Title
A Review on Optical Anisotropy

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ABSTRACT

Optical anisotropy describes the phenomenon where light propagating a medium will have differing indices of refraction dependent upon the direction. GaSe, a layer semiconductor, is an anisotropic material, and in particular, is uniaxial birefringent. This short review will discuss the optical properties, namely the anisotropy, of GaSe as evaluated by Seyhan et al., concluding with a discussion of the experimental results.

INTRODUCTION

The phenomenon of optical anisotropy may occur in some materials where light will travel through the medium differently depending upon the direction of propagation. The electromagnetic properties of an anisotropic material differ from those of an isotropic material in that **P** and **D** are not necessarily parallel with **E**, which results in χ and ε becoming tensors for anisotropic materials, as opposed to scalars in isotropic materials[1]. GaSe is an example of an anisotropic material that is also uniaxial birefringent as light propogates differently along the its ordinary index (with two identical indices of refraction) and extraordinary axis (whose index of refraction differs from the other two axes). In GaSe, which is a layer semiconductor which contains a c-axis that is perpendicular to the layer planes.

One method of evaluating birefringence is through photoluminescence (PL) and Fourier Transform Infrared Spectroscopy (FTIR) of the material when the light propagation direction (k) is parallel or perpendicular to the c-axis. This review will focus on the anisotropy of GaSe, evaluated through both PL and FTIR by Seyhan et al[2].

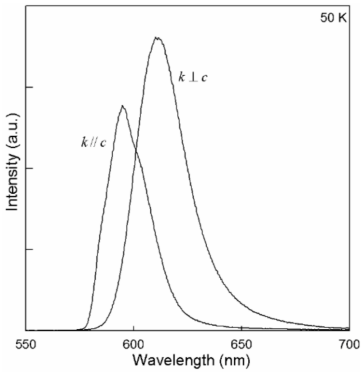

Fig. 1 Photoluminescence spectra of GaSe with respect to k//c and k⊥c axis.

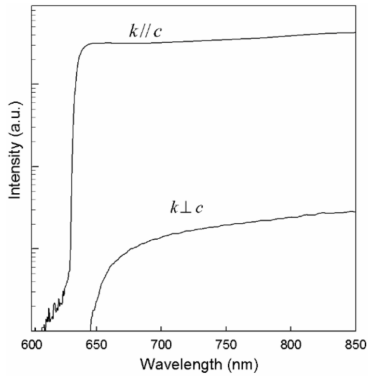

Fig. 2 Transmission spectra of GaSe at room temperature.

RESULTS

In their study, Seyhan et al. studied the anisotropic properties of GaSe using PL emission and transmission spectra. **Figure 1** is the results of the PL spectra. The anisotropy of GaSe is demonstrated through the differing locations of the peaks, with the peak energy of the k//c case 50 meV greater than that of the k⊥c case at 50K[2]. A similar observation can be made for **Figure 2**, where the onset of k//c transmission is seen at 630 nm at 1.97 eV while for k⊥c it is seen at 645 nm at 1.92 eV. These two results are in agreement with each other, supporting the fact that GaSe is anisotropic.

CONCLUSION

By observing the differences in the energy positions of the PL emission band and FTIR transmission edge for GaSe, its anisotropy can be observed. These differences are evidence that anisotropy is an absorption related phenomenon, dictated by the $\boldsymbol{\chi}$ and $\boldsymbol{\varepsilon}$ tensors as previously mentioned in the introduction. Furthermore, the differing peak values when k//c and k⊥c represent the uniaxial birefringence, where the index of refraction, and thus the speed of propagation of light, which is related to the intensity, differ. In particular for this study, k//c had higher energy than k⊥c by about 50 meV as well as an onset at a lower wavelength, reflecting changes that are characteristic of uniaxial birefringence. In conclusion, the uniaxial birefringent properties of the anisotropic material GaSe can be demonstrated through both PL and FTIR analyses.

REFERENCES

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