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Laser Damage Threshold Data (For 1000 Nm) Of Diethyl 3, 3′-[(2, 4-Dichlorophenyl) Methylidene] Bis (1h-Indole-2-Carboxylate) Nlo Crystals

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ABSTRACT

Anisotropic - Crystalline materials have some important patterns of applications relatively with non crystalline materials. Here Diethyl 3,3′-[(2,4-Dichlorophenyl) Methylidene] Bis (1h-Indole-2-Carboxylate) Crystals are of main applications such as Opto electronic and frequency response, nlo applications. The XRD data make known that Diethyl 3,3′- [(2,4-Dichlorophenyl) Methylidene] Bis (1h-Indole-2-Carboxylate) Crystals have Chemical formula as $C_{29}H_{24}Cl_2N_2O_4$ and Crystal system is Monoclinic, Space group is $P2_1/c$ and parameters are a, b, c (Å) as 9.777, 15.939, 17.582 and β is 101.94. If it is used as 1000 nm as the wavelength, % of LDT rating is 8.57% and possibility of not probable damage and Laser fluence will be 25.5 kJ/m² and Filter LDT will be 29.5k J/m².
Keywords: NLO Laser Damage Threshold

I. INTRODUCTION

A crystalline material is a solid material in which the component atoms are arranged in a definite pattern and whose surface regularity reflects its internal symmetry. The definition of a solid appears obvious, a solid is generally thought of as being hard and firm.

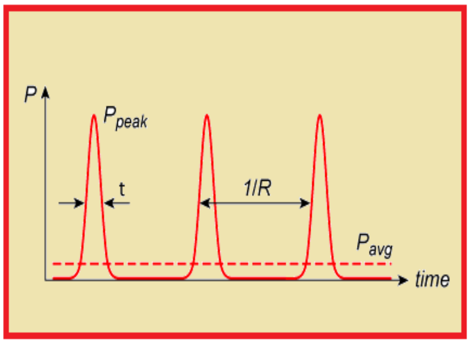

Figure 1. Power Vs Time plot

Fluence and intensity on the surface of the component are critical parameters, the area of the laser spot is also critical. Even very high-power lasers may be transmitted through or reflected off of a durable optical filter if the spot size is sufficiently large to reduce the fluence and/or intensity. The diameter of a laser spot with a Gaussian profile is most accurately measured at the $1/e^2$ intensity points as shown in the diagram below.

Lasers:

LDT is generally specified in terms of pulse fluence for "long-pulse lasers." Long-pulse lasers have pulse durations τ in the nanosecond (ns) to microsecond (μs) range, with repetition rates R typically ranging from about 1 to 100 Hz. Most Semrock filters have LDT_{LP} values on the order of 1 J/cm², and are thus considered "high-power laser quality" components. An important exception is a narrowband laser-line filter in which the internal field strength is strongly concentrated in a few layers of the thin-film coating, resulting in an LDT_{LP} that is about an order of magnitude smaller. As an example, suppose a frequency-doubled Nd:YAG laser at 532 nm emits 10 ns pulses at a 10 Hz repetition rate with 1 W of average power. This laser has a duty cycle of 1 x 10^{-7}, a pulse energy of 100 mJ, and a peak power of 10 MW. If the beam is focused down to a 100 µm diameter spot on the surface of a component, the pulse fluence is 1.3 kJ/cm^2, and thus it will almost surely damage a component with a 1 J/cm^2 LDT_{LP}. However, if the spot diameter is 5 mm, the pulse fluence is only 0.5 J/cm^2, and thus the component should not be damaged. LDT at 532 nm should be about half the LDT at 1064 nm, since the energy of one photon of light at 532 nm is twice that of a photon at 1064 nm. Second, the LDT tends to scale with the square root of the pulse duration τ . For example, a 20 ns pulse should have an LDT that is $\sqrt{2}$ times higher than that for a 10 ns pulse with the same pulse energy. Damage from cw lasers tends to result from thermal (heating) effects. For this reason the LDT_{CW} for cw lasers is more dependent on the material and geometric properties of the sample, and therefore, unlike for long-pulse lasers, it is more difficult to specify with a single quantity. As a very rough rule of thumb, many all-glass components like dielectric thin-film mirrors and filters have a LDT^{CW} (specified as intensity in kW/cm^2) that is at least 10 times the long-pulse laser LDT_{LP} (specified as fluence in J/cm^2). High-power cw lasers often have "hot spots," or portions of the laser beam cross section with significantly higher intensity relative to the nominal intensity. A good rule of thumb is to multiply the nominal laser spot intensity by a factor of at least two to allow for possible hot spots. Quasi-cw lasers are pulsed lasers with pulse durations τ in the femtosecond (fs) to picosecond (ps) range, and with repetition rates R typically ranging from about 10 – 100 MHz for high-power lasers. These lasers are typically mode-locked, which means that R is determined by the round-trip time for light within the laser cavity. With such high repetition rates, the time between pulses is so short that thermal relaxation cannot occur. Thus quasi-cw lasers are often treated approximately like cw lasers with respect to LDT, using the average intensity in place of the cw intensity. Picosecond lasers tend to have relatively large duty cycles (~ 10^{-3}), so the peak powers are not very large. Ultrafast lasers (τ < 100 fs), on the other hand, can have very large peak powers, and the high electric fields associated with these pulses directly attack electronic bonds of dielectric materials causing some very interesting effects. For continuous wave (CW) lasers the damage threshold can be calculated from the peak power and beam diameter. For Ultrafast pulsed lasers in the psec to fsec regime, the electric field of the pulse attacks the electronic bonds of the dielectric coating. Peak powers can be quite high.

II. RESULTS AND DISCUSSIONS

The crystal diethyl 3,3′-[(2,4-dichlorophenyl)methylidene]bis(1H-indole-2-carboxylate) is prepared by slow evaporation method and Ethyl indole-2-carboxylate (1.88 g, 10 mmol) was dissolved in 20 ml ethanol; commercially available 2,4-dichlorobenzaldehyde (0.88 g, 5 mmol) was added and the mixture was heated to reflux temperature. Concentrated HCl (0.5 ml) was added and the reaction was left for 1 h.

After cooling, the white product was filtered off and washed thoroughly with ethanol. The reaction was monitored, Colorless block-like crystals of the designation compound suitable for X-ray analysis were obtained in 92% yield by slow evaporation of an ethanol solution.

In the title compound, $C_{29}H_{24}Cl_2N_2O_4$, the mean planes of the two indole ring systems (r.m.s. deviations = 0.1249 and 0.0075 Å) are approximately perpendicular to one another, with a dihedral angle of 80.9 (5)° between them. The benzene ring is inclined to the mean planes of the two indole ring systems by 76.1 (3) and 78.3 (4)°. Weak intramolecular C—H⋯π interactions affect the molecular conformation. In the crystal, pairs of N—H⋯O hydrogen bonds link the molecules into inversion dimers which are further linked into supramolecular chains by N—H⋯O hydrogen bonds and short Cl—Cl contacts. Fig.3.1

represents the atomic arrangement of diethyl 3,3'-[(2,4-dichlorophenyl)methylidene]bis(1H-indole-2-carboxylate).

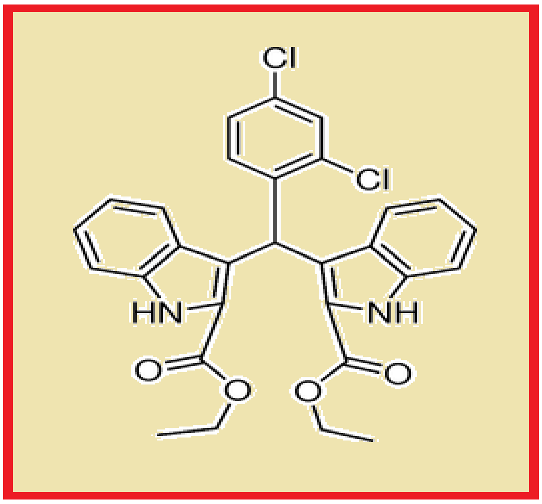

Figure 1. $C_{29}H_{24}Cl_2N_2O_4$ atoms arrangement

Crystal data

Chemical formula	$C_{29}H_{24}Cl_2N_2O_4$
Crystal system, Space group	Monoclinic, $P2_1/c$
Temperature (K)	298
a, b, c (Å)	9.777, 15.939, 17.582
β	101.94°
Crystal size (mm³)	0.30 × 0.20 × 0.10

The XRD data reveals that diethyl 3,3'-[(2,4-dichloro-phenyl) methylidene] bis (1H-indole-2-carboxylate) is monoclinic in type and $P2_1/c$ group and from LDT it specifies that for 1000nm LASER damage not probable and for higher nm LASER damage is probable.

III. CONCLUSION

Diethyl 3,3'-[(2,4-dichlorophenyl) methylidene] Bis-(1h-indole-2-carboxylate) crystals are grown by slow evaporation method and here the grown material is subjected to XRD and LDT and from that it is monoclinic in nature can be analysed and for pulsed lasers in the range of μsec to nsec, the energy density varies as a function of the square root of the time domain. As a rule of thumb, an optic can withstand 10 times more energy when used with a 1 μsec pulsed laser than a 10 nsec pulsed laser. Chemical formula is $C_{29}H_{24}Cl_2N_2O_4$ and Crystal system is Monoclinic and Space group is $P2_1/c$ and Temperature (K) as 298 and parameters are a, b, c (Å) as 9.777, 15.939, 7.582 β is 101.94°and Crystal size (mm³) 0.30 × 0.20 × 0.10. Laser MuX with Long pulse type with wavelength of 1000 nm and Energy 50J duration of 25ns and Rate of Repetition of 50MHz and diam of beam 50mm will produce. The single and multiple shots (10 pulses) laser damage threshold values were found to be 3.68 and 3.5 GW/cm² respectively. If it is used as 1000 nm % of LDT rating is **8.57%** and possibility of not probable damage and Laser fluence will be **25.5 kJ/m²** Filter LDT will be **29.5 kJ/m²**, If it is used as higher nm % possibility of damage is probable.

IV. REFERENCES

[1]. Bridgman P.W., 'Some properties of single metal crystals', proc. Nat. Acad. Sci. 10,411,(1925) Becker.R and Doring.W, Ann.physik 24,719,(1935)

[2]. Czochralski Z,`Measurement of velocity of crystallization of metals,Z.Physik.Chem.,92,219,(1918)

[3]. BridgmanP.W, Some properties of single metal crystal',Pro.Nat.Acad. Burton.W.K, Cabrera.N, and Frank.F.C., Phil. Trans. Roy, Soc.A243,299 (1951)

[4]. Buckley.H.E,`Crystal Growth',Chapman and Hall,London (1952)

[5]. Elmer.T.H, Am.Ceram.Soc.Bull.32,23, (1953)

[6]. Cabrera.N, Levine.M.M,Phil.Mag. 1,450, (1956)

[7]. Campbell.J.E, High Temperature Technology, Wiley, New York, (1959)

[8]. Bennema.P, Ph.D Thesis, Tech. Univ. Delft, Groningen, Netherlands (1965)

[9]. Bravais.A,Etudes Cristallographique, Paris, Cauthier Villars, (1966)

[10]. Bennema.P, Kern.R and simon.B, Phys.Stat.Sol.19,211,(1967)

[11]. Adamski.J.A, powell.R.C and Sampson.R.L, ICCG Brmingham, 246,(1968)

[12]. Aleksandrov.V.I, Osiko.V.V, Tatarinstev.V.M, Synthesis of laser materials from the melt by direct radio frequency in a cold container, Otchet FIAN, Moscow, (1968)
[13]. Bachmann.K.J, Krisch.H.J, and Vetter.K.J, J.CrystalGrowth,7,290, (1970)
[14]. Cockayne.B and Gasson.D.B,J.Materials Sci. 5,837,(1970)
[15]. Dessaur.R.G, Patzner.E.J, and Poponik.M.R, U.S.Patent 3,493,770, (1970)
[16]. Eickhoff.K and Gurs.K. J.Crystal Growth, 6,21,(1970)
[17]. Ankrum.P.D, Semicondutor Electronics, prentice-Hall, Jersey, (1971)
[18]. Domey.K.F, Solid State Tech.41 (1971)
[19]. Bardsley.W, Green.G.W, and Hurle.D.T.J,J. Crystal Growth, 16,277, (1972)
[20]. Bennema.P and Gilmer.G.H, Kinetics of Crystal Growth, in ``Crystal Growth:An Introduction``, Ed.P.Hartman, North Holland, Amsterdam (1973)
[21]. Brice.J.C,`The growth of crystals from liquids', North-Holland Publishing Company, Amsterdam,(1973).
[22]. Brice.J.C.`The growth of crystals from melt',North-Holland Publishing company, Amsterdam,(1973)
[23]. Chara.M and Reid. R.C, `Modeling crystal growth rates from solutions' Prentice-Hall (1973)
[24]. Diggs.T.G,Hopkins.R.H and Seidensticker.R.G.J.CrystalGrowth, 29, 36(1973)
[25]. Bardsley.W, Hurle.D.T.J, and Joyce.C.G, J.Crystal Growth,40, 33,(1974)
[26]. Bardsley.W, Green.G.W, Holliday.C.H, Hurle.D.T.J, Joyce.C.G, Macewan.W.R and Rufton.P.J, Inst.physics(London) Conference Series No.24,355,(1975)
[27]. Cadoret.R, Cadoret.M.J. Crystal Growth, 31,142,(1975)
[28]. Elwell.D and Scheel.H.J, `Crystal Growth from high temperature solutions'Academic press, London(1975)
[29]. Carruthers J.R, J.Electrochem.Soc., 114,959, (1976)
[30]. Aleksandrov.V.I, Osiko.V.V, Prokhorov.A.M, Tatarinstev.V.M, Synthesis and crystal growth of refractory materials by melting in a cold container, in current topics in materials science, Vol.1, Ed.E.Kaldis, North Holland publishing company, (1978)
[31]. Brandle.C.D, in `Crystal Growth:A tutorial approach`, Eds.W.Bardsley,
[32]. Binsma.J.J.M, `Crystal growth and defect Chemistry of CuInSe2(Thesis)`, University of Nijmegen, Nijmegen, (1981)
[33]. Chowdari.B.W.R and Ravisekhar.Y,J.Chem.Phys. 75(6),2513, (1981)
[34]. Fink.H.W and Ehrlich.G, Surf.Sci. 110, L611, (1981)
[35]. Anuradha.P, Ramkrishna Murthy.M and Bhagavan Raju.I.V.K, Phys.Stat. Sol (a), 74,K93, (1982)
[36]. Chandra.B.P, Cry.Res.Techno. 17,505,(1982)
[37]. Bhat.H.L,Roberts.K.J and Sherwood.J.N, J.Appl.Cryst.,65,390,(1983)
[38]. Dieppe.P and Calvert.P,`Crystals and Joint diease', Chapman and Hall, London,(1983)
[39]. Brice.J.C,`Crystal Growth Processes' Halsted Press, John Wiley and sons, New York(1986)
[40]. Desai.C.C and Ramana.M.S.V,J.Crystal Growth, 91,126, (1988)
[41]. Chang, Y.-C., Riby, J., Chang, G. H., Peng, G.-F., Firestone, G. & Bjeldanes, L. F. (1999). Biochem. Pharmacol. 58, 825–834.
[42]. Enraf–Nonius (1994). CAD-4 EXPRESS. Enraf–Nonius, Delft, The Netherlands.
[43]. Ge, X., Fares, F. A. & Yannai, S. (1999). Anticancer Res. 19, 3199–3203.