Simultaneous thermal and optical characterization of semiconductor materials exhibiting high optical absorption by photopyroelectric spectroscopy

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The development of new techniques for non-destructive testing of the materials is still critical in view of scientific activity and potential application in the industry. Among other issues, the determination of the thermal and optical properties of materials is in the spotlight. The photopyroelectric (PPE) method belongs to modulated techniques where the excitation light intensity varies periodically in time, and the signal is processed with a lock-in phase-sensitivity technique. The PPE method is now a well-established measurement technique for the thermal characterization of condensed matter samples. Mandelis and Zver [1] and Chirtoc and Mihailescu [2] made the first systematic theoretical approach for the PPE technique over thirty years ago.

This work presents the results of the investigations on the thermal and optical properties of materials exhibiting high optical absorption. As test samples, some II-VI binary semiconductors were grown by using the Bridgman-Stockbarger method. The photopyroelectric (PPE) method, in two configurations (calorimetric and spectroscopic), was applied for both thermal and optical characterization of the specimens. The thermal diffusivity was obtained in the back detection configuration (BPPE) with an intensity-modulated laser as an excitation source.

The same detection configuration, but with a tunable light source, provided information about the energy gap, the absorption coefficient, and the investigated sample's thermal diffusivity. The results obtained with these two methods were also compared with the data collected by conventional transmission and luminescence spectroscopies (absorption coefficient, energy gap). The main conclusion is the photopyroelectric spectroscopy (PPES) can provide in one measurement good quality information about the thermal and optical properties of the specimen.

References

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