Research Centre 1

Subject : Chemistry

Centre for Study on Preparation and Nonlinear Optical Characterization of Dye-doped Polymer films for Optical limiting

Co-ordinator : Dr. Shubhrajyotsna Aithal

Description :

Optical limiting is one of the important applications of third order optical nonlinearity of materials. Nonlinear optical materials can be used for protecting sensors against high-intensity laser pulses and high-power laser beams. Devices developed for this purpose are called optical limiters. An optimum practical optical limiter can be designed and fabricated by predicting and studying the characteristics of an ideal optical limiter. An ideal optical limiter is a photonic device or component has ideal optical limiting characteristics. It can take any intensity input laser beam both continuous wave (CW) or pulsed wave of any time duration. It has to process such incident light beam internally using nonlinear properties of the medium and provide output laser beam of constant intensity or fluency.

Objectives :

(1) To study the nonlinear properties like the two-photon absorption (TPA) induced fluorescence and optical limiting capability of a new dye 4-[4-(Dimethylamino)styryl]-1-docosyl pyridinium bromide hereafter called as DASPB doped in Methyl methacrylate – methacrylic acid co-polymer (PMMA-MA) polymer matrix. The linear absorption, single photon fluorescence, two-photon induced fluorescence behaviour are to be studied. The intensity dependent nonlinear absorption at various wavelengths/dye concentrations and optical power limiting behaviour are also to be studied using continuous wave laser beams.

(2) To study the linear absorption properties, nonlinear absorption, nonlinear refraction properties, and optical power limiting properties of two acceptor – donor molecules, 3-[N-ethyl-4-(4-nitrophenylazo)phynyl-amino]propionitrile (Disperse Orange 25) and 4-[4-(Phenylazo)phenylazo]-o-cresol (Disperse Yellow – 7). These azo dye molecules generally exhibit large Reverse Saturable Absorption (RSA), which is currently considered to be the most important power limiting mechanism. It is proved theoretically that using materials with high RSA, it is possible to achieve higher nonlinear attenuation.

(3) To study Optical Phase Conjugation (OPC) property of these dye-doped polymer films using Degenerate Four Wave Mixing (DFWM) set-up using continuous wave 532 nm laser beam and continuous wave 633 nm beam of semiconductor diode lasers. To investigate the

reflectivity of phase conjugated wave as a function of various parameters which include the concentration of dyes, the thickness of films, intensity of pump and probe beams, the angle between pump and the probe beams etc., and to verify the suitability of the dyes for interferometric applications.

(4) Finally, to study the factors affecting the various determinant issues and their critical constituent elements of dye-doped polymer films usage in Photonic applications, by means of using a new framework consisting of four constructs – Advantages, Benefits, Constraints, and Disadvantages called ABCD analysis framework.

Publications/ Working Papers :

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[2] ShubrajyotsnaAithal, P. S. Aithal, and Gopalkrishna Bhat, (2011). Study of nonlinear absorption in a dye doped polymer film due to frequency up-converted fluorescence, Proceedings of the International Conference on Laser, Material Science and Communication, Dept. of Physics, University of Burdwan, West Bengal, Ed. U. Chatterjee and P.K. Chakrabarti, ISBN : 978-93-80813-14-1, pp. 107-109, (2011), DOI : http://doi.org/10.5281/zenodo.62033.
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[3] Shubhrajyotsna Aithal, Sreeramana Aithal, and Gopalkrishna Bhat, (2011). Nonlinear Absorption Studies of Disperse Orange Doped Polymer Film, Trends in Optics and Photonics II, Proceedings of International Conference on Trends in Optics and Photonics, December 7-9, 2011, Kolkata, India. Editors : Ajay Ghosh and Debesh Choudhury, ISBN 978-81-908188-1-0, P. 132-137, (2011), DOI : http://doi.org/10.5281/zenodo.62034.
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