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Optical fundamental band-gap energy of semiconductors by photoacoustic spectroscopy

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Abstract: The optical band-gap energy of the semiconductors GaAs, CdSe, Cds, ZnSe and Si doped with P at a concentration of $4 \times 10^{18} cm^{-3}$, are obtained by photoacoustic spectroscopy technique. Excellent agreements are found with the values recorded in the literature.

1. INTRODUCTION

The investigation of optical absorption in semiconductors by photoacoustic spectroscopy (PAS) has been a subject of intensive interest in recent years[1-4], mainly of its importance as a guide in the studies of the band-gap energy which is an important parameter in transistor design[4,5].

In this work, we present the results of optical absorption measurements of some III-V and II-VI semiconductors at room temperature. We have used the well-known PAS to compute the optical band-gap energies of GaAs, CdSe, CdS, ZnSe and Si doped with P, i.e., Si:P system, measured by the microphonic technique in the wavelenght region around the fundamental absorption edge[1-4,6].

1.1 RESULTS OF PA SPECTRA

In Figure 1 we show the photoacoustic spectra for a range of intrinsic direct-band semiconductors in powder form, i.e., GaAs, CdSe, CdS, ZnSe and also for the extrinsic indirect band semiconducting specimen Si doped with P impurity atomos at a concentration of $N = 4 \times 10^{18}$ cm^{-3}. The spectra are obtained at room temperature. The Si:P system was chosen due to its importance as a good device as well as an ideal prototype for studies of effects of disorder[7]. Results for the presented range of energies are in satisfactory agreement with other measurements[1-4,6].
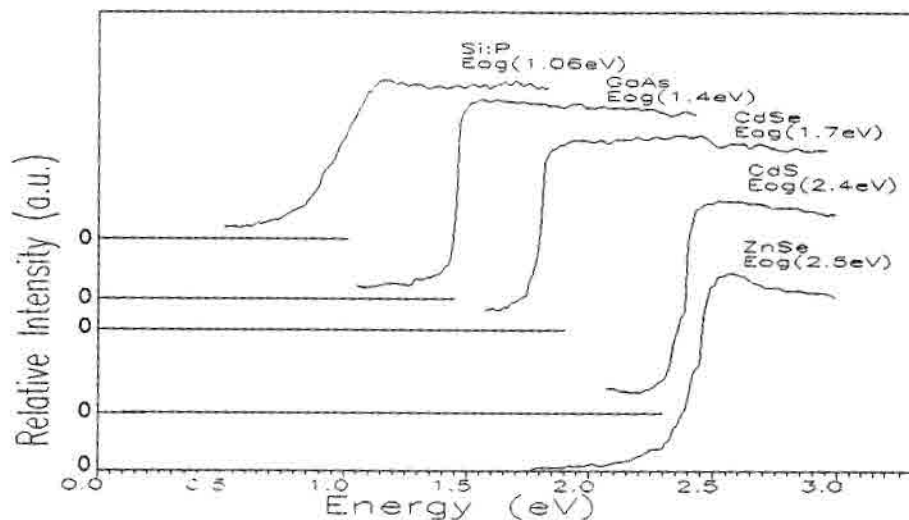

FIGURE 1 · ROOM TEMPERATURE PHOTOACOUSTIC SPECTRA

1.2 RESULTS OF OPTICAL BAND-GAP

The optical band-gap energy is obtained by a spectral shape that is fitted to the absorption spectra of the PA intensity, i.e., Figure 1, as a function of the photon energy $\hbar\omega$. It is represented by the following equation[8,9],

$$\alpha(\hbar\omega) = \lambda\hbar\omega \left[\Gamma^2 + (\hbar\omega - \hbar\omega_o)^2 \right]^{-1/2} + \lambda_o , \tag{1}$$

where Γ is a damping parameter and λ_o is a constant added to correct the possible error on the origin of the data. The values obtained for the optical band-gap E_{og} are: $E_{og}(GaAs) = 1.4eV$, $E_{og}(CdSe) = $?eV, $E_{og}(CdS) = 2.4eV$ and $E_{og}(ZnSe) = 2.5eV$. They are in excellent agreements with the values recorded in the literature[1,3,4,6,8-12]. For the Si:P system we found $E_{og}(Si:P) = 1.06eV$, in agreement with the photoluminescence excitation spectroscopy quoted as $E_{og} = $?eV[13,14].

CONCLUSION

In summary, we have presented a scheme to obtain the optical gap energy of different types of semiconductors by PAS technique. The results agree very well with existing data. Finally we ... that the investigation of the pas can be expanded further ... infrared region of the spectrum giving more detailed ... of other optical properties.

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