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Synthesis and Characterization of Bismuth Ferrite by Chemical Route

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ABSTRACT

In the present work of bismuth ferrite ($BiFeO_3$) multiferroic Nanoparticles synthesized by Chemical Route followed by thermal treatment at annealed at 300°C, 400°C and 500°C. It is found that $BiFeO_3$ nanoparticles crystallized at annealed 300°C. $BiFeO_3$ nanoparticles with different sizes distributions show obvious ferromagnetic properties, and the magnetization is increased with reducing the particle size. The prepared samples were characterized by X-ray diffraction of powder (XRD), scanning electron microscope (SEM) or extracting their surface morphology and their crystallographic structure and revealed a homogenous size distribution of nanometric Bismuth Ferrite perovskite powders with a grain size of 200 nm which is in well agreement.

Keywords: Bismuth ferrite, Nanoparticles, X-ray diffraction, SEM

INTRODUCTION

Bismuth Ferrite $BiFeO_3$ is also commonly referred to as BFO in materials science. It is an inorganic chemical compound with perovskite structure and one of the most promising multiferroic materials. Bismuth ferrite BiFeO3 (BFO) is one of the most popular research materials in condensed matter physics at present. The room temperature phase of $BiFeO_3$ is classed as rhombohedral belonging to the space group R3C. It is synthesized in bulk and thin film form and both its antiferromagnetic (G type Ordering) Neel Temperature and ferroelectric Curie

temperature are well above room temperature. BFO is much important for novel applications as sensors as well as actuators due to the coupling between magnetic and electric domains above room temperature and accepted high polarization in single crystal.

METHODOLOGY

(i) Chemicals Used: Bismuth nitrate, Ferric nitrate, Citric Acid

(ii) Preparation of BiFeO3 materials by chemical route. A stock solution of 0.2 M Bismuth nitrate in aqueous medium was prepared. The 0.2 M Ferric nitrate solution and 0.2 M

Bismuth nitrate solutions were mixed in a 500 mL beaker under stirring condition. Citric acid was added cautiously. The ammonia solution was then added drop-wise into the mixed solution under continuous stirring condition and a light brownish gel was obtained. The powders obtained from the above procedures were annealed at 300°C, 400°C and 500 °C so that the volatile matters like moisture and other unwanted components were removed. After the complete chemical synthesis and heat treatment of the synthesized products, the sample were characterized using X-ray diffraction (XRD) with a X-ray diffra-ctometer with CuKα radiation (λ=0.154178 nm) and Scanning Electron Microscope (SEM) for extracting their surface morphology and their crystallographic structure.

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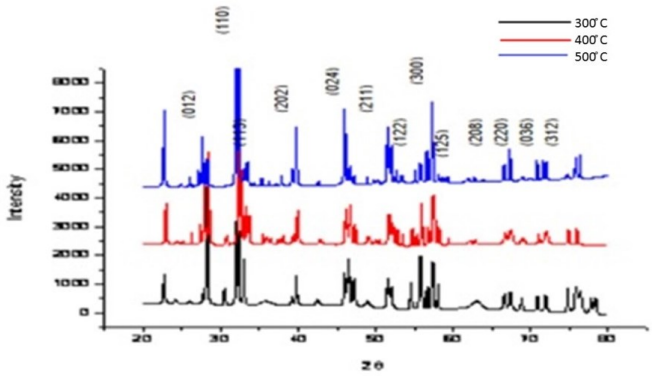
RESULT AND DISCUSSION:

The synthesized bismuth ferrite nanoparticles were characterized by using the room temperature powder X-ray diffraction with filtered 0.154 nm CuKα radiation for their phase analysis studies at different annealed temperatures of annealed 300 ℃, 400 ℃ and 500 ℃. The prominent peaks in XRD plot are indexed to various hkl planes of BFO, indicating formation of BFO. Besides these prominent peaks, some other peaks of low intensity are also observed, which do not belong to BFO. The sample annealed at 500 ℃ is having many extra peaks other than BFO whereas that prepared at 300 ℃ is less impurity peaks. The literature survey of BFO synthesis relates these impurity peaks to be that of BFO. The appearance of these extra phases at 500 ℃ could be due to large bismuth loss at higher temperature. Powder annealed at 400 ℃ is having less impurity phase of BFO, as is evident from the lesser peak height than 500 ℃. The synthesized bismuth ferrite nanoparticles were characterized by using the SEM for revealing their



The proportional increase in particle size is also confirmed by their surface morphology studies

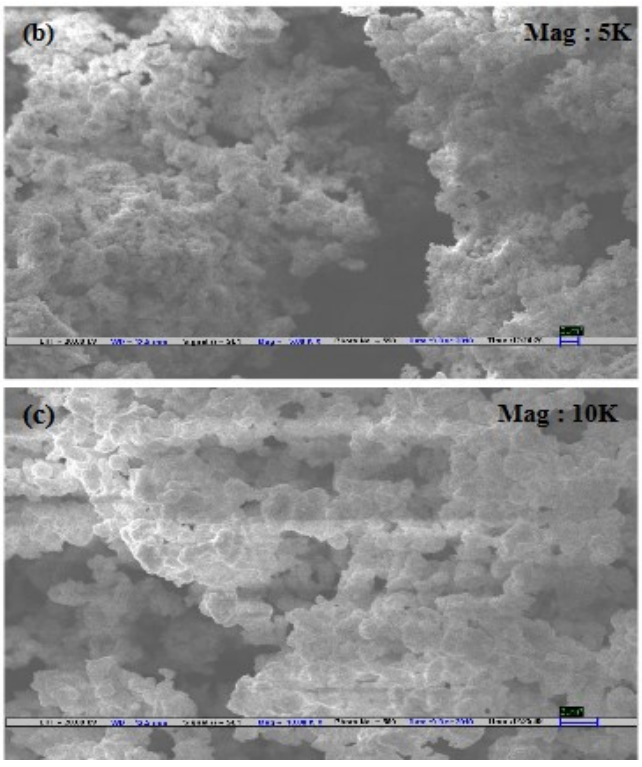


Figure: SEM image of BFO of nanoparticle size of 200nm

surface morphology at different annealed temperatures of 300 ℃, 400 ℃ and 500 ℃. The particle size estimated from SEM images for the BFO sample is about 200 nm for the annealed temperature 300 ℃, 400nm for the annealed temperature of 400 ℃ and 500 nm for the annealed temperature of 500 ℃.

In the reported experiment, bismuth ferrite nanoparticles are successfully synthesized by chemical route method using citric acid. The synthesized bismuth ferrite nanoparticles were characterized by X-Ray Diffraction (XRD) and Scanning Electron Microscope (SEM). The XRD characterization results indicates the rhombo centered structure of bismuth ferrite nanoparticles and the SEM analysis reveals that the diameter of bismuth ferrite nanoparticles changes with thermal treatment and varies from 200 to 500 nm by increasing the annealed temperature from 300 ℃ to 500 ℃. This method avoids using traditional high temperature and therefore could be easily extended to other systems.

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