



FTIR AND UV ANALYSIS OF $\text{Bi}_2\text{Te}_{2.7}\text{Se}_{0.3}$ MATERIAL

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ABSTRACT

FTIR (Fourier transmission Infrared) is the best method to identify the chemical properties of the material. In this technique IR rays are applied to the sample. Some rays are transmitted and some are absorbed by the material. The molecular structure can be identified by the spectrum. We have used $\text{Bi}_2\text{Te}_{2.7}\text{Se}_{0.3}$ Pure material. The Result identify that $\text{Bi}_2\text{Te}_{2.7}\text{Se}_{0.3}$ materials were more improved data than the Bismuth telluride material. Characterization of the material is very important and on that basis we can applied for the appliocation of that materials in laser diode, Cooling system, optical fiber etc.

KEYWORDS: FTIR, UV Spectroscopy, $\text{Bi}_2\text{Te}_{2.7}\text{Se}_{0.3}$, Material Science, Semiconductor

INTRODUCTION

Thermoelectric materials are widely useful in the power state or used in solid state fields [1]. $\text{Bi}_2\text{Te}_{2.7}\text{Se}_{0.3}$ alloy is one of the best thermoelectric material in room temperature because it has low thermal conductivity in lattice, This effect is very affective on the doping of selenium on the Bismuth telluride material [2]. Analysis of the FTIR properties of a particular material $\text{Bi}_2\text{Te}_{2.7}\text{Se}_{0.3}$, typically involves examining its infrared absorption spectrum to identify the vibrational modes of its chemical bonds and functional groups.[3] Through the use of spark plasma sintering, Kim et al. successfully synthesized a tiny and evenly dispersed $\text{Bi}_2\text{Te}_{3-x}\text{Se}_x$ Nano compound, guaranteeing excellent purity and dense packing[4]. The stoichiometric atomic ratios of selenium (Se), tellurium (Te), and bismuth (Bi) elements were validated by the EDAX analysis. In addition, the TEM pictures showed that there was agglomeration in the powders, indicating a fundamental crystalline size with comparatively tiny dimensions[6]. The characterization of nanostructure materials presents a great challenge as the structured and crystalline dimension are beyond the structural and optical view (Ju and Kim 2016, Nomura et al. 2015, Park et al. 2016). Nanostructured materials are unnaturally formed materials with constitutive phase or grain structures modulated on a dimension less than 100 nm. TE materials hold the key to the essential advancement in energy alteration and storage, both of which are crucial in order to meet the protest of universal heating and the finite nature of fossil fuels [7].

Material Preparation:

Selenium is the doped material which is mixed with the $\text{Bi}_2\text{Te}_{3-x}$ material and make $\text{Bi}_2\text{Te}_{2.7}\text{Se}_{0.3}$ material[8]. For the mixture of material , use of Motel pestle is required. The fine powder is made from the solid material and mixed in the proper ratio and 99.999% pure Sigma-Aldrich material is used. For the Mixture of proper material using of Motel Pestel is used.

In FTIR characteristics we have put the fine powder material

on a probe and analyzed the result. Same as in the UV visible spectroscopy we have mixed a small amount of fine powder in the DMSO (Dimethyl Sulfoxide) liquid and shook well for the mixture and keep this material in the side on the next day we had to characterize the UV visible spectroscopy result. [9]

Experimental Method:

For the FTIR, Fourier transformation infrared spectroscopy is used to analyze the identity of the organic, polymetric or inorganic material. It is also measures the amount of absorption of IR rays. We had used the powder material of the sample and keep for testing. The range of Infradad is taken from 650 cm^{-1} to 4000 cm^{-1} [10,11]

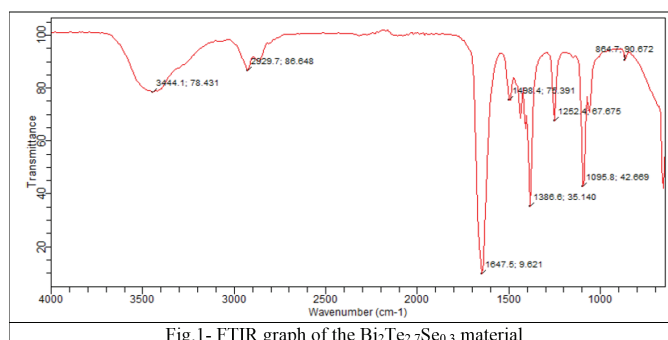


Fig.1- FTIR graph of the $\text{Bi}_2\text{Te}_{2.7}\text{Se}_{0.3}$ material

UV-Vis spectroscopy measures the absorption or reflection of light in the ultraviolet and visible regions of the electromagnetic spectrum (typically 200-800 nm)[12]. When a semiconductor material is exposed to UV-visible light, photons with energy greater than the band gap excite electrons from the valence band into the conduction band, resulting in a characteristic absorption peak[13,14].

In figure-2 graph shows the link between two more factors, wavelength (measured in nanometers, nm), and absorption intensity (measured in electron volts, eV)[15]. The blue line

shows the wavelength trend as a function of absorption energy. The wavelength grows as the absorption energy drops from 20 eV to 1 eV. The equation $E = hc/\lambda$, where E is energy, h is Planck's constant, c is the speed of light, and λ is the wavelength, describes the inverse connection between power and wavelength. This equation is compatible with the observed relationship[16,17,18].

The wavelength increases sharply on the graph at higher energies, but as the energy drops, the wavelength progressively flattens out[18,19].

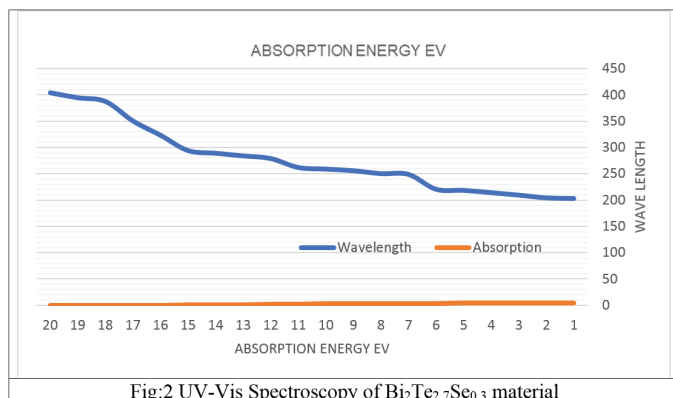


Fig:2 UV-Vis Spectroscopy of $\text{Bi}_2\text{Te}_{2.7}\text{Se}_{0.3}$ material

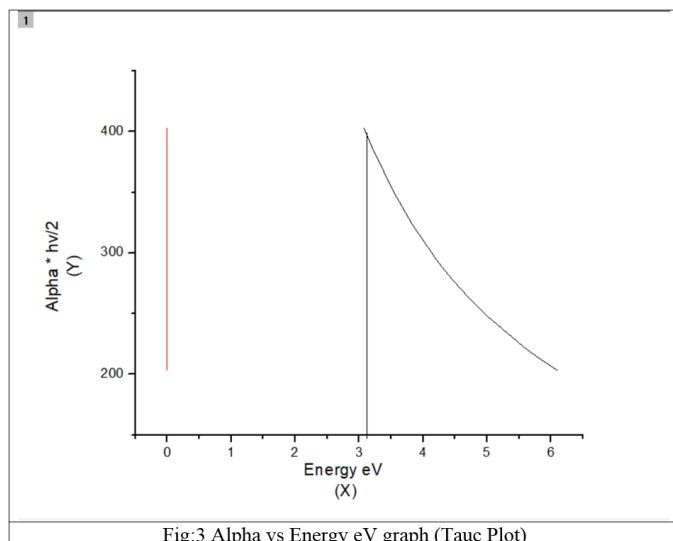


Fig:3 Alpha vs Energy eV graph (Tauc Plot)

RESULT AND DISCUSSION

The infrared range is from 650 cm^{-1} to 4000 cm^{-1} . The presence of conjugated double bonds ($\text{C}=\text{C}$ stretch) and aromatic rings indicates good charge transport properties due to the delocalization of electrons, which is a desirable property for materials used in the organic field[19]. There is a prominent peak at around 222.2 nm with an absorbance of 2.831 , indicating strong absorption at this wavelength. In addition to the peak at 222.2 nm , other peaks around 237.6 nm (1.334) and 258.2 nm (1.18) also show significant absorption[19,20].

The graph shows that absorption energy and wavelength have a definite inverse relationship. The wavelength rises as the absorption energy drops. There appears to be very little absorption in this frequency spectrum, as the absorption intensity is continuously low. The connection between absorption energy, wavelength, and absorption intensity for a particular material is

well visualized by this graph [21]. The most important lesson is that energy and wavelength have an inverse relationship with very little change in absorption intensity. Supplementary data or contextual information about the substance and experimental settings can be added to this study to further enhance it[20,22].

The band gap from the graph is 3.12 eV . A simple and efficient technique for figuring out the band gap energy and researching the optical characteristics of $\text{Bi}_2\text{Te}_{2.7}\text{Se}_{0.3}$ is to use UV-visible spectroscopy[23]. The material's potential for thermoelectric applications is highlighted by the measured band gap energy of around 3.12 eV . These realizations are essential for further refining the material for particular uses in electrical devices and energy conversion.

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