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Light absorption properties of mesoporous barium hexaferrite, $BaFe_{12}O_{19}$

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ABSTRACT

Light absorption properties are one of the most important characteristics of semiconductor materials, since it is related to particle size, electric resistance, powder density, and dielectric constant. Barium hexaferrite ($BaFe_{12}O_{19}$) particles were synthesized by ceramic and chemical co-precipitation method. Light absorption properties were studied in relation to the particle size, morphology, and surface porosity. The band gap was calculated by the Kubelka-Munk method from the obtained experimental absorption spectrum. Band gap energies of 1.82 and 1.86 eV were estimated for the particles synthesized by the ceramic method and for the co-precipitation method respectively. The results show that both synthesized $BaFe_{12}O_{19}$ samples can be effectively excited with visible light irradiation. In addition to this, due to its other good characteristics such as its magnetic properties, high resistance to corrosion, and chemical stability, make the barium hexaferrite an excellent material for diverse technological applications.

1. Introduction

There are diverse methodologies for the estimation of the band gap energy for semiconductor materials, from optical to electrochemical [1–5]. The most common method used is the diffuse reflectance method, in which the absorption spectrum of the studied material is analyzed [1,2,6]. Semiconductors are mainly used as catalysts, solar cells, lasers, Gamma ray detectors, and electronic devices due to their efficient charge transference and their photon absorption properties [7,8]. Materials as MFe_2O_4, (where, M = Ba, Zn, Fe, Co, Cu, Mn), $BiFeO_3$, $BaFe_{3-x}$, present a band gap energy of ~2 eV, therefore, are efficiently exited under visible light irradiation [9–16] and in addition, has excellent magnetic properties [16–22]. $MFe_{12}O_{19}$ (where, M = Ba, Sr, Cu, Pb) [19,23–25] magnetic properties are known to be highly dependent of the electronic configuration of the substituting cations as well as on their site preference into the structure [26–29]. Barium hexaferrite is a semiconductor material, technologically important due to its low production cost and by its multiple applications as permanent magnets, as high density recording devises, speaker components, electric motors, microwave devices, and recently as catalysts [10,11,15,16,30–32]. In addition, Barium hexaferrite possesses exceptional properties as high Curie temperature, high cohesive strength, high magnetic field anisotropy, chemical stability, and corrosive resistance [30,32,33]. The goal of this work is to synthesize the $BaFe_{12}O_{19}$ by both ceramic and chemical co-precipitation method, and then study and to compare their band gap energy as a part of their optical properties, according to the particle size, morphology, surface area, and porosity.

2. Materials and methods

For the synthesis of the $BaFe_{12}O_{19}$ by the ceramic method, a mixture of barium carbonate and iron oxide was used, then the mixture was sintered at 1473 *K*, as reported by Ataie et al [34]. On the other hand, for the synthesis by the chemical co-precipitation method, barium nitrate and iron nitrate salts were precipitated at pH = 11 and then sintered at 1173 *K*, as reported in our previous work[15].

The $BaFe_{12}O_{19}$ crystalline phase was determined by the use of an X-ray diffractometer Bruker-AXS D8 Advanced with CuK radiation ($\lambda = 1.5406$ Å). The particle size and morphology were studied by Transmission Electron Microscopy (TEM, JEOL

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