SYNTHESIS OF BARIUM TITANATE NANOMATERIAL BY CO-PRECIPITATION METHOD AND CHARACTERIZATION

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Abstract: *Barium titanate ($BaTiO_3$) nanoparticles have been synthesized by co-precipitation method. XRD analysis was used to study the structure and estimate the size of the particles. Scanning electron microscopy was used to study the morphology of the material. Thermogravimetric analysis (TGA) of $BaTiO_3$ particles.*

Index Terms: Barium titanate, co-precipitation , nanomaterial, TGA.

I. INTRODUCTION

A material is a chemical substance or mixture of substances may be natural or man-made constitute foundation of technology [1]. Materials Science deals with the study of relationship between, processing structure, and properties of the materials. Nanotechnology is science, engineering, and technology conducted at the nanoscale, which is about 1 to 100nm combines knowledge from the fields of Physics, Chemistry, Biology, Medicine, Informatics, and Engineering. Barium titanate is the inorganic compound having oxides of barium and titanate with the chemical formula $BaTiO_3$ exist in the form of white powder and transparent as larger crystals. It is an dielectric materials due to its high dielectric constant, positive temperature coefficient, and nonlinear optical properties [2-3]. It has five phases as a solid, listing from high temperature to low temperature: hexagonal, cubic, tetragonal, orthorhombic, and rhombohedral crystal structure. All of the structures exhibit the ferroelectric effect except cubic. It is insoluble in water and soluble in concentrated sulfuric acid [4-6].

II. MATERIALS AND METHODS

The analytical grade materials were used to synthesize the required samples.

Synthesis of $BaTiO_3$: The co-precipitation method was adopted to prepare BT nanoparticles.0.1M Titanium tetrachloride ($TiCl_4$) solution and 0.1M $Bacl_2.2H_2O$ solutions were prepared in distilled water and both of these solutions were mixed and stirred for 5 minutes.0.1M solution of oxalic acid taken in 1000ml beaker and stirred for 2minutes and a mixture solution of $TiCl_4$ and $Bacl_2$ was added slowly drop wise from the burette with continuous vigorous stirring for 2 hours. The precipitation was allowed to settle down and dried at room temperature and grinded with mortar and pestle for 10minutes and calcinated for 2hours at 450^{o}C [7].

III. RESULTS AND DISCUSSION

The XRD pattern of $BaTiO_3$ is as shown in Figure-1. The XRD pattern of $BaTiO_3$ reveals crystalline structure of the sample

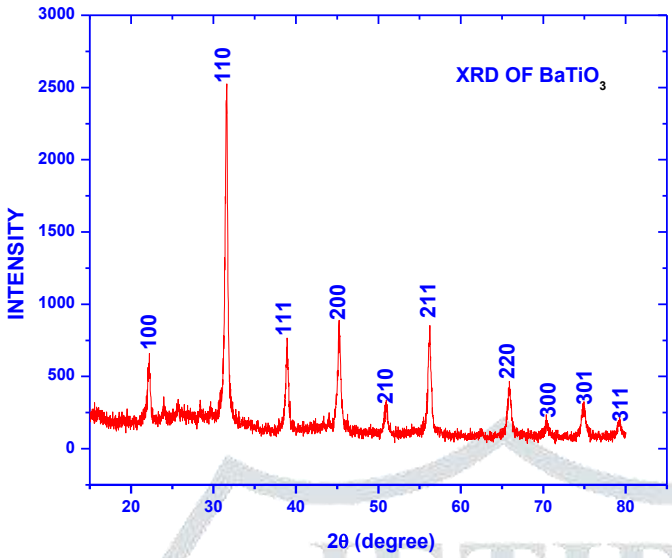

Figure-1: XRD of $BaTiO_3$ nano-material

formation of tetragonal phase of $BaTiO_3$, which is approved by the appearance of X-ray reflections at 2θ values 22.152°, 31.528°, 38.889°, 45.273°, 50.855°, 56.235°, 65.797°,70.586°,74.96° and 79.153° (JCPDS 05-0626). The average crystallite size of the $BaTiO_3$ crystals is estimated to about 20.766 nm by Scherrer's formula.

The SEM image of $BaTiO_3$ particles was obtained to analyze their surface morphology. The SEM photograph $BaTiO_3$ of magnification 20kx ,in Figure-2, indicates the existence of its crystalline structure. Both large and small size particles are appearing corresponding to crystal growth and well dispersion respectively.

The thermogravimetric analysis (TGA) graph of $BaTiO_3$ under heating rate of 10° C min^{-1} is shown in Figure-3. The water weight loss is 2.71% up to the temperature 309°C.The weight loss at the temperature range 310°C to 660°C is 2.84% is due to of entrapped, carboxylates, nitrates, and unburnt carbon. And at the temperature range 660°C to 1000°C weight loss is

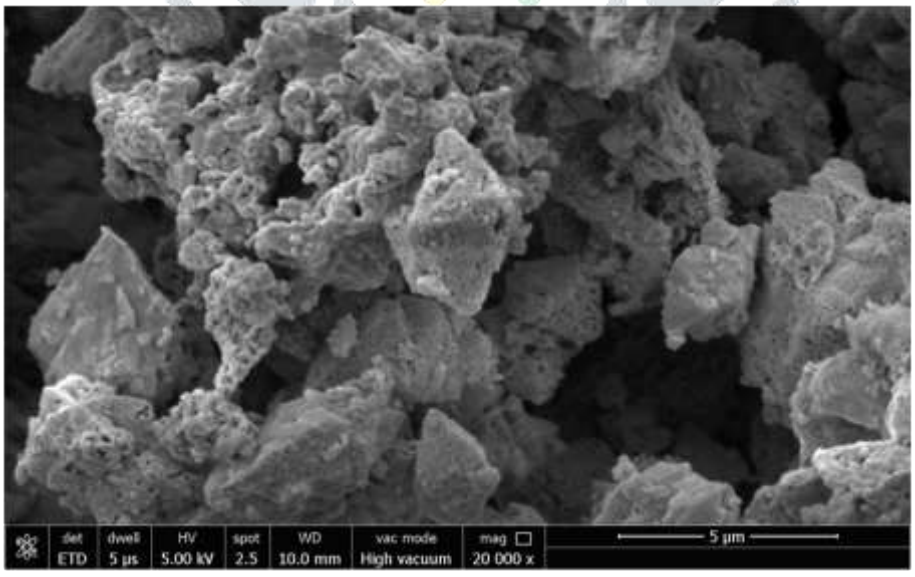

Figure-2: SEM image of $BaTiO_3$ nano-

1.94%due to decomposition of residual $BaCO_3$.

IV. CONCLUSION

The above discussion outlines the synthesis and characteriation $BaTiO_3$ nanomaterial. In this experimental work we have

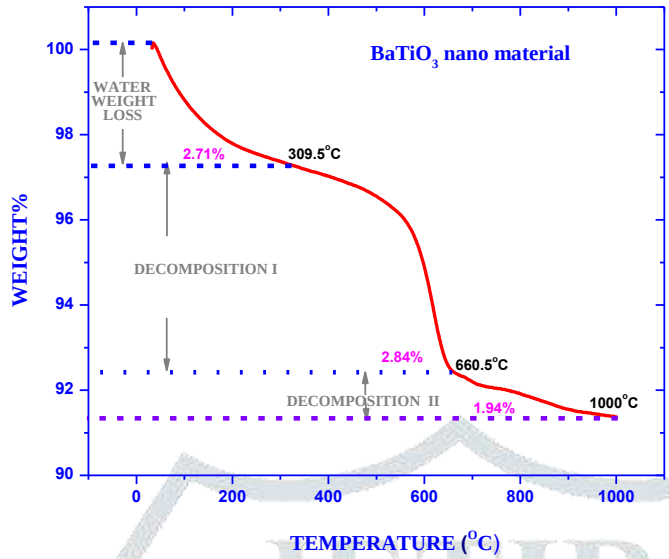

Figure-3: Tthermogravimetric curve of $BaTiO_3$ nano-material

adopted co-precipitation method to synthsize $BaTiO_3$ powder. The particle size estimated as 20.766nm.SEM was used study the surface morphology of $BaTiO_3$ nanoparticles.TGA provides the knowledge of thermal properties of $BaTiO_3$ nanomaterial.

V. Acknowledgements

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