

Studies on the electrical conductivity, optical absorption and x-ray diffraction in bismuth thin film

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Abstract. Spectroscopically pure bismuth is evaporated onto glass substrates at different substrate temperature using a Hind Hivac coating plant. The electrical conductivity of bismuth thin films, prepared at different substrate temperatures is measured and thermal activation energy is evaluated. From the recorded optical absorption spectrum in the ultraviolet and visible regions optical band gap E_g is determined. X-ray diffractograms are recorded and lattice parameters are determined.

Keywords. Thin film; electrical conductivity; optical absorption; x-ray diffraction.

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1. Introduction

Bismuth is a semimetal. Semimetals are a class of solids which are used to probe the Fermi surface and the band structure of the crystalline solids [1]. The narrow band gap of bismuth and its alloys find applications in Hall effect devices, hyper frequency power sensors, thermopiles and microwave detectors [2]. The electrical, optical and structural studies of bismuth thin films have been reported by many authors [3, 4]. But the studies made earlier on bismuth thin films have large inconsistencies. In this paper a systematic study is reported on the electrical, optical and structural properties of bismuth thin film.

2. Experimental

Thin films of bismuth are prepared by vacuum evaporation of 99.999% pure bismuth (obtained from SISCO) by resistive heating method. The evaporation is carried out from a molybdenum boat at a pressure of 10^{-5} torr. Substrate temperature is varied by a controlled variac arrangement and temperature is monitored by a copper-constantan thermocouple. The thickness of the film is determined by Tolansky's interference technique [5]. Electrical connections are given using silver paste and conductivity measurements have been done using a four probe set-up (DFP-02). The conductivity is measured at regular intervals of 5 K in the temperature range 300–525 K. The uv-visible absorption spectra is recorded using Shimadzu 160A spectrophotometer. The analysis of