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GROWTH, MECHANICAL, DIELECTRIC AND PHOTOCONDUCTING PROPERTIES OF BISGLYCINE HYDROBROMIDE NLO SINGLE CRYSTAL

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Abstract. Single crystals of Bisglycine Hydrobromide (BGHB) have been grown by slow evaporation technique. The unit cell dimensions and morphology of the grown crystals are confirmed by single crystal X-ray diffraction. The grown crystals were also subjected to microhardness. The microhardness studies indicate that the Vickers hardness number of the crystal decrease with the increase in applied load. Dielectric constant and dielectric loss measurements were carried out at different temperatures and frequencies. The photoconductivity studies confirm that the title compound has negative photoconductivity nature.

1. Introduction

There is continued demand for nonlinear optical crystals grown to a state of high purity and structural perfection. Unfortunately, there are problems in growing high-quality single crystals of most nonlinear optical materials. Nonlinear optical (NLO) materials are playing a key role in optical fields such as laser frequency conversion and optical parametric oscillators [1].The crystal chemistry of metal borates, both as natural minerals and as synthetic materials with potentially useful physical properties ranging from nonlinear optical (NLO), ferroelectric, piezo- electric to semiconducting behaviors, is of continuing interest [2-4]. In the present investigation, the growth of has been achieved by slow evaporation technique .Characterization studies such as single crystal X-ray diffraction (XRD), microhardness, dielectric and photoconductivity studies have been carried out and the results are presented.

2. Experimental procedure

Bisglycine hydrobromide salt was synthesized by dissolving glycine and hydrobromic acid in the stoichiometric ratio (3:1) in double distilled water. The synthesized salt was purified by successive recrystallization process. Supersaturated solution of Bisglycine hydrobromide was prepared and filtered. The filtered solution was kept beaker covered with porous papers and kept in a dust-free atmosphere. After the period of 24 days, colorless, transparent crystals were obtained and it is depicted in Fig. 1.

3. Results and Discussion

3.1. Single crystal X- ray diffraction. The single crystal X-ray diffraction has been carried out using Enraf Nonius-CAD4 diffractometer. From the measurements we found that the grown specimen of grown single crystal belongs to monoclinic system and the lattice parameters a = 5.38 Å, b = 8.16 Å, c = 18.38 Å and cell volume V = 806.9Å^3.

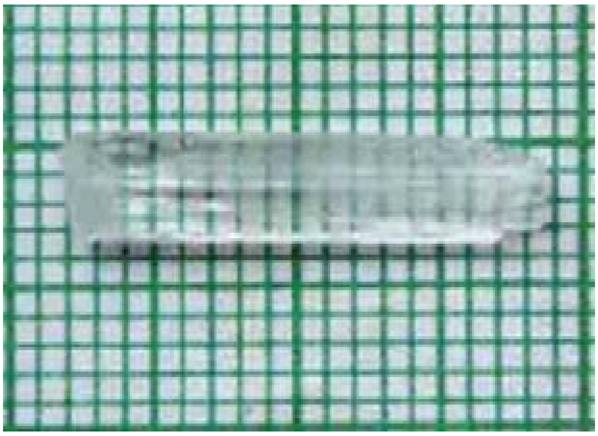

Fig. 1. As grown Bisglycine hydrobromide single crystal.

3.2. Microhardness Property. The microhardness measurements were carried out with a load range from 10 to 100 g on using Vickers hardness tester (LEITZ WETZLER) fitted with a diamond pyramidal indenter and attached to an incident light microscope. The Vickers microhardness number was calculated using the relation,

$$H_v = (1.8544\ P/d^2), \quad (1)$$

where P is the indenter load and d is the diagonal length of the impression. Figure 2 shows the variation of P with Vickers hardness number (H_v) for grown single crystal.

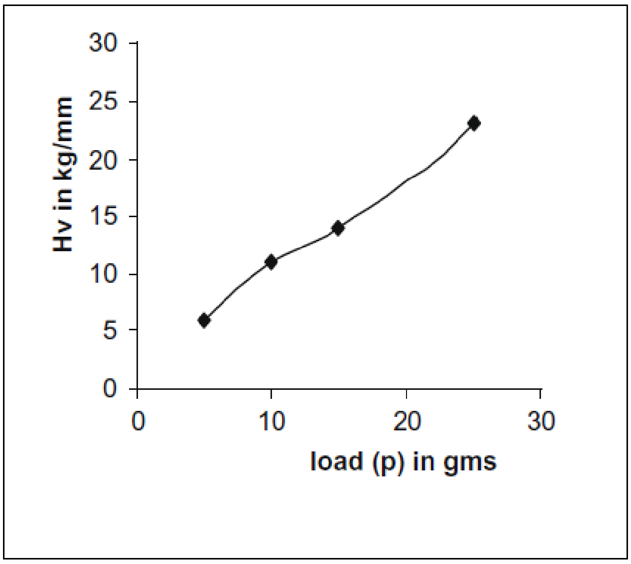

Fig. 2. Variation of *H*v with load *P*.

It is evident from the plot that the Vickers microhardness number decreases with increasing applied load. According to Meyer's law, the relation connecting the applied load is given by

$$P = k_1 d^n, \quad (2)$$

where *n* is the Meyer index or work hardening exponent and k_1, is the constant for a given material. By plotting log *P* against log *d* (Fig. 3), the values of work hardening coefficient was calculated as 1.67, which is less than 2, establishing the crystal to be a hard material. Large value of *n* indicates large effect of dislocations.

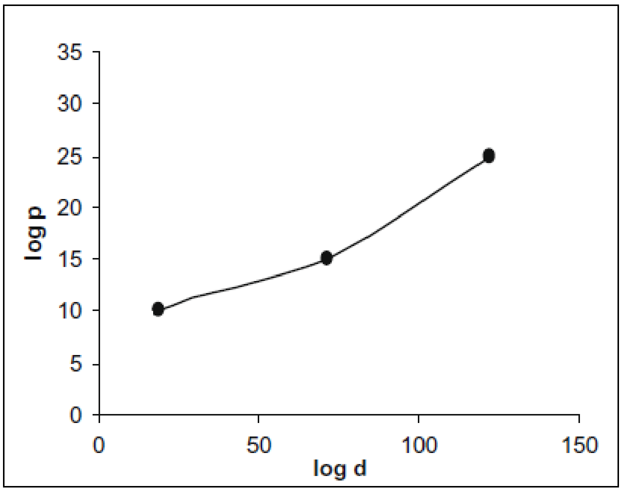

Fig. 3. Plot of log *d* versus log *P*.

3.3. Dielectric studies. The dielectric study on single crystal was carried out on majority plane using the instrument, HIOCKI 3532-50 LCR HITESTER. A sample dimension $1 \times 0.5 \times 0.1$ cm^3 having silver coating on the opposite faces was placed between the two copper electrodes and thus a parallel plate capacitor was formed. The capacitance on the sample is measured by varying the frequency from 50 Hz to 5 MHz and dielectric constant (ε) Vs applied frequency is plotted (Fig. 4). The increase in dielectric constant at low frequency is attributed to the space charge polarization [5]. The dielectric loss is also studied as a function of frequency at different temperatures (Fig. 5). These curves suggest that the dielectric loss strongly depends on the frequency of the applied field, similar to that of dielectric constant which is common in the ionic system [6, 7].

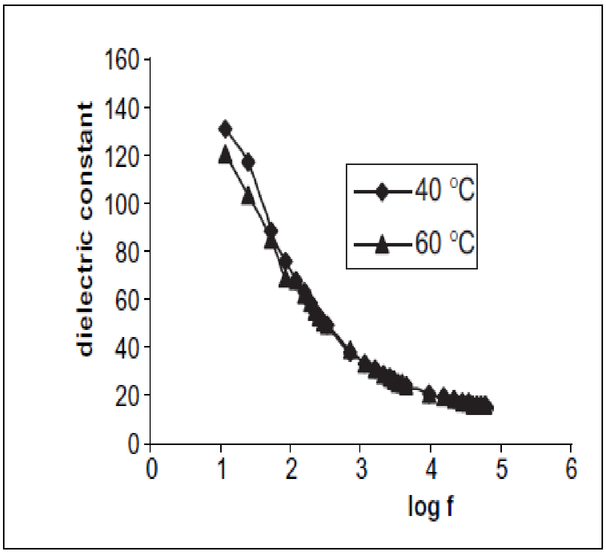

Fig. 4. Dielectric constant versus log f.

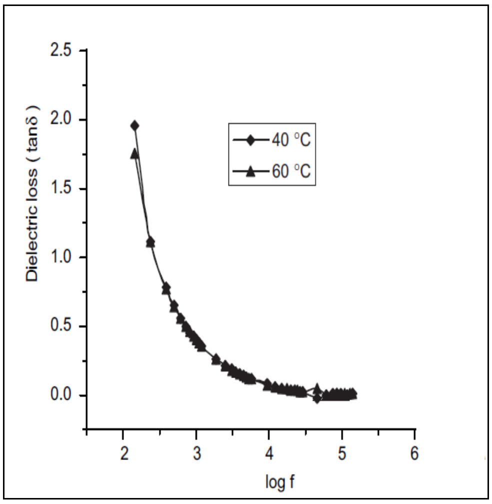

Fig. 5. Dielectric loss versus log f.

3.4. Photoconductivity study. Photoconductivity measurements were made using Keithley 485 picoammeter. The dark current was recorded by keeping the sample unexposed to any radiation. Figure 6 shows the variation of both dark current (I_d) and photocurrent (I_p) with applied field. It is seen from the plots that both I_d and I_p of the sample increase linearly with applied field. It is observed from the plot that the dark current is always higher than the photo current, thus confirming the negative photoconductivity.

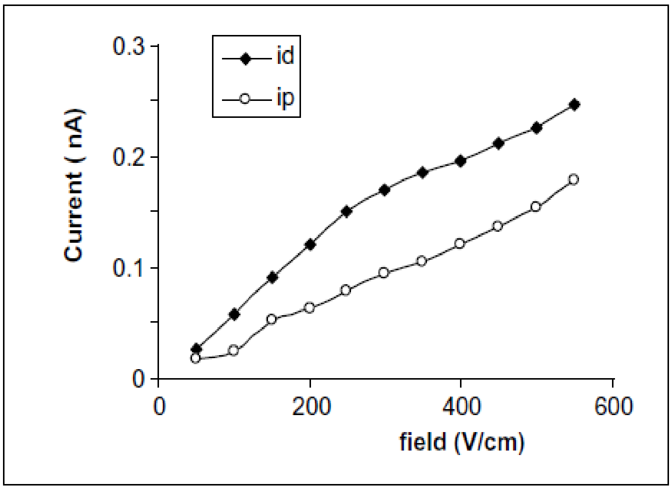

Fig. 6. Field dependent photoconductivity of grown single crystal.

4. Conclusion

Single crystal of bisglycine hydrobromide has been grown by slow evaporation method. The lattice parameters were found by single crystal XRD technique. Single crystal XRD confirms the grown crystal. The microhardness study indicates that the bisglycine hydrobromide crystals belong to the class of hard materials. The variation of dielectric constant and dielectric loss were studied with varying frequency at different temperatures. The photoconductivity study confirms the negative photoconductivity nature of the crystal.

References

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