

Photoluminescence characterizations and nonlinear optical of PM-355 nuclear track detector film by alpha-particles and laser irradiation

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Abstract

The imaging processing technique was used for studying a laser beam nature that transmitted through films of PM-355. The thermal nonlinearity of PM-355 films was studied using a 635 nm cw diode laser at 15 mW as the source of excitation. Third order nonlinear optical properties of PM-355 films irradiated with α -particles at different times and pristine sample has been studied using Z-scan technique. The samples showed a negative and large nonlinear refractive index and reverse saturable absorption (RSA) with high values of the nonlinear absorption coefficient. The fluorescence spectra of PM-355 films were investigated at room temperature and wavelength range of 250–500 nm for a pristine film and in different times of exposure to α -particles. The broad peaks were between 350, 420 and 465 nm. All-optical switching property of PM-355 samples irradiated with α -particles at 20 min was also studied using the standard pump-probe technique.

Keywords: saturable absorption, nonlinear refractive index, diffusion, polymer, fluorescence

(Some figures may appear in colour only in the online journal)

1. Introduction

The films of solid state nuclear track detectors (SSNTDs) are made from various types of materials. They are used as powerful tools for many applications, such as radiation protection and monitoring of environmental radiation, in these applications emitted α -particles by natural radioactivity is detected. So, they are significant to consider the SSNTD materials reaction against α -particles. The experimental laboratory has been confirmed that the track geometry can be predicted and determined as a result of track, after a certain etching time under restricted conditions. These experimental steps are essential for the use of SSNTD film in laboratory processes [1]. Physical and chemical properties of SSNTD films can be modified by the ions implantation due to its intensity and energy [2]. Poly-allyl-diglycolcarbonate

(PADC) or CR-39 is commonly known as SSNTD and its molecular formula is given as $(C_{12}H_{18}O_7)_n$. The PM-355 detector is a member of PADC family, and has a similar chemical formula with CR-39. Furthermore, because of the unique properties of PM-355 detectors (such as high isotropy, homogeneity and high transparency) make it used in different subjects and applications [3, 4]. Detector films are reacting with various radiations (such as Gamma rays, alpha particles, heavy charged particles, and Ultraviolet radiation). Structural changes of polymers such as double bond formation, chain scission, aggregation of chains, and emission of molecules can occur when they irradiated with different types of radiations [5]. A few studies exist in the literature with basic information about PM-355 films reacted with α -particles from a laser beam [4, 6].