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Photoacoustic determination of energy band gap of semiconductors

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Abstract. Semiconducting materials are employed in the fabrication of a number of semiconductor devices and opto-electronic detectors etc depending on their properties, state of purity and perfection and energy band gap values. In the present study, a latest and novel photoacoustic spectroscopic technique has been employed for the determination of energy band gap of some semiconductors namely CdS, CdSe, CdTe, ZnS, ZnO, Se and Si in the powder form. Values obtained have been compared with those reported by conventional methods.

Keywords. Photoacoustic spectroscopy; band gap energy; absorption edge.

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1. Introduction

A gap present (Dance 1969) between valence and conduction bands of a semiconductor greatly influences the latter's properties. The determination of energy band gap of semiconductors (Dance 1969; Ray 1969; Smith 1968; Gibson 1958; Nudelman and Mitra 1969) is an important parameter for their applications in research and industry. As most of the semiconductors (Pao 1977) are found in the form of powder and tiny particles of opaque nature, they pose difficulties in their conventional transmission or reflection measurements. In the reflection measurement, the sample should be ground and polished to increase its reflectivity and effective area. In the transmission measurement the sample should be grown into a large and transparent crystal. With the advent of modern technology of forming films of materials, the above difficulties are overcome easily. A method was devised for the determination of absorption band edge by measurement of reflection coefficients of material's film evaporated in the vacuum (O'Bryan 1936). In the case of some semiconductors, the edge of the fundamental optical absorption band can also be estimated by measuring the absorption coefficients at different wavelengths. A criterion for determining the width of the forbidden band in insulators and semiconductors is given by the variation with wavelength of the photoelectromagnetic (PEM) effect (Gibson 1958). The band gap energy of semiconductor used in a p.n. junction can be estimated (Despande 1975) by measuring the saturation current (I_s) at different temperatures T (lower than the room temperature) and the energy band gap is estimated from the shape of the graph $\log I_s$ vs $1/T$, with an accuracy of $\pm 0{\cdot}1$ eV. The other methods for locating the absorption band edge are based on the principles of (i) pressure dependence (Ray 1969) of the absorption edge, (ii) magneto-optical effects and cyclotron resonance measurement (Moss 1961),