Available online at www.sciencedirect.com
ScienceDirect
Optics & Laser Technology 39 (2007) 1262–1268
Optics & Laser Technology
www.elsevier.com/locate/optlastec

Optical phase conjugation by degenerate four-wave mixing in basic green 1 dye-doped gelatin film using He–Ne laser

Qusay Mohammed Ali, P.K. Palanisamy*

Centre for Laser Technology, Department of Physics, Anna University, Chennai 600 025, India

Received 7 February 2006; received in revised form 17 July 2006; accepted 17 July 2006
Available online 28 November 2006

Abstract

Optical phase conjugation in gelatin film doped with basic green 1 has been measured using CW laser radiation ($\lambda = 632.8$ nm) generated by He–Ne laser of total power 35 mW. The degenerate four-wave mixing (DFWM) experiment allowed for measurement of phase conjugate reflectivity as a function of dye concentration, backward beam intensity, forward beam intensity, probe beam intensity, mean pumping beam intensity and angle between the forward pumping beam and probe beam. For 1 mM concentration of basic green 1-doped gelatin film, 0.1% phase conjugate reflectivity has been observed.

Keywords: Nonlinear optics; Optical phase conjugation; Dye

1. Introduction

The term phase conjugation is used to describe a nonlinear process in which both the direction of propagation and the overall phase factor of an arbitrary beam of light are precisely reversed. Degenerate four-wave mixing (DFWM) is a simple method to achieve phase conjugation by using the third-order nonlinearity χ^3 of the electric susceptibility tensor. In DFWM two strong counter-propagating pump waves and a weak probe beam with the same frequency interact in the nonlinear medium, and a new wave is generated which is the phase conjugate (PC) of the probe beam. This phase conjugated wave travels back along the original path of the incoming wave undergoing reverse phase evolution.

Phase conjugation by DFWM has been demonstrated in numerous nonlinear media. Most of these experiments utilized high peak power pulsed lasers. The photorefractive effect and the saturable absorption which enhance the effective third-order optical susceptibility make it possible to realize phase conjugation with low power lasers.

One of the attractions of using organic dyes as nonlinear media for conjugation is that for any desired wavelength in the visible or near infrared, a dye can be found which absorbs at this wavelength. A further advantage is that most dyes are commercially available, i.e. they are inexpensive and easily obtainable compared with other nonlinear media.

Low power optical phase conjugation (OPC) based on the DFWM arrangement was demonstrated in gelatin films doped with eosin and erythrosin dyes [1,2], in boric acid glasses doped with fluorescein and rhodamine 6G dyes [3,4], in gelatin films doped with fluorescein dye [5], in polyvinyl alcohol and gelatin films doped with phenosafranin dye [6], in methylene blue and erythrosine-doped gelatin films [7], in polyvinyl alcohol films embedded with eosin, erythrosine B and Rose Bengal [8], in disperse red-doped polystyrene film [9], in methyl orange-doped polyvinyl alcohol [10] and in disperse red 1-doped poly(methyl methacrylate) [11].

In the present study solid matrix (gelatin) doped with basic green 1 dye has been characterized by Z-scan technique [12] and identified as a material suitable for nonlinear optical devices. Since this dye exhibits reasonably good third-order nonlinearity, we in this paper report our experimental results and observation of OPC by DFWM in

*Corresponding author. Tel./fax: +91 44 2220 3160.
E-mail addresses: profpkpannauniv@yahoo.co.in, pkp@annauniv.edu (P.K. Palanisamy).

0030-3992/$ - see front matter © 2006 Elsevier Ltd. All rights reserved.
doi:10.1016/j.optlastec.2006.07.009