# Nonlinear refraction of Coomassie brilliant blue dye in PVA matrix

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Materials exhibiting nonlinear optical behaviour have been attracting intense interest in recent years due to their applicability in a variety of optical devices. Devices based on these materials exploit various types of nonlinear behaviour, including scattering, two-photon absorption, self-focusing and self-defocusing. Among these, optical limiters or optical power limiters (OPL) form a class of promising devices, which finds its application in radiation damage protection of sensitive optical detectors. Defocusing optical limiters based on nonlinear refractive effects make use of the ensuing distortion of the incident beam, termed thermal lensing, which causes a reduction in the fluence on the detector to be protected. The physical origin of nonlinear refraction can be electronic, molecular, electrostrictive or thermal. Recently, thermal effects have been reported to occur both with cw laser beam and nanosecond pulses [1–7]. A Laser beam, while passing through an absorbing media, induces temperature and density gradiants that change the refractive index profile. This intensity-induced localized change in the refractive index results in a lensing effect on the optical beam above certain power threshold values. Self-focusing, a power-dependent phenomenon, occurs when the refractive index change is positive, whereas negative refractive index change will result in self-defocusing [8]. Both processes can be used to clamp an outgoing optical beam at a constant fluence when the input beam is above a certain threshold.

Here, we report the results of our experiments on the organic chromophore Coomassie Brilliant Blue R-250 (LOBA CHEMIE) using Z-scan technique. The sample was prepared in the solid film form in polyvinyl alcohol (PVA) matrix, adopting the guesthost method which is described elsewhere [9]. The linear absorption spectrum of the sample was recorded with UV-VIS spectrophotometer (Fig. 2).

The Z-scan experiment was performed using a 632.8 nm cw He-Ne laser beam, which was tightly focused on to the sample using a lens of focal length 7.5 cm (Fig. 1). The experimental set up used was based on the original design by Sheik-Bahae *et al.* [10, 11]. The sample was moved across the focal region along the beam propagation direction. The transmission of the beam through an aperture placed in the far field was measured using a photo detector. The light intensity at the focal point was 10.6 kw/cm$^2$. Since the sample length was less than the diffraction length of the

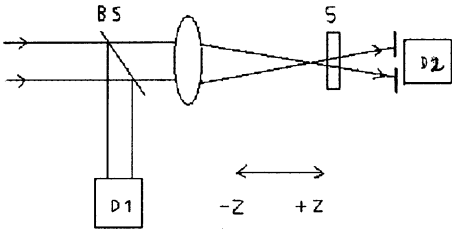


*Figure 1* Schematic diagram of the Z-scan setup.

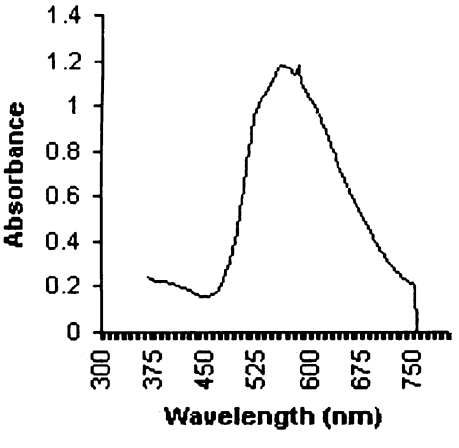


*Figure 2* Linear absorption spectrum of the sample.

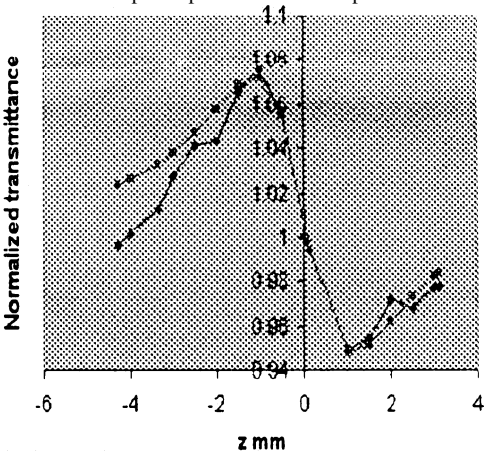


*Figure 3* Closed Z-scan curve of the sample.

focused beam, thin sample approximation was used to analyze the data [11]. The closed aperture Z-scan curve of the sample is shown in (Fig. 3). The curve is characterized by a prefocal peak, followed by a post-focal valley, which implies that the nonlinear refractive index is negative.

  

Coomassie Brilliant Blue R-250 dye prepared in the solid film form in polyvinyl alcohol (PVA) matrix, when investigated by Z-scan technique using a cw laser beam, exhibited a negative refractive nonlinearity, which may occur due to the self-defocusing effect caused by the local variation of refractive index with temperature and from the Z-scan data, the nonlinear coefficient of the refractive index at wavelength 632.8 nm was evaluated as $n_2 = 2.45 \times 10^{-12}$ m$^2$/w. Detailed investigations on the nonlinear behaviour of the material at various low powers and intensities are in progress and the results will be communicated shortly.

## References


1. R. C. C. LEITE, S. P. S. PORTO and T. C. DAMEN, *Appl. Phys. Lett.* **10** (1967) 100.
2. B. L. JUSTUS, A. L. HUSTON and A. J. CAMPILLO, *Ibid.* **63** (1993) 1483.
3. P. BROCHARD, V. GROLIER-MAZZA and R. CABANEL, *J. Opt. Soc. Am. B* **14**(2) (1997).
4. J.-G. TIAN, C. ZHANG, G. ZHANG and J. LEI, *App. Opt.* **32**(33) (1993) 6628.
5. J. S. SHIRK, R. G. S. PANG, F. J. BARTOLI and A. W. SNOW, *Appl. Phys. Lett.* **63** (1993).
6. L. W. TUTT and T. F. BOGGESS, *Prog. Quant. Electron* **17** (1993)299.
7. B. L. JUSTUS, Z. H. KAFAFI and A. L. HUSTON, *Opt. Lett.* **18** (1993) 1603.
8. R. L. SUTHERLAND, "Hand Book of Nonlinear Optics"(Marcel Dekker, Inc. New York, 1996).
9. S. K. GEETHA, S. S. P. KUMARI and C. I. MUNNERA, *J. Mater. Sci. Lett.* **21** (2002) 1339.
10. M. SHEIK-BAHAE, A. A. SAID and E. W. VAN STRYLAND, *Opt. Lett.* **14** (1989) 995.
11. M. SHEIK-BAHAE, A. A. SAID, T. WEI, D. J. HAGAN and E. W. VAN STRYLAND, *IEEE J. Quant. Electron. QE* **26** (1990) 760.



*Received 20 February*
*and accepted 3 April 2004*