

Structural Characterization of Lead Sulfide Thin Films by Means of FTIR Analysis after Irradiation of B-ray

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Abstract

PbS semiconductor from IV-VI group, is found to be promising material for its applications in the area of photodetector for IR radiation. The structural properties of PbS thin films have been investigated. PbS thin films have been deposited on suitably cleaned quartz substrates by thermal evaporation method. The structural properties were determined by FTIR recorder spectrometer model Shimadzu were used to measure the transmission and absorption spectra of PbS thin film deposited on quartz substrate in spectral range (400–4000 nm) before and after irradiation of β -rays.

Keywords: PbS thin films, Thermal evaporation method, FTIR, β -ray.

1. Introduction

A variety of physical properties of nanoparticles semiconductors have been reported in the literature [1-5]. Many authors have predicted for nanoparticle semiconductors enhanced nonlinearities resulting from quantum confinement effects [6-8]. The materials application that has attracted considerable attention relates to nonlinear optics [9,10]. Most studied nanocrystalline semiconductors belong to the II-VI and IV-VI groups as they are relatively easy to synthesize and are generally prepared as particles or in thin film form. In the last years, several methods to synthesize PbS nanoparticles, semiconductor from IV-VI group, were studied such as grown in a glass, glass-ceramic, polymer matrix respectively [11-13]. PbS is a semiconductor with band gap about 0.41 eV at room temperature and 0.29 eV at liquid-N₂ temperature. For PbS, the size effect can be observed for a crystallite as large as 180Å, which contains over 10⁵ atoms [4].

2. Experimental Work

Thin films of PbS having thickness around (350) nm were deposited by using vacuum coating unit type (Edward E306A). Test quartz slides, cleaned by alcohol with ultrasonic waves in order to remove the impurities and residuals from their surfaces. The cleaning of quartz substrates is very important process because the influences like oil or dust affect on the thin films properties. First of all, the gadgets of the vacuum chamber were cleaned by acetone. A clean evaporation source – molybdenum boat – was fixed in the filament holder inside the chamber. Stoichiometric PbS powder having purity around 99.99 % was kept in a molybdenum boat. The substrates were cleaned first by acetone. The chamber was evacuated at a pressure better than 10⁻⁵ Torr by the combination of rotary and diffusion pump. When 10⁻⁶ Torr vacuum was attained in vacuum chamber, the heater was connected to the evaporation source was switched on which in turn slowly heated the source of PbS to temperatures greater than the melting point. This allowed the evaporation of PbS material. The thickness of the deposited films was obtained from light-beam Fizeau fringe method. The structural properties were determined by FTIR recorder spectrometer model Shimadzu were used to measure the transmission and absorption spectra of PbS thin film deposited on glass substrate in spectral range (400–4000 nm) before and after irradiation of β -rays.

3. Results and discussion

Fourier transformation-Infrared spectroscopic results give information about phase composition can be established from the infrared (IR) spectra. The following figures show the FTIR spectra of PbS films deposited on glass substrate before and after irradiation of β -rays. Figure (1) (a, b) shows that the absorption peak is around (424.34, 462.92, 509.21, 532.35, 555.50, 586.36, 621.08, 640.37, 671.23, 702.09, 721.38, 763.81, 840.96, 875.68, 910.40, 937.40, 975.98, 999.13, 1018.41, 1045.42, 1076.28, 1099.43, 1165.00, 1207.44, 1249.87, 1311.59, 1330.88, 1357.89, 1392.61, 1419.61, 1454.33, 1512.19, 1554.63) cm^{-1} broken spectra which is related to the formation of PbS molecules before and after irradiation of β -rays at three week.

In all the above results, it is recognized that peak at (331.73, 408.88, 432.03, 486.03, 609.46, 648.04, 740.61, 810.05, 864.05, 887.19, 941.20, 972.06, 1010.63, 1110.92, 1172.64, 1211.21, 1311.50, 1350.08, 1419.51, 1720.39, 1735.81, 1905.54, 1951.83, 12005.83) cm^{-1} are related to quartz substrate.

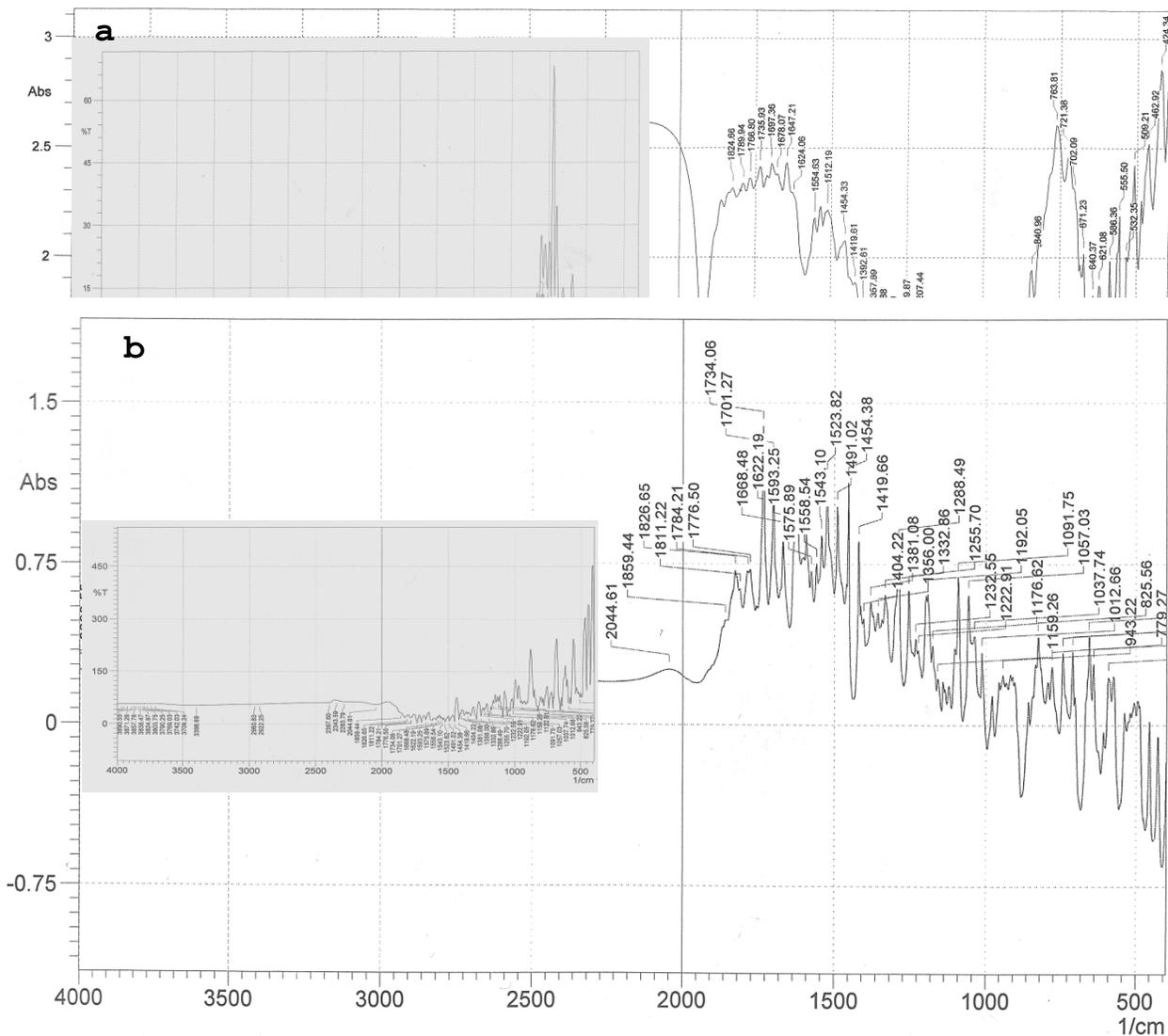


Figure (1) FTIR spectrum of PbS films deposited on quartz substrate at thickness 350 nm of (a) before irradiation of β -rays and (b) after irradiation of β -rays.

CONCLUSIONS

PbS thin films were deposited onto quartz substrate by thermal evaporation technique at 350 nm thickness. The structural properties were determined by FTIR recorder spectrometer model Shimadzu were used to measure the transmission and absorption spectra of PbS thin film deposited on quartz substrate in spectral range (400–4000 nm) before and after irradiation of β -rays.

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