 ,we can make sure that the salt is taken out of the product.

Reaction 1 $Ag(NO_3) + MCl_2 \longrightarrow AgCl + M(NO_3)_2$

Observing white precipitation implies the existence of salt in final product. In this case ,the centrifuging is repeated with the same conditions. From experience, this can be achieved by seven set of centrifuging action.

Table 1. Spcification of basic powders for making $MgSnO_3$ nano particles

Nano Powder	Weight(gr) - mole	Chemical formula	Sn/Mg ratio
$MgSnO_3$	3.5 (0.01 mole)	$SnCl_4.5\ H_2O$	1:1
	0.952 (0.01 mole)	$MgCl_2$	
	2.33 (0.04 mole)	$Mg(OH)_2$	

For investigation on the effect of heat and examination of their heat stability ,they were annealed for 4 hours in 200,400 and 800 Celsius degree and were cooled with the same rate.

Concerning that the main goal of this study was to investigate the effect of atomic diameter on the particle size of nano powder, the Calcium element which has a bigger atomic diameter was selected and its powder is prepared by the above mentioned process as well.

Table 2. Spcification of basic powders for making $CaSnO_3$ nano particles

Nano Powder	Weight(gr) - mole	Chemical formula	Sn/Ca ratio
$CaSnO_3$	3.5 (0.01 mole)	$SnCl_4.5\ H_2O$	1:1
	1.11 (0.01 mole)	$CaCl_2$	
	2.96 (0.04 mole)	$Ca(OH)_2$	

Study of nanostructure of $CaSnO_3$ and $MgSnO_3$Powders using XRD and SEM analysis'

According to XRD images (Fig. 1 and Fig. 2) by comparing the peaks to standard samples,the existence of Calcium and Magnesium stanate was proved.in 200 C,400 C and 800C.it can be seen that the powder annealed in 400 C has good particle size and less variations in size.In higher temperatures some peaks are increased in upper angles which corresponds with the reference samples.[3]Observations from XRD analysis shows that by changing the raw matrials of making Stanate nano powders from Magnesium to Calcium,which has a bigger atomic diameter,,the size of resulted powder of $CaSnO_3$ is bigger than nanoparticles of $MgSnO_3$in all temperatures.the size of D nano particles was calculated by the Schorrer formula (equation 1)and is reported in tables 3 and 4.In the equation, the wave length of the used X ray is λ=1.541 A , β is the width of maximum peak and θ is the diffraction angle.

$D=\frac{0.9\lambda}{\beta \cos\theta}$ Equation 1

Table 3. The effect of temperature on the particle size of $MgSnO_3$ Powder

Annealig Temperature°©	200	400	800
size of nanoparticle	24.73	4.73	28.50

Table 4. The effect of temperature on the particle size of $CaSnO_3$ Powder

Annealig Temperature°©	200	400	800
size of nanoparticle	44.36	12.71	29.59

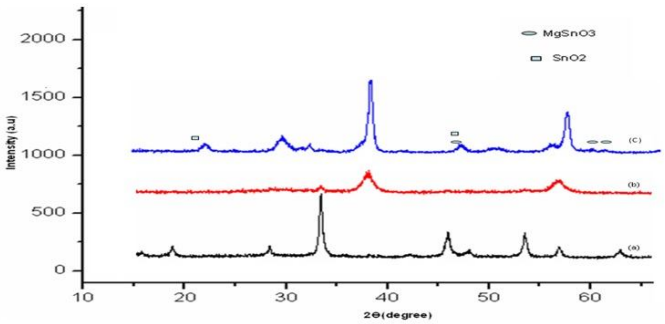


Fig. 1. Comparison of XRD diagrams of $MgSnO_3$ in different temperatures a)200°C b)400°C C)800°C

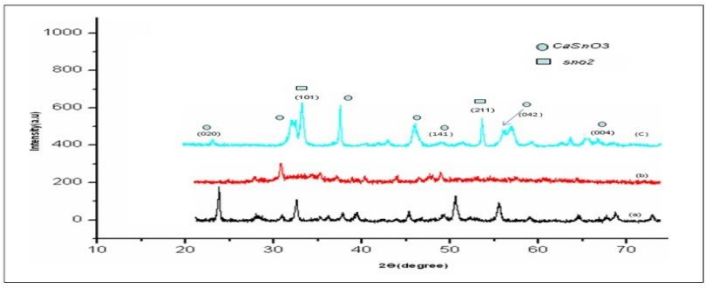
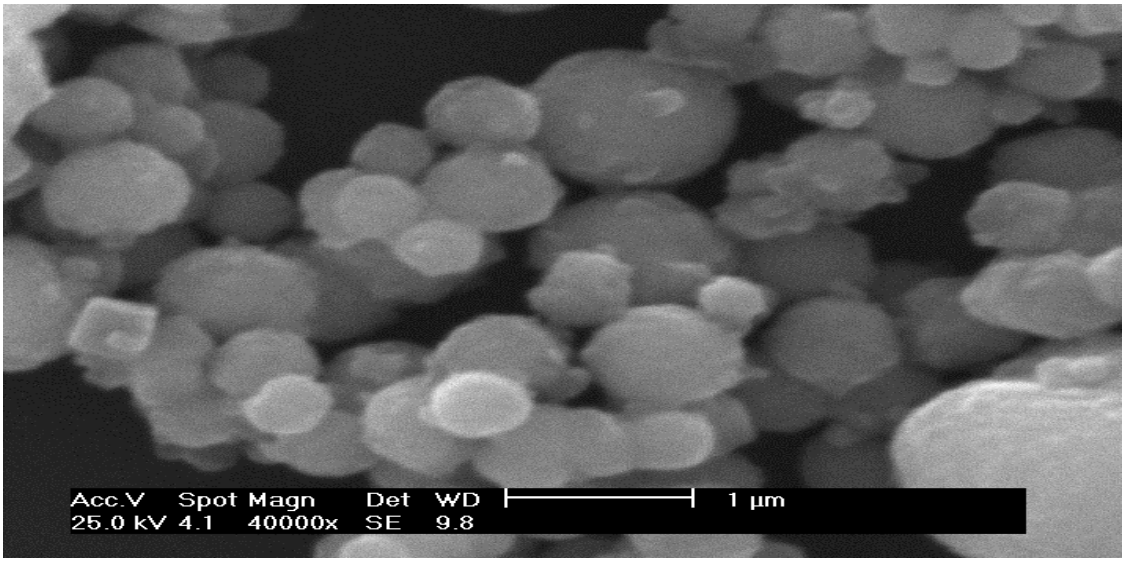


Fig. 2. Comparison of XRD diagrams of $CaSnO_3$ in different temperatures a)200°C b)400°C C)800°C

According to the results from XRD analysis and calculation of size of nanoparticles by Schorrer equation in the temperature of 400C,heated for 4 hours , have the smallest particle size .concerning that smaller size is more desirable for many function of the powder for applications such as sensors,only this powder was selected for morphology test.The images of differential scanning microscopy (Fig. 3. and Fig. 4.) show the particles. The porosity of particles is also clear in the pictures,which is a good and key specification for applications such as gas sensors and increases the sensitivity of the sensor.



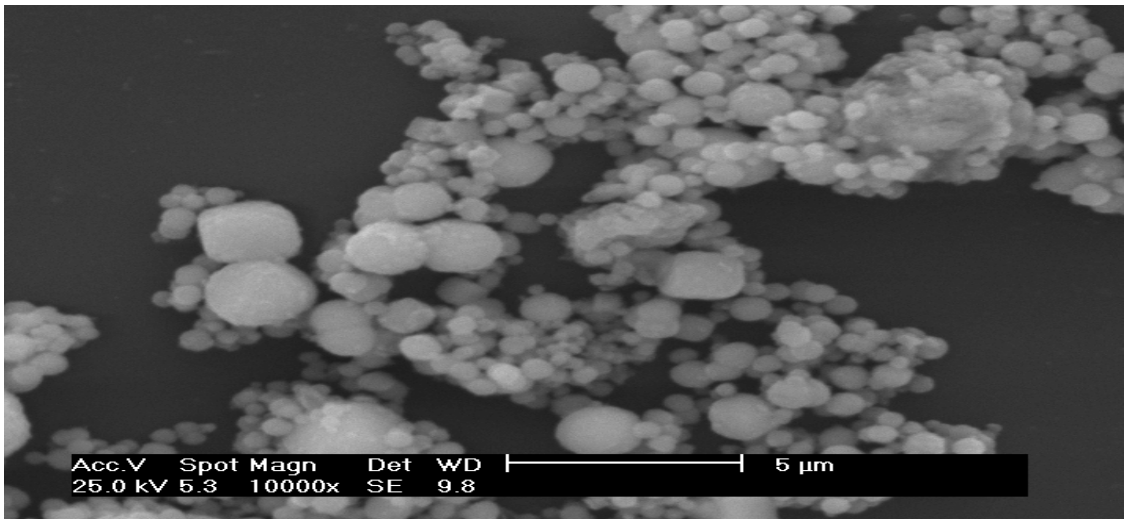


Fig. 3.SEM image of $MgSnO_3$ nano particles, annealed in 400 ^oC with power of 10,000 and 40,000

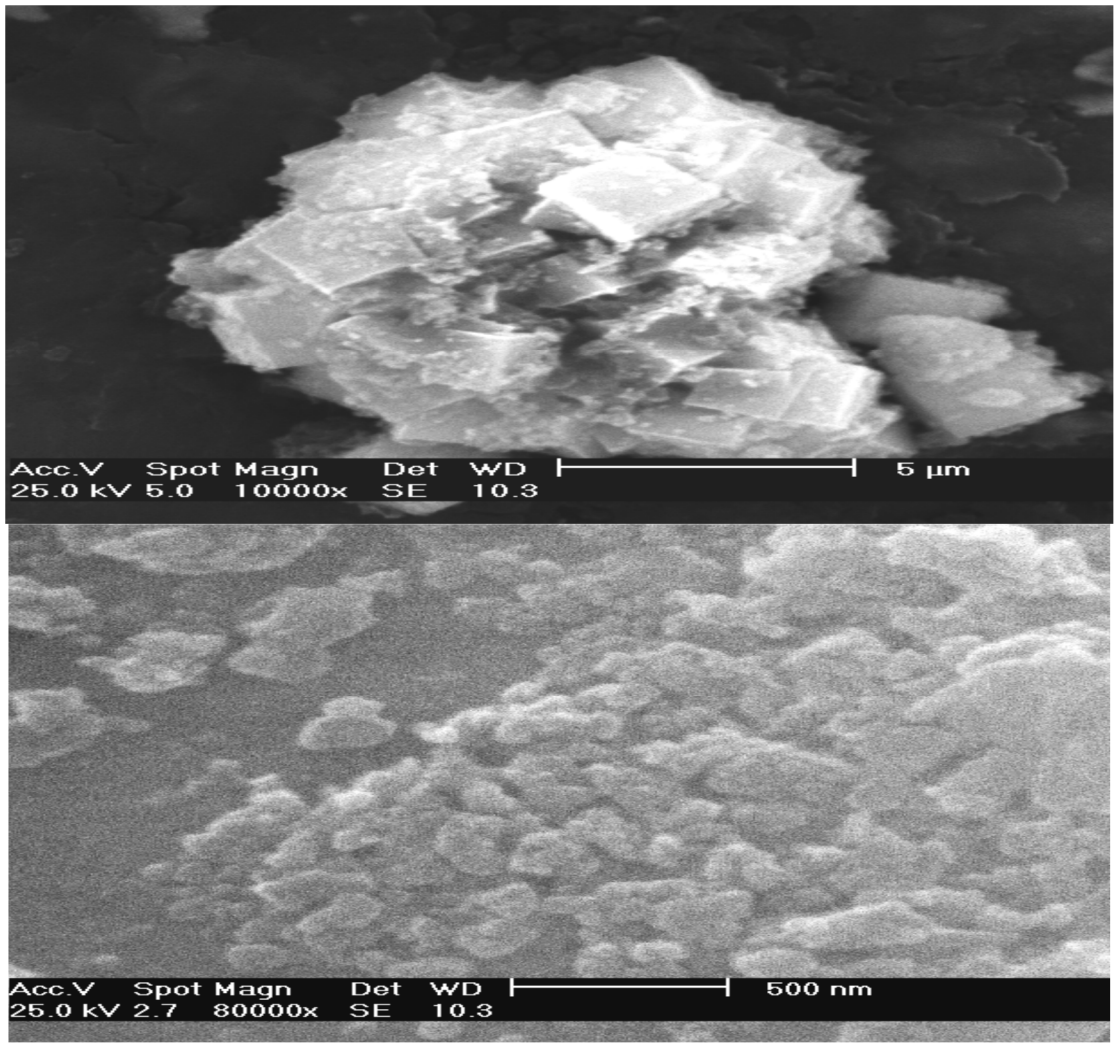


Fig. 4.SEM image image of $CaSnO_3$ nano particles ,annealed in 400 ^oC with power of 10,000 and 80,000

RESULTS AND DISCUSSION

Using XRD spectrum, the size of particles and their reaction to various annealing temperatures was clearly observed. Furthermore, it was seen that by rising the temperature from 400 to 600C ,the size of nano particles is increased. Also, by changing magnesium to Calcium, which has a bigger atomic diameter, the size of nano particles is increased. Consequently, it can be suggested that for gas sensors application, $MgSnO_3$ nano powder is more suitable due to their smaller particle size and their better interaction with the introduced gas and the higher achievable sensitivity.

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