Energy Gap of CdS by Photoacoustic Spectroscopy

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Abstract

Photoacoustic Spectroscopy (PAS) has been set up at Physics Department, KMITL, in order to characterize some interesting materials. The system consists of high intensity broad spectrum light source (Xenon lamp 450 W), PA cell from MTEC model 300, UV-VIS monochromator and lock-in amplifier with chopper. The wavelength selection is usually controlled by HJY Spectrometer Control Program. Cadmium Sulfide (CdS) powder was used as the sample to determine its energy gap. The energy gap of CdS from our experiment is 2.43 eV with respect to 2.42 eV from the accepted value.

Keywords: photoacoustic spectroscopy (PAS), E_g of CdS

1. Introduction

Photoacoustic method is a technique always used and characterized light absorption properties and/or some thermal properties of materials. Many semiconducting powder was previously used for measurement of E_g of materials such as BaS, CuI, CuO by PAS technique [1]. In 2004, sintering kinetics of NiO was investigated by Nikolic *et al*. [2]. A material called "4H-SiC" one of semiconductors for high-power, high-temperature, and high-frequency devices was investigated its band gap energy with respect to theoretical prediction [3] by PAS technique. Savic *et al*. [4] also used PAS method to measure thermal diffusivity and electron transport properties of NTC thermisters. In 2007, Perez Ruiz *et al*. used photoacoustic technique to find velocity of some metals [5]. Carotenoid content in seedlings of maize seeds was also studied [6], and recently, Lim *et al* [7] used the open photoacoustic method to determine the thermal diffusivity of polypyrrole conducting polymer composite films. In this paper, in order to check the system performance, an attempt was made to apply this technique to characterize some optical and thermal properties of interesting materials at Physics Department, KMITL, and the measurement of the energy gap of CdS powder was done.

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2. Experiment with Pas System

In photoacoustic spectroscopy, photoacoustic cell (PA cell) acts as the main part of the system. The light radiation absorption of a sample occurs in PA cell and then show the thermal wave effect. A specially designed microphone is used to detect the pressure wave from air and converts the wave into voltage output. The PAS system in Physics Department, KMITL is shown in a block diagram below (Figure 1).

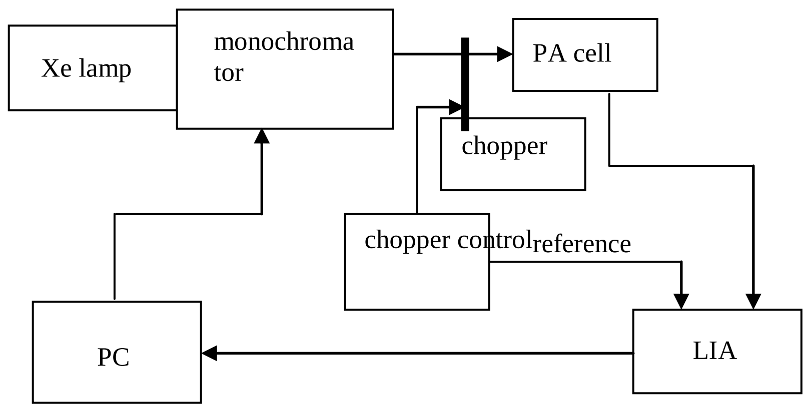

Figure 1 PAS system

In this work, a high intensity 450 watts Xenon lamp is used as a broad spectrum light source. Two gratings UV-VIS Monochromator is used, with the first grating coverings between wavelegths 180-400 nm and the second one working for wavelengths 400-750 nm. The third grating slot is left empty for future near-infrared applications. Lock-in amplifier with chopper is also used as an essential part for a small signal detection from PA cell. Our PA cell is the product of MTEC (model 300), USA. The accompanying program, HJYSpectrometerControl, was used for wavelength selection with 2 nm step in visible region (400-750 nm). Entrance slit and exit slit of monochromator were both selected to be 1.5 mm. Eighty hertz of chopper was selected to use as a reference frequency to lock-in amplifier. Carbon black is always used as a standard sample.

3. Results and Discussion

The spectrum of carbon black and CdS are shown in Figures 2 and 3. Because of being near unity of the absorption coefficient, a source intensity spectrum can be represented by PA signals of carbon black. When signals from CdS powder are divided by signals from carbon black at the same wavelength, then the true signal excluding the effect of source intensity variation is obtained. After the deduction of data [1] we get the energy gap value of CdS equal to 2.43 eV or 510 nm as shown in the Figure 4. That is in agreement with CdS accepted energy gap of 2.42 eV.

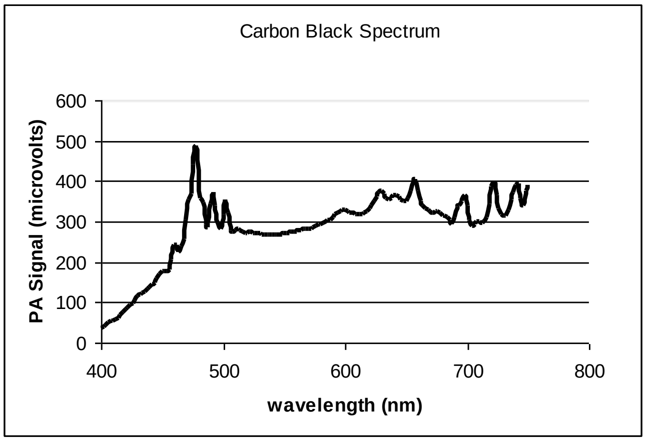

Figure 2 PA Spectrum of standard sample (carbon black).

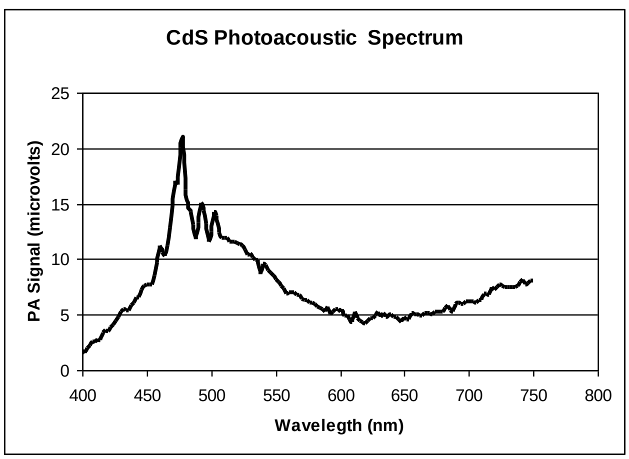

Figure 3 PA Spectrum of CdS.

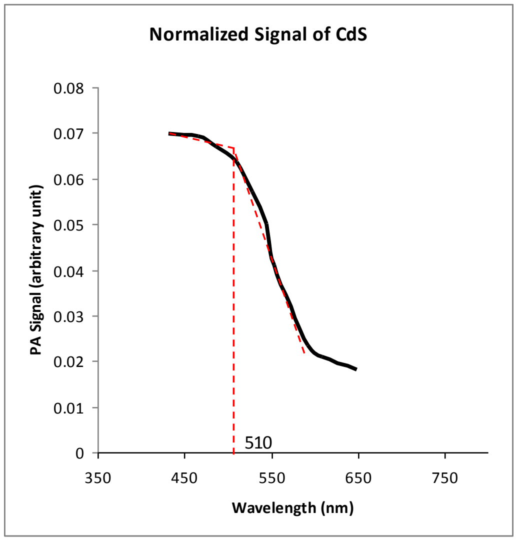

Figure 4 Normalized signals, Vs wavelengths and value of E_g after deduction.

4. Conclusions

Photoacoustic spectroscopy arrangement at the Physics Department, KMITL, was successfully set up. The measurment of Eg of CdS powder made by the arrangement was satisfactory. In the near future, we would like to develop this technique, for more convenience and precision, to fully computerized photoacoustic spectroscopy.

5. Acknowledgement

The authors would like to thank Assoc. Prof. Dr. Jiti Nukaew, Assoc. Prof. Dr. Warawoot Thowladda, Mr. Benchapol Tunhoo, Mr. Amorn Terdsakulwong for their encouragements and suggestions. We also thank Physics Department, KMITL, for facility supports.

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