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EVOLUTION OF FAR-FIELD DIFFRACTION PATTERNS AND NONLINEAR OPTICAL PROPERTIES OF SAE 70 OIL

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ABSTRACT

The investigation of nonlinear optical characteristics of SAE 70 oil, by using self - diffraction techniques and Z-scan technique, using continuous wave (CW), visible laser beam is presented. Multiple diffraction rings were observed, when a beam propagates through this oil. A large thermal-induced nonlinear refractive index, up to 2.498×10^{-7} cm^2/W was obtained from SAE 70 oil, under 473 nm continuous wave (CW), laser irradiation. The nonlinear absorption of SAE 70 oil was obtained from open aperture, z-scan technique. Optical limiting performance of SAE 70 oil was investigated under irradiation, by a CW laser beam using transmission measurement, through the sample which indicates that this material is a potential candidate, for optical limiting applications in low power CW regime.

KEYWORDS: Nonlinear Optics, Nonlinear Refractive Index, Z-Scan Technique, Optical Limiting

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1. INTRODUCTION

Rapid technological advancements in optics have placed greater demand, on the development of nonlinear optical materials, with prominent applications in optical limiting and all optical switching [1-3]. So many materials have been tested for this goal viz., dense atomic vapors [4], nematic liquid crystals [5], solids [6], liquids [7] in vegetable oils [8]. In this article, we have presented the results of experimental investigations of the nonlinear properties of ASE 70 oil, owe to the severe shortages of the use of such materials, in optical applications. The multiple diffraction rings [9] have been used, to investigate the nonlinearities in these materials. Z-scan technique [10] is another technique that has also been used, for the same goal.

In the diffraction ring technique, the number of rings generally depends on the, on-axis nonlinear phase shift suffered by the laser beam, during the passage through the medium sample. When a Gaussian beam passes through a nonlinear medium, a concentric ring intensity distribution tends to form in the far field. This phenomenon has aroused wide interest among researchers, since Callen et al [11] observed first the far field annular intensity distribution, of a He-Ne laser beam passing through the nonlinear liquid CS_2, in 1967. By counting the number of rings that appear in each pattern, one can simply determine the nonlinear refractive index. The phase shift depends on an optical intensity, magnitude and saturation value, of the nonlinear refractive index, sample thickness, etc. Z-scan technique, based on the spatial distortion of a laser beam passed through the medium sample, is widely used in material characterization, because of its simplicity, high sensitivity and well-elaborated theory. The Z-scan method, exploits the self-focusing and refocusing phenomena, in nonlinear optical materials. In this method, the nonlinear sample is exposed through the focal plane of a tightly focused Gaussian laser beam and the change in the far-field intensity pattern is monitored. For a pure refractive nonlinearity, the light field induces an intensity- dependent nonlinear phase, as a consequence of the transverse Gaussian intensity