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Optical limiting behavior correlated with the surface and etching time of irradiated nuclear track detector

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Abstract The effects of different laser incident intensity on the optical characteristics of PM-355 nuclear track detector have been studied by using photoluminescence (PL) and UV–visible spectroscopic techniques. The polymers were irradiated with alpha particles with close contact to ^{241}Am (in contact with a mean energy 5.49 MeV) and then exposed to continues waveguide (cw) laser with different incident intensity. A noticeable decrease in the photoluminescence spectral intensity was observed with increasing laser incident intensity. From the UV–visible spectra, it is found that a shift in the absorption edge towards a longer wavelength with increasing laser incident intensity can be readily observed. The absorption peak with increasing incident intensity is seen to change into a broad one. The optical band gaps determined from the UV–visible spectra were found to decrease with the increase of cw laser doses. The calculations were made of the number of carbon atoms per conjugation length, N and number of carbon atoms per clusters, M embedded in the network of polymers. The effective of etching time on optical power limiting behavior of sample was also investigated. The optical power limiting behavior was found to vary with the etching time. It also shows a very good optical limiting behavior with a limiting threshold varying from 16.6 to 19.9 mW. These results indicate that the PM-355 nuclear track detector is a promising candidate for applications in the nonlinear optic field.

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1 Introduction

Polymer-based solid state nuclear track detectors (SSNTDs) are extensively used for the detection of several types of radiation [1]. The induced modifications in physicochemical properties of SSNTDs due to ions implantation are highly correlated with the ions intensity and energy [2, 3]. One of the most commonly used SSNTDs is the polyallyl-diglycolcarbonate (PADC) commercially known as CR-39 detector. The molecular formula of CR-39 is $(C_{12}H_{18}O_7)n$. The other member of PADC family is the PM-355 polymeric detector. It has the same chemical formula that of CR-39. Moreover, it is characterized by its high isotropy, homogeneity and high transparency [4, 5]. Among such applications, SSNTDs are widely used in radiation protection and environmental radiation monitoring. Quick and accurate evaluation of track densities have caused many attempts to construct counting systems while visual counting, or using sophisticated images analysis systems, ensures accurate determination of number of tracks [6, 7], other techniques are used for inexpensive and fast assessment of track density.

The purpose of this study is to explore the absorption coefficient, optical band gap and image processors of etched PM-355 detectors after the irradiation with α-particles and diode laser of 635 nm wavelength. The optical limiting properties for the PM-355 irradiated by α-particles and laser incident intensity at $I_o = 16.13$ KW/cm^2 with different etching time are studied and optical limiting thresholds of the samples are calculated.

2 Irradiation process

A beam of Gaussian TEM_{00} distribution from a diode laser (SDL-635 nm-100T) of 100 mWatt power output illuminate the PM-355 samples on its front face perpendicularly,