

# The Perovskite Phase Optimize of Barium Titanate Nanoparticles

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**ABSTRACT.** The barium titanate gel has been made by sol-gel techniques and then sintered at  $800^{\circ}\text{C}$  for its nanoparticles powder. Previously, all of the samples are made into the mass ratio, particularly its notation in gram units to the composition with polyvinyl alcohol. Finally, its perovskite phase of the barium titanate nanoparticles were found and optimum occurs in the proportional mass ratio or  $\text{BaTiO}_3/\text{PVA}$ . By *X-ray* diffraction equipment, it be examined to got the optimum tetragonal crystallite where it indicates the perovskite phase had been optimal formed. The both of *PSA* and *TEM* equipments were uses and found that barium titanate nanoparticles in which dominantly for all of them.

**Keywords:** Perovskite, tetragonal, barium titanate, polyvinyl alcohol, sol-gel, sinter

## 1. INTRODUCTIONS

Perovskite phase of barium titanate nanoparticles is a form of the crystallite structure and it has the chemical formula notation is  $\text{BaTiO}_3$ . Where Ba and Ti atoms are two cations with different size, and O is an anion that bonds to all [1-3]. The stable state of barium titanate nanoparticles into the perovskite phases greatly determined to its uses [4-7]. Particularly as a raw material for piezoceramic or piezoelectric [8]. This study has been conducted and obtained to the perovskite phases of barium titanate nanoparticles by sol-gel techniques and by sintered at  $800^{\circ}\text{C}$  [9-12]. By the notations for all sample in the  $\text{BaTiO}_3$ ,  $\text{BaTiO}_3/\text{PVA}$ , and  $\text{BaTiO}_3/2\text{PVA}$  were made to sight that effects of polyvinyl alcohol inside the composites. Subsequently it was made by sol-gel techniques and then sintered to the temperature specific at  $800^{\circ}\text{C}$  [13-14]. The investigations about their characteristics had been traced by XRD, PSA, and TEM.



## 2. MATERIALS AND METHODS

The raw materials with purity level about 99.0 percents was used in this study i.e. barium carbonate powder ( $\text{BaCO}_3$ ), titanium oxide powder ( $\text{TiO}_2$ ), ammonium hydroxide 25.0 percents ( $\text{NH}_4\text{OH}$ ), nitric acid ( $\text{HNO}_3$ ), polyvinyl alcohol powder (PVA), and aqua bidestilata. Step by step process into the sol-gel methods were conducted and then obtained to gel  $\text{BaTiO}_3$  involves three mass ratio and three samples in the  $\text{BaTiO}_3$ ,  $\text{BaTiO}_3/\text{PVA}$ , and  $\text{BaTiO}_3/2\text{PVA}$ . After that process is sintered at  $800^\circ\text{C}$  to gel  $\text{BaTiO}_3$  becomes dried powder of  $\text{BaTiO}_3$  nanoparticles. The investigation for all above samples had been conducted by particularly equipment i.e. X-ray diffraction (XRD) to reported their size of crystallite, volume of fraction, crystallite structure, and that are uses equation (1) and equation (2). By use a particle size analysis (PSA) was reported their particle size distributions and crystallite uniformity. By use a transmission electron microscopy (TEM) was reported to the grain images. Finally, Archimedes methods were used to computing the density.

$$\frac{4 \sin^2 \theta}{\lambda^2} = \frac{(h^2 + k^2)}{a^2} + \frac{l^2}{c^2} \quad (1)$$

$$B(2\theta) = \frac{K\lambda}{L \cos \theta} \quad (2)$$

(where  $h, k, l$  for Miller indices and  $a, c$  for lattice constants. While peak width  $B$  is depend on angle  $\theta$ , where is inversely parameters to crystallite size  $L$ .)

## 3. RESULTS AND DISCUSSIONS

Barium titanate powder were obtained and by following all methods was found a perovskite barium titanate instead of the tetragonal structure is optimum for sample with mass ratio i.e.  $\text{BaTiO}_3/\text{PVA}$  and had been conducted at  $800^\circ\text{C}$ . The Equation (1) and (2) were used to calculating their crystallite phases and the crystallite size. Its crystallite size of barium titanate nanoparticles has been shown in the Figure 2(a), where seems two differences results by means of PSA and XRD. All results from PSA has been shown is nanoparticle size. Meanwhile by results of XRD still had few of microparticle and nano particle. Its tetragonal structure was found is optimum in about a hundred percents and by tracing the volume fraction yielded in the sample of  $\text{BaTiO}_3/\text{PVA}$  and  $\text{BaTiO}_3/2\text{PVA}$ . Therefore, polyvinyl alcohol is effectively as a catalyst in the process for optimally formed and obtained to perovskite barium titanate when were sintered at  $800^\circ\text{C}$  and this has been shown by pattern of the XRD in the Figure 1.

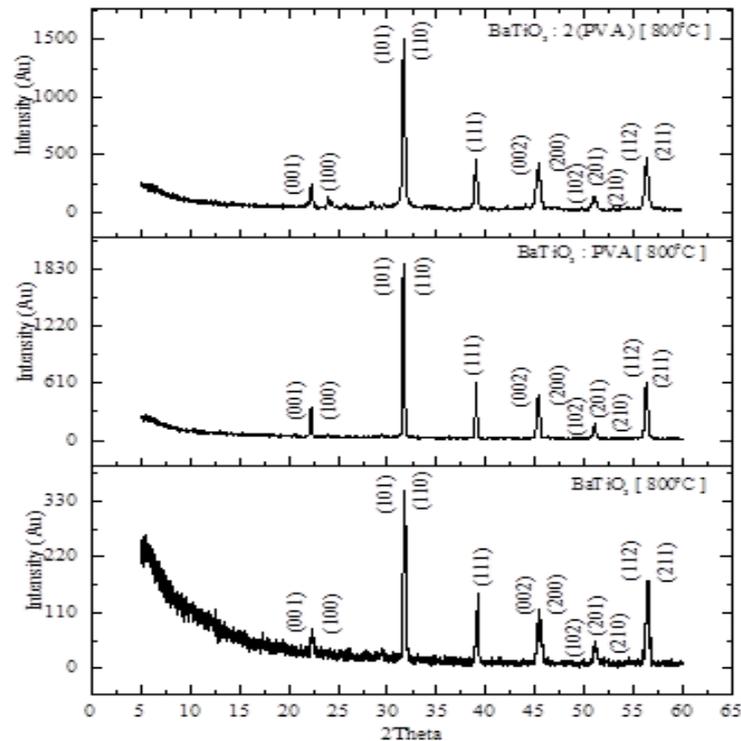


Figure 1. The XRD Pattern of all samples were sintered at 800<sup>0</sup>C

The particle size of barium titanate nanoparticles had been traced by two equipments like a XRD as well as was shown in the Figure 2a). and by uses a PSA as well as was shown in the Figure 2b). Where its results both of dominantly in about nanometers and that appropriately with aims of this works. From Figure 2b). were seem its result for number of density of all samples and that look are different among two curves. Where wet methods ways had obtained appropriate results if it compared with dry methods results. The density of barium titanate material is about 6.03 g/cm<sup>3</sup> and it kind of pore materials [15].

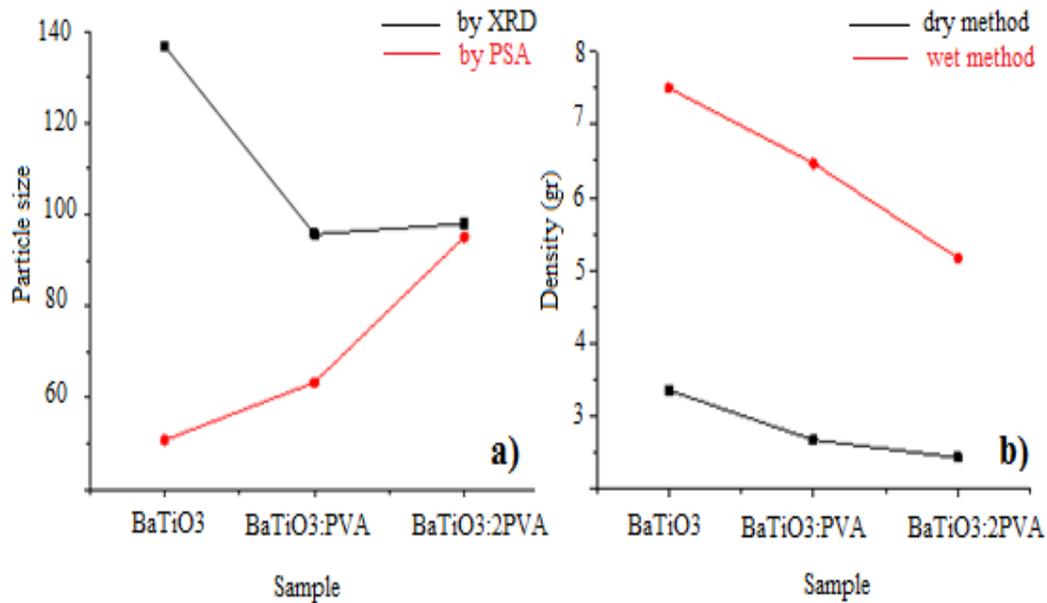


Figure 2. (a) The crystallite size of the Barium Titanate resulted at 800<sup>0</sup>C and  
(b) The density of barium titaanate resulted at 800<sup>0</sup>C

The particle size distribution for all sample were sintered at 800<sup>0</sup>C and it was shown in the Figure 3. Where its results was appropriate with the sol-gel products for get its particles in the nanometers scale. Increases of the PVA inside the composites had been effectively to increases its quantities of particles become absolutely in the nanometers scale. It seems two are sample of BaTiO<sub>3</sub>:Pva and BaTiO<sub>3</sub>:2PVA in which that results absolutely success to creates becomes barium titanate nanoparticles. In the other words, PVA as well as indicates as a catalyst to accelerate that particles formed to be in nanometers scale.

From Figure 4. was seems its grain size of the barium titanate nanoparticles and that is in accordance with the aim of this works. In the other words, this efforts has been made a barium titanate nanoparticles is good and successfully with sol-gel preparation sample. Subsequently by sintered of the sample in effectively at 800<sup>0</sup>C and this indicates that perovskite phases had been optimum occurs.

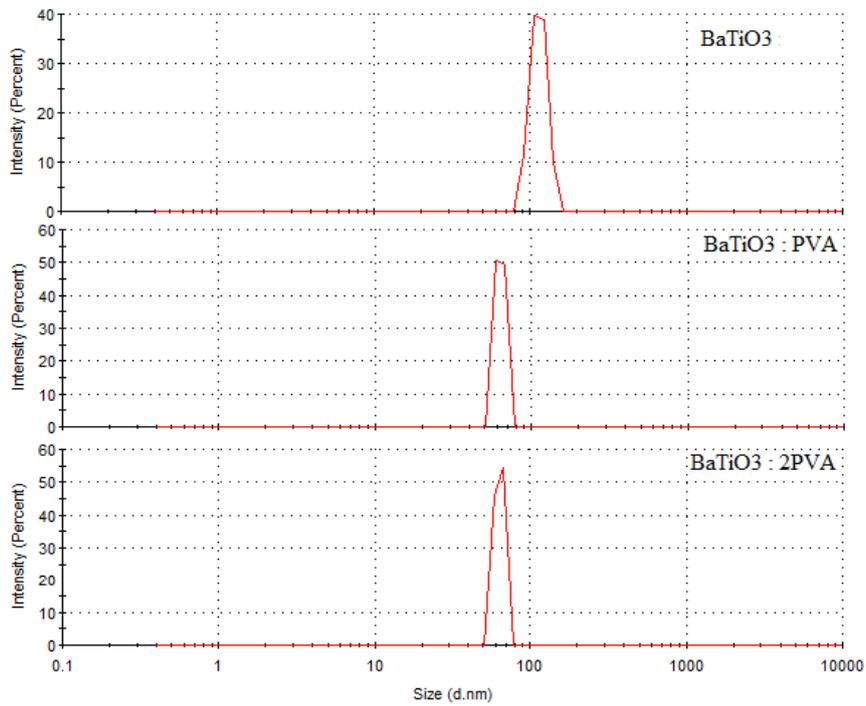


Figure 3. The PSA curves of the barium titanate at 800<sup>0</sup>C (a) for BaTiO<sub>3</sub>, (b) for BaTiO<sub>3</sub> : PVA, (c) for BaTiO<sub>3</sub> : 2PVA

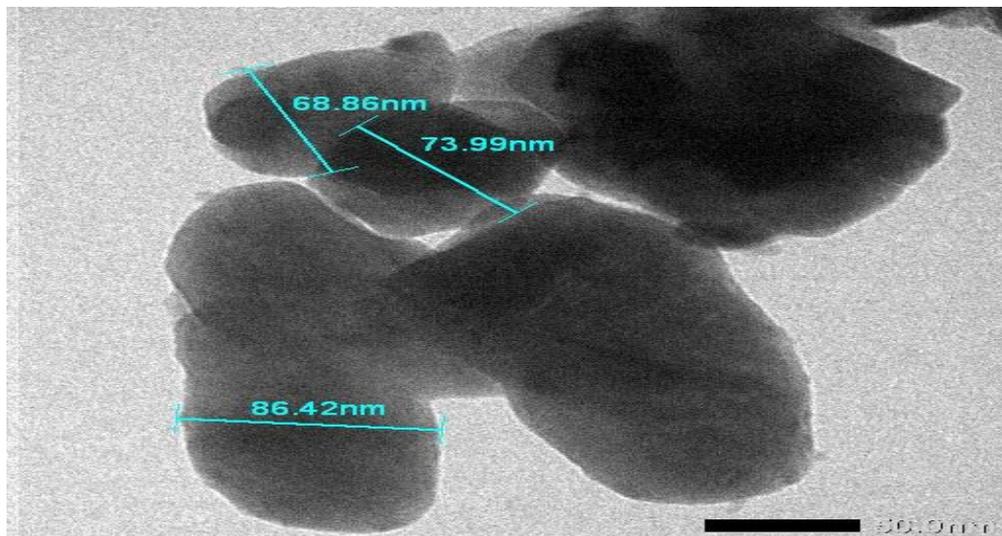


Figure 4. The grain size of the barium titanate nanoparticles of sample were detected by TEM at 800<sup>0</sup>C for BaTiO<sub>3</sub> : PVA

#### 4. CONCLUSIONS

Experimentally was obtained the effects of polyvinyl alcohol on the samples and then its effectively formed to perovskite barium titanate nanoparticle when were synthesis by sol-gel techniques and sintered at 800°C with optimum quantitie. Where by PVA additions inside the composition had been contributed as a catalyst for accelerate its process.

## 5. REFERENCES

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