

High pressure electrical resistivity study on nonlinear bis thiourea cadmium chloride (BTCC) single crystal

S. Aripnammal*¹, R. Selva Vennila², S. Radhika¹, and S. Arumugam³

¹ Department of Physics, Gandhigram Rural Institute, Deemed University, Gandhigram - 624 302, Dindigul District, Tamil Nadu, India.

² Department of Physics, Anna University, Chennai - 600 025, India

³ Department of Physics, Bharathidasan University, Trichy, India

Received 16 September 2004, revised 10 November 2004, accepted 16 December 2004

Published online 15 August 2005

Key words BTCC, electrical resistivity, EDXRD.

PACS 66.61.Hq

The Bis Thiourea Cadmium Chloride (BTCC) crystals have been crystallized by slow evaporation technique. The lattice parameters of the grown crystals have been determined by the Energy dispersive x-ray diffraction technique (EDXRD) and the structure has been confirmed. The high pressure electrical resistivity study have been carried out on this crystal and the results have been reported here.

© 2005 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim

1 Introduction

Nonlinear optics plays an important role in the emerging photonic and optoelectronic technologies. Nonlinear optical (NLO) materials find wide applications in the area of laser technology, optical communication and the optical storage technology. The search for new and efficient NLO materials has resulted in the development of many organic NLO materials with high nonlinear susceptibilities [1,2]. However, their often inadequate transparency, poor optical quality and lack of robustness, low laser damage threshold and inability to grow to large size have impeded the use of single crystal organic materials in practical device applications. Hence, Recent search is concentrated on semiorganic materials due to their large non-linearity, high resistance to laser induced damage, low angular sensitivity and good mechanical hardness [3]. Thiourea possesses a large dipole moment and it forms a number of notable semiorganic materials such as Bis Thiourea Cadmium Chloride (BTCC) [3], Zinc Thiourea Sulphate (ZTS) [4], Zinc Thiourea Chloride (ZTC) and Copper Thiourea Chloride (CTC). The single crystals of these materials have very high laser damage threshold [5]. Motivated by these considerations, the non linear crystal BTCC has been chosen for the present study. Therefore, the high pressure electrical resistivity study has been carried out and the results are presented in this paper.

2 EDXRD

The single crystals of BTCC have been grown by slow evaporation technique. And, they have been analysed by the Energy dispersive x-ray diffraction technique using Rigagu rotating anode x-ray generator. The collected EDXRD pattern is shown in Fig. 1 and the peaks have been indexed by XRD analysis software. The single crystal BTCC has been crystallised in orthorhombic structure with lattice parameters $a=12.8945 \pm 0.0212\text{\AA}$, $b=5.8267 \pm 0.0145\text{\AA}$, $c=6.5207 \pm 0.0162\text{\AA}$ and the cell volume $V=489.916\text{\AA}^3$.

3 High pressure electrical resistivity study

The high pressure electrical resistivity measurements were made by four probe method [6] in Bridgmann anvil setup with anvils made up of EN24 (AISI 4340) alloy steel (Composition : C-0.40%, Mn-0.6%, Ni-1.55%, Mo-0.3%, Cr-1.1% and balance % Fe hardened to RC 60). The working face of the anvil was 10 mm in diameter

* Corresponding author: e-mail: aripnammal@yahoo.co.in

and had a tapering angle of 10^0 . The pressure medium was steatite of 0.2 mm diameter. The gaskets were pyrophyllite discs of 10 mm diameter. A hydraulic press was used to apply the force. Bismuth transition points are used for pressure calibration. The variation of electrical resistivity (ρ) with pressure is shown in Fig. 2.

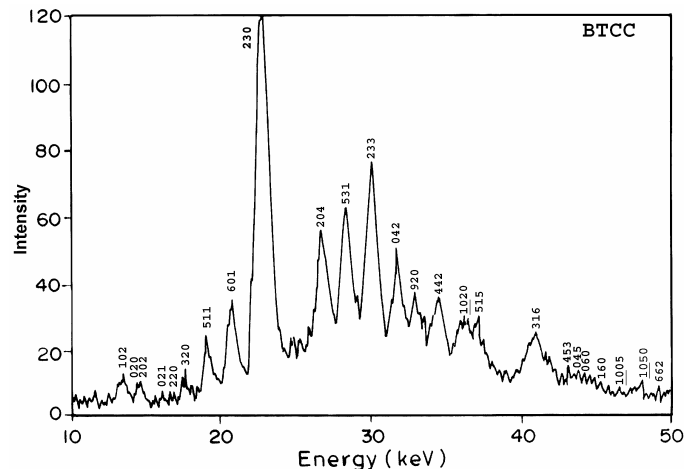


Fig. 1 EDXRD pattern of cadmium thiourea chloride.

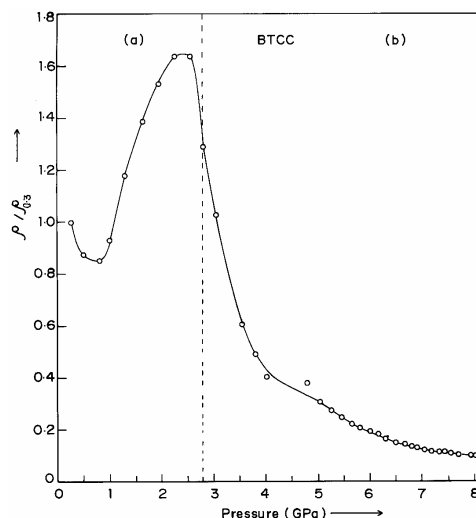


Fig. 2 The electrical resistivity versus pressure.

4 Results and discussion

The EDXRD study shows that the NLO BTCC crystal have been crystallised in the orthorhombic structure. The high pressure electrical resistivity study on the BTCC crystal gives hints for the possible phase transitions. The resistivity first decreases gradually with the increase of pressure. Then, at a particular pressure of about 1 GPa, there is a sharp increase in resistance after which the resistance again drops with the increase of pressure. This is similar to the reported [7, 8] behaviour, observed in SnTe in which the increase of resistivity curve at 1.8 GPa corresponds to first order structural phase transition. It is also notable that the SnTe is also having the same orthorhombic structure. Therefore, the observed discontinuous rise in the resistivity of this BTCC crystal at about 1GPa may be due to the pressure induced phase transition. The similarity of the resistivity behaviour of BTCC below 3.0 GPa (the region left to the dotted line) is well compared with that of reported [7, 8] SnTe. This gives the hints for possible pressure induced phase transitions. The nature of phase transition is to be confirmed by the high pressure x-ray diffraction studies. The smooth drop beyond 3 GPa represents the effect of pressure on the resistivity of the high pressure phase.

5 Conclusions

The BTCC single crystal has been crystallized in orthorhombic structure. The High pressure electrical resistivity study has shown that the resistivity first decreases, then increases sharply and then again slowly drops. The increase of resistivity gives hints for possible pressure induced phase transition whose nature may be confirmed by x-ray diffraction studies.

References

- [1] P. A. Angeli Mary and S. Dhanuskodi, Cryst. Res. Technol. **36**, 1231 (2001).
- [2] R. Rajasekaran, P. M. Ushasree, R. Jayavel, and P. Ramasamy, J. Cryst. Growth **229**, 563 (2001).
- [3] G. Xing, M. Jiang, Z. Shao, and D. Xu., Chin. Phys. Lasers **14**, 302 (1987).
- [4] H. O. Marcy, L. F. Warren, M. S. Webb, C. A. Ebbers, S. P. Velsko, G. C. Kennedy, and G. C. Catela, Appl. Opt. **31**, 5051 (1992).
- [5] V. Venkataramanan, C. K. Subramanian, and H. L. Bhat, J. Appl. Phys. **77**, 6049 (1995).
- [6] N. Victor Jaya, Ph. D. thesis, Anna University (1988).
- [7] J. A. Kafalas and A. N. Marins, Science **143**, 952 (1963).
- [8] S. Aripnammal, C. Venkateswaran, and S. Natarajan, phys. stat. sol. b **197**, K1 (1996).