Thermal-induced nonlinearities in rose, linseed and chamomile oils using CW visible laser beam

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Abstract

Self-diffraction rings or spatial self-phase modulation (SSPM) were observed in rose, linseed and chamomile oils under 473 nm continuous wave (CW) laser irradiation. The measurements were performed by propagating the laser beam through a cell containing each sample. The number of rings as well as diameter of the outer-most ring in each pattern obtained increases monotonically with increasing input power. The diffraction ring patterns are theoretically simulated using Fresnel-Kirchhoff diffraction integral in the case of an optically thin medium. The experimental and simulation results show that when a laser beam with Gaussian profile is transmitted through oils medium, a series of circular diffraction rings forms in the intensity distribution pattern in the far-field. The nonlinear refractive index, n_2, was determined from the number of observed rings and by the z-scan technique. The results obtained from self-diffraction rings experiment and Z-scan are compared and analyzed for the three different oils. Large value obtained of the order of n_2=1.32 x10^{-6} cm^2/W for chamomile oil using diffraction ring pattern technique. This large nonlinearity is attributed to a thermal effect resulting from linear absorption. Moreover, the optical limiting characteristics of rose, linseed and chamomile oils were investigated.

Key words: Self-phase modulation, Thermal nonlinearity, Diffraction ring pattern, Nonlinear refractive index, Z-scan technique.

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1. Introduction