FAR-INFRARED SPECTROSCOPY OF ELECTRONIC MATERIALS

R. A. Lewis (University of Wollongong, Physics); R. E. M. Vickers (University of Wollongong, Physics); Y.-J. Wang (NHMFL)

Introduction

In general terms we investigated the infrared spectra of electronic materials subject to high magnetic fields with a view to elucidating electronic and phonon states and their interactions. Two classes of materials were studied: semiconductor impurity systems (ZnSe:Li, Ge:B and Si:P) and metamagnetic lanthanum oxides.

Experimental

Measurements were made using a Bruker 113v Fourier spectrometer equipped with globar and Hg light sources and liquid-helium–cooled Si bolometer detector. Appropriate beam splitters were employed to optimize the signal for the various spectral features examined. Experiments at high magnetic field were carried out using the 18 T superconducting magnet and the 30 T resistive magnet. The light was conducted to the sample at field centre via a metal light pipe and a condenser cone. Measurements were made with the magnetic field parallel to the direction of light propagation (Faraday configuration) using nominally unpolarized radiation; in this geometry, **E** is perpendicular to **B**.

Results and Discussion

Excellent results were obtained for the Si:P up to 18 T with B||<111>, while the sample seemed to be slightly misaligned in the 30 T magnet. Strong hybridization of states is observed, notably the $2P_+$-like state interacting successively with the zero-field $3P_0$ and $3P_-$ states at about 5 and 10 T, respectively. For Ge:B good results were obtained for both the bound acceptor state G line as well as the Landau lines for B||<110>. The Landau lines showed some interesting features that were much more complex than expected. For ZnSe:Li the transition states varied little with magnet field but a reanalysis of the zero field spectra enabled a new interpretation of the data. The metamagnetic lanthanum oxides appear to show little variation with field. Further analysis is warranted on all the experimental data.

Conclusions

For Si:P Absorption spectroscopy provides additional information to that provided by PTIS [1] and moreover has been carried out to much higher magnetic fields. Anti-crossing between the $3P_0$ transition and the $4P_0$ transition, and between the $3P_-$ transition and the $4P_0$ transition, has been observed. For ZnSe, on the basis of the data and analysis obtained, we conclude that the origin of the complex structure in the absorption spectrum is the presence of *two* acceptors, Li and As. For Ge:B it is seen that qualitatively the theoretical predictions [2] are in good agreement with the experimental results however, quantitatively, the experimental and theoretical results for some transitions are significantly different.

Acknowledgements

We acknowledge the valuable contribution made to this research effort by D. Smirnov.

References

[1] Yao-Ming Mu, *et al*, Phys. Rev. B, **48**, 10864 (1993).
[2] W. O. G. Schmitt, *et al*, J. Phys.: Condens. Matter, **3**, 6789 (1991).