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Studis on Mechanical Properties of Potential an Organic NLO material- 2-Chloro-N-[4-(dimethylamino) benzylidene]aniline

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Abstract: 2-Chloro-N-[4-(dimethylamino)benzylidene]aniline crystal, an organic optical material, has been synthesized and good optically quality materials were grown by slow evaporation technique. The crystal was subjected to Vickers microhardnessmeasurement to study the mechanical behaviour of the material and Meyer's index number.Surface laser damage threshold energy of the grown crystal has also been studied.
Keywords: Vickers microhardness, organic compounds, laser damage threshold.

1. Introduction and Experimental

The microhardness of a single crystal is a vital parameter to define the strength of the material. This property is basically related to the crystal structure of the material or in other words, the way in which the atoms are packed, and the electronicfactor operating to make the structure stable. Physically speaking hardness is the resistance offered by the crystal for the crystal for localized plastic deformation. Optical breakdown is a common phenomenon observed in the crystals when subjected to high intensities of laser light. Hence, it is necessary to understand the thresholdenergy the crystal for the application purpose. As far as fabrication of the device is concerned, the hardness and laser surface damage threshold values were very essential which inspired us to study the mechanical studies of the grown material.To our best of our knowledge there is no study available on the mechanical properties of the title material by Vickers microhardnessand LDT studies.The mechanical characterization of title crystals was made by Vickers microhardness tests at room temperature. Crystal with flat and smooth faces and free from any visual defects were chosen for the static indentation tests. The surface (101) was polished gently using velvet fabric with methanol and mounted properly on the base of the microscope. Now the selected face was indented gently for a dwell period of 10second by varying the loads using both Vickers indenter attached to an incident ray research microscope (Mitutoyo MH112, Japan).Laser damage threshold measurements are usually carried out by pulsed irradiation. In order to determine the laser induced surface damage threshold a Q-switched Nd:YAG laser (Litron model no: LPY704G-10) (1064 nm, 10 ns, 5 Hz) was used.

2. Results and Discussion

2.1 Vickers microhardness

The Vickers indented impressions were almost diamond pyramid in shape. The shape of the impression is structure dependent, facedependent and also materialdependent. For each load, at least three well-defined impressions were taken, and the average of all the diagonals (*d*) was considered. The Vickers hardness number (H_v) was calculated using the standard formula,

$$H_v = 1.8544P/d^2, \qquad \text{--- (1)}$$

where*P* is the applied load in kg, *d* in mm and H_v is in kg/mm^2. Fig.1 shows the variation of H_v as a function of applied load ranging from 10 g to 100 g for title crystal.

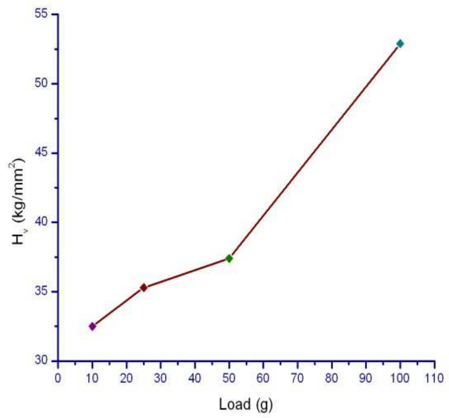

Fig: 1 Vickers hardness number H_VVs Load

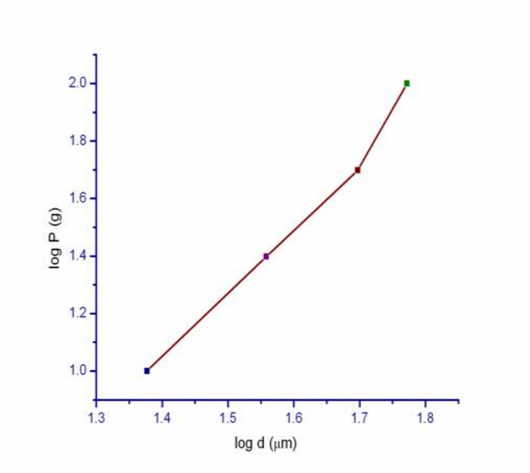

Fig:2 Plot of log P Vslog d

Crack initiation and fragmentation become significant beyond 100 g of the applied load. So hardness test could not be carried out above this load. It is very clear from the figure that$H_v$increases with the increase of load. The Meyer's index number was calculated from the Meyer's law, which relates the load and indentation diagonal length as $P = kd^n$

$$\log P = \log k + n \log d \qquad \text{--- (2)}$$

where k is the material constant and 'n' is the Meyer's index.

In order to find the value of 'n', a graph is plotted for log d Vs log P (Fig.2) which gives a straight line. From the slope of the line the Meyer's index number 'n' was calculated to be 2.44.

From the graph,H_v should increase with the increase of P if n >2 and decrease with same if n < 2. The 'n' value agrees well with the experimental data (Fig.2). According to Onitsch 'n' should lie between 1 to 1.6 for harder materials and above 1.6 for softer materials. Thus, title belongs to softmaterialcategory[1,2].

2.2 Surface laser damage threshold

The laser beam initially focused on the convex lens of focal length 30 cm and then focused into the crystal.The crystal is mounted on a sample holder and slightly kept away from the focal spot of the beam to avoid any possible damage. The beam radius for the 1064 nm wavelength is ascertained to be 0.4mm. Laser operation can be controlled by Gaussian remote control back panel where the energy/volts button controls the output energy of the laser by varying the charge voltage applied to the flash lamp.

The surface damage of the crystals in GW/cm^2 was calculated using the below equation.

$$P = E / \tau\pi r^2 \qquad \text{----(3)}$$

where "E" is the energy in mJ, "τ" is the pulse width in ns; "r" is theradius of the spot in mm. At the damaging spot, one can takevarious features like the melting and solidification in the form of circular blobs adjacent to the damaging site, highly reflecting regions due to cleavage, ablation of material and cracking. The calculated surface laser damage threshold of the crystal was 1.39 GW/cm^2.

Table: 1 LDT study condition

Test type:	Surface laser damage
Sample size:	7 mm × 3 mm × 2 mm
Test conditions:	
Test wavelength:	1064 nm
Pulse repetition frequency:	5 Hz
Pulse width (FWHM):	10 ns
Polarization:	Linear
Test beam profile:	TEM_{00}
Axial modes:	Multiple shots

Conclusion:

The higher LDT shows that the grown crystal has higher mechanical strength which in tune with the higher hardness number (Hv). The higher mechanical strength and lower islocation contentare the foremost reason for the higher LDT.

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References:

1. P.Nisha Santhakumara, S.Kalainathan,ArunaiNambi Raj, Vickers microhardness studies on cadmium mercury thiocyanate (CMTC) single crystal grown in silica gel, Materials letters 62 (2008) 305-308.
2. AmirdhaSher Gill, S.Kalainathan, Microhardness properties of 4-methoxy benzaldehyde N-methyl 4-stilbazolium tosylate, Materials letters 65 (2011) 53-55.

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