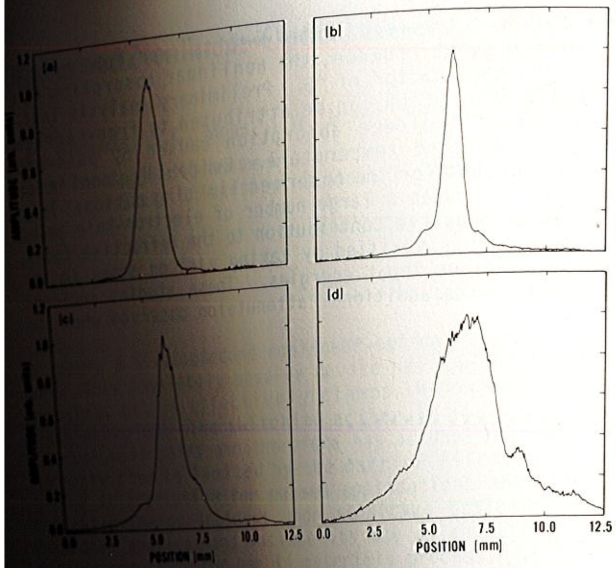

Fig. 3 Spatial beam profiles in the plane of the aperture with (a) the Si removed and with the Si at (b) -6 cm, (c) 0 cm, and (d) +6 cm from the focus of L_1. The fluence was fixed at ~130 mJ/cm^2 for scans (b)-(d)

obviously narrows. Finally, with the Si 6 cm beyond focus, we observe extreme overall broadening of the beam. If the limiter is operated with the Si in this latter position, it should be possible to decrease the energy at which limiting begins while simultaneously increasing the energy at which single-shot melting occurs.

References

1. R. C. C. Leite, S. P. S. Porto, and T. C. Damen, Appl. Phys. Lett. 10, 100 (1967).
2. M. J. Soileau, W. E. Williams, and E. W. Van Stryland, IEEE J. Quantum Electron. QE-19, 731 (1983).
3. J. E. Bjorkholm, P. W. Smith, W. J. Tomlinson, and A. E. Kaplan, Opt. Lett. 6, 345 (1981).
4. [illegible] Hill, C. Parry, and A. Miller, Opt. Commun. 43, 151 (1982).

Nonlinear Absorption and Nonlinear Refraction Studies in MEBBA

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In this paper we report measurements of nonlinear absorption and optical self-action (self-focusing) in 4-methyl benzylidene 4'-n-butylaniline (MEBBA) with picosecond pulses at 0.53 μm and 1.06 μm. P_2, the second critical power for self-focusing [1], was measured as a function of pulsewidth (37 to 150 psec FWHM) and polarization state at 0.53 and 1.06 μm. This material, a new liquid crystal, was found to have a critical power lower than CS_2 for 125 psec pulses at 0.53 μm (indicating that n_2 is larger than that for CS_2).

Large nonlinearities have been previously reported in liquid crystals and such materials have been used in cw 4-wave mixing experiments [2]. These large n_2's are due to light induced reorientation of the large anisotropic liquid crystal molecules (a slow process). Roa and Jayaraman have reported measurements of n_2 in MBBA with 20 nsec ruby laser pulses [3]. Their value of n_2 was approximately 20 times that of CS_2 for similar conditions.

P_2 was measured using the technique shown in figure 1 and described in detail in reference 4. A lens (L_1) is used to focus light into the liquid crystal and a second lens (L_2) reimages the transmitted light through an aperture. Transmission through the aperture abruptly changes as P_2 is reached. The transmission is lowered by both self-focusing and the subsequent plasma formation. Figure 2 is an example of such laser induced switching for CS_2 and MEBBA at 0.53 μm with 125 psec pulses. The switching power was found to be independent of the focal length of L_1, at both wavelengths used, indicating that the dominant nonlinear process is self-focusing [4]. The P_2 for MEBBA at 0.53 μm is approximately 80 times smaller than at 1.06 μm for the same pulsewidth. Self-focusing theory predicts only a change of four between the two wavelengths. This large

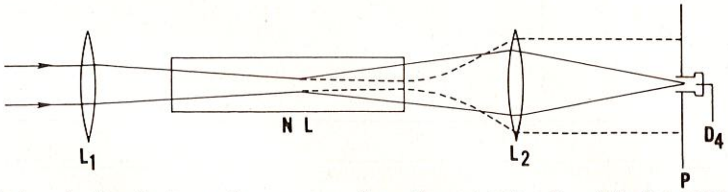

Fig. 1 Technique for measuring the onset of self-focusing. The solid lines schematically trace the input beam for low input power. The beam is focused into the nonlinear medium by lens L_1 and then imaged by L_2 through an aperture onto detector D_4. The transmission for low input powers can be near unity. As the input power is increased to approximately P_2, the critical power for self-focusing [1], the beam undergoes severe phase aberrations (i.e., nonlinear refraction) and the transmission through the aperture decreases. The high power situation is shown schematically by the dotted lines.

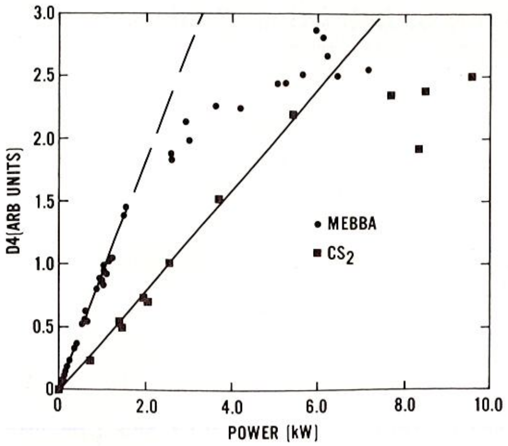

Fig. 2 Nonlinear optical switching in CS_2 and MEBBA (4-methyl benzylidene 4'-n-butylaniline). D_4 is the reading of a detector behind an aperture through which the beam transmitted through the nonlinear medium is imaged. D_4 is linear with input power until P_2 is reached. P_2 for the methoxy variation (MBBA) of this molecule is over an order of magnitude larger for similar conditions. The data shown are for 125 psec (FWHM), linearly polarized 0.53 µm pulses.

dispersion means that the mechanism responsible for nonlinear refraction with picosecond pulses is not simply molecular reorientation. The larger nonlinearity at 0.53 µm may be due to the onset of nonlinear absorption.

Nonlinear absorption in MEBBA was observed at 0.53 µm and the results are plotted in figure 3. This figure is a plot of the inverse transmission as a function of the incident irradiance (expected to be nearly linear for two-photon absorption). Within the uncertainties of the experiment no pulsewidth dependence of the nonlinear transmission was observed. The two-photon absorption coefficient extracted from this data is 0.4 ± 0.1 cm/GW. No nonlinear absorption was observed at 1.06 µm up to irradiances where there was obvious breakdown of the material.

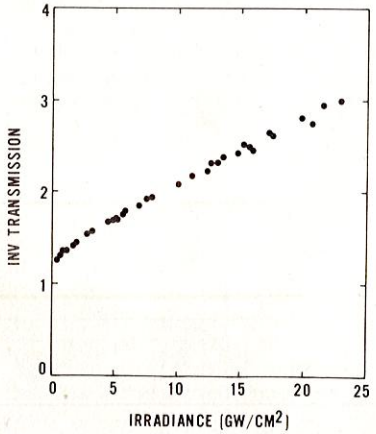

Fig. 3 The inverse of the transmission of a 0.5 cm pathlength cell filled with MEBBA is plotted as a function of the incident irradiance of 0.53 µm, 30 ps (FWHM) pulses. The nearly linear dependence is indicative of two-photon absorption.

The relatively large and relatively fast nonlinearity in MEBBA indicates that this material could have important applications in areas of picosecond optical switching, phase conjugation and optical bistability.

1. J. H. Marburger, Progress in Quantum Electronics, J. H. Sanders and S. Stenholm, eds., New York: Pergamon, 1977, pp. 35-110.

2. Khoo, I. C., Phys. Rev. A, 25, 1040, 1982.

3. D. V. G. L. Narasimha Rao and S. Jayaraman, Appl. Phys. Lett., 23, 539, 1973.

4. M. J. Soileau, W. E. Williams, and E. W. Van Stryland, IEEE Jour. Quant. Elec., QE-19, 4, pp. 731-735, 1983.