Optical properties of CR-39 Detector Irradiated with Gamma-rays and (He-Ne) Laser

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Abstract

The impacts of gamma-beams and He-Ne laser of optical properties for CR-39 track indicator were studied. Twenty locations separated into five gatherings. In the first-place aggregate, one finder un- irradiated (control). Second gathering, five indicators irradiated to 60Co gamma source with various dosages 300, 500, 800, 1200 and 1600 kGy (γ). Third gathering, 5 identifiers illuminated with gamma beam with various dosages 300, 500, 800, 1200 and 1600 kGy afterward presented to 15 min of He-Ne laser at 10 mW control (γ +laser). Fourth gathering, nine indicators were presented to various force 1, 5 and 10 mW of He-Ne laser at various circumstances 5, 10 and 15 min (laser). The optical properties were considered with bright unmistakable UV-visible and FTIR spectroscopic. In addition, the optical vitality band cavity and carbons number was computed at various gamma measurements and diverse time's introduction of He-Ne laser. The outcomes for second, third, fourth and fifth gatherings demonstrate expanding in the absorbance with expanding in the time presentation of He-Ne laser and gamma dose. The FTIR spectrum indicate moving in the groups of CR-39 track indicator presented to gamma beam, laser and (γ +laser), for gamma beam demonstrate expanding in the absorbance at 300 kGy and unsymmetrical diminishing of absorbance at 500-1600 kGy, and for CR-39 identifier presented to (γ +laser), the impacts demonstrate unsymmetrical diminishing in the force absorbance with increment in the gamma measurements, at laser impacts indicate expanding in the absorbance A, with expanding in the time introduction of He-Ne laser at various forces. [DOI: 10.22401/JUNS.20.3.12]

Keywords: CR-39 track indicator, FTIR, He-Ne laser, UV-visible.

Introduction

Along chain courses of polymers CR-39، act particularly as opposed to other comprehended materials and claim wonderful properties in view of that are comprehensively used as a piece of various sensible and mechanical applications [1-7]. It is striking that molecule society adjusts the polymer frame work by chain scission, cross-interfacing, free radical alternative, protruding holding pair [6, 7]. The results are accountable for the movements in fundamental, optic, electrical, and mechanical properties of the lit up polymeric materials, which may allow tailoring the properties of the polymers as indicated by essentials [7-11].

The centrality of polymers in light radiating diodes, creation of optical sensors, anti-reflective coatings, consolidated optics for correspondence and banner taking care of particular duplicated channels etc., requires the requirements for focus the effects of implantation on the optical properties of polymers for instance, consumption and band fissure [3, 11-13].In our work, we have concentrated the consequences of He-Ne laser and gamma-pillar's irradiated by measuring the optical properties of CR-39 locators, using UV-visible and FTIR spectroscopic frameworks. The monomer structure of CR-39 polymer is as demonstrated in Fig.(1).

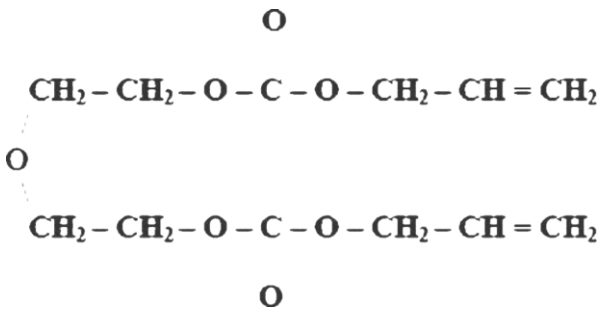


Fig.(1) The monomer molecular structure of CR-39 detectors.

The enhancements made on the maintenance and of lit and control tests was reviewed by UV-visible and FTIR spectroscopes. This survey is not quite recently getting information concerning the

communication associated with He-Ne laser and gamma-pillars with CR-39, additionally to consider the common sense of improving their properties, increasing their execution in several fields, that we focus the effects of gamma bar and He-Ne laser with the UV-visible spectrum and FTIR spectrum of CR-39 track discoverer as the spectroscopic audits. In like manner, we analyzed the acts of optical band opening imperativeness with growing gamma dosage and presentation time of He-Ne laser. The synchronous nearness of circuitous and direct band fissure such as in CR-39 discoverer and the amount of carbon dioxide particles N in a pack are further more discovered.

Experimental Details

The indicators specimens of CR-39 with size 1.5x1.5cm^2 were cut to 250 µm thick sheets, the CR-39 sheets are made of per shore jumbling LTD organization, England. Twenty locators partitioned into five gatherings.

To begin with gathering, one indicator un-illuminated (control). Second gathering, five identifiers illuminated to ^{60}Co gamma (γ) source with various measurements 300,500, 800, 1200 and 1600 kGy. Third gathering, 5 locators illuminated with gamma beam with various measurements 300, 500, 800, 1200 and 1600 kGy and after that presented to 15 min of He-Ne laser at 10 mW control (γ+laser). Fourth gathering, nine locators were presented to various forces 1,5 and 10 mW of He-Ne laser at various circumstances 5, 10 and 15 min.

The UV-visible spectrum investigations of both control and illuminated examples were studied using Shimadzu UV-1601PC UV-obvious, Japan. In wavelength scope of 200nm–800nm, all the retention spectrum were recorded, keeping control as the reference. FTIR-spectroscopy utilized as a part of this review was FTIR show from Bruker organization, Germany. The wave number extend utilized as a part of this review was in the mid-infrared 400- 4000 cm^{-1}.

Results and Discussion

1. UV–visible spectrum analysis:

Fig.(2) to Fig.(6) demonstrate the UV-visible spectrum of control and irradiated CR-39 detectors with various dosages of gamma-beams, He-Ne laser and gamma+ laser independently. From these optical spectrum, plainly the control test has a sharp reducing in assimilation with broadening wave length up to certain esteem, trailed by a level area in the UV-visible range. The optical spectrum of all illustrations demonstrate moving in the ingestion edge towards much longer than wavelength with expanding doses. This conduct is by and large deciphered as brought on by the development of expanded frames of conjugate bonds, i.e. conceivable development of carbon bunches or possibly absconds.

The assimilation groupings in the researched opportunity of wavelengths are related to the π–π* electronic moves [14-18].

This kind of moves happens in the unsaturated focuses of the particles, electronic in mixes containing two-fold or triple bonds furthermore in aromatics. The fermentation of the π electron requires littler vitality and consequently, move of this sort of happens at longer wavelengths.

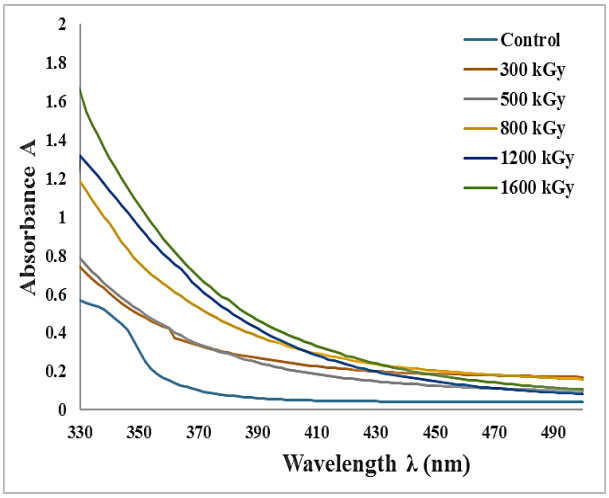


Fig.(2): UV-visible spectrum of CR-39 detector un-irradiated (control) and irradiated with gamma ray for doses 300, 500, 800, 1200 and 1600 kGy and wavelength range from 330 nm to 500 nm.

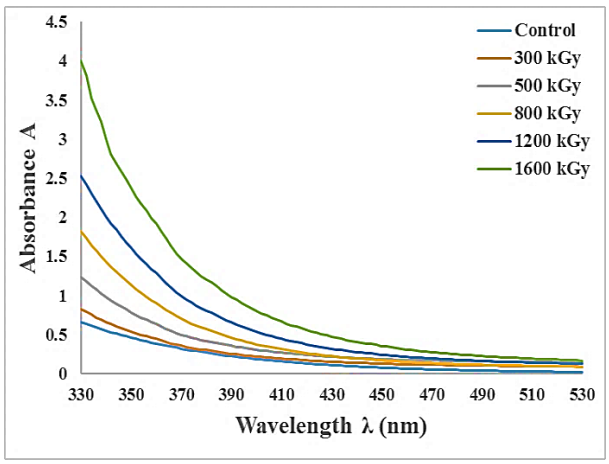


Fig.(3): UV-visible spectrum of CR-39 detector un-irradiated (control) and irradiated with gamma ray for doses 300, 500, 800, 1200 and 1600 kGy and exposed at 15 min of He-Ni laser of 10 mW power, wavelength range from 330 nm to 530 nm.

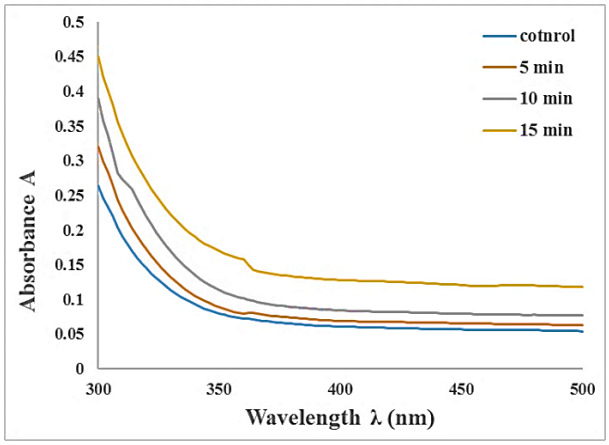


Fig.(4): UV-visible spectrum of CR-39 detector control and different exposure time of He-Ne laser 5, 10, 15 min at power 1 mW, wavelength range from 300 nm to 500 nm.

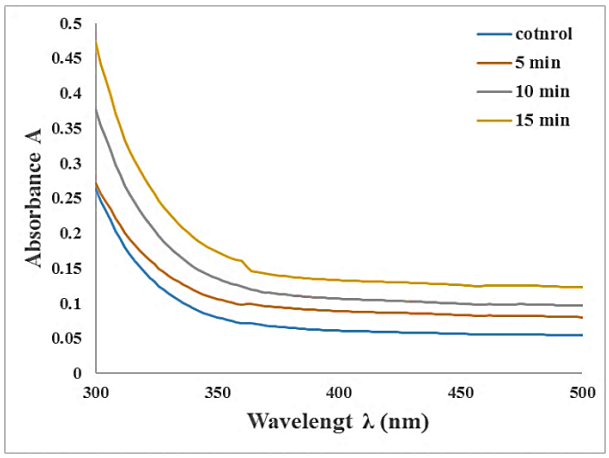


Fig.(5): UV-visible spectrum of CR-39 detector control and different exposure time of laser 5, 10, 15 min at power 5 mW, wavelength range from 300 nm to 500 nm.

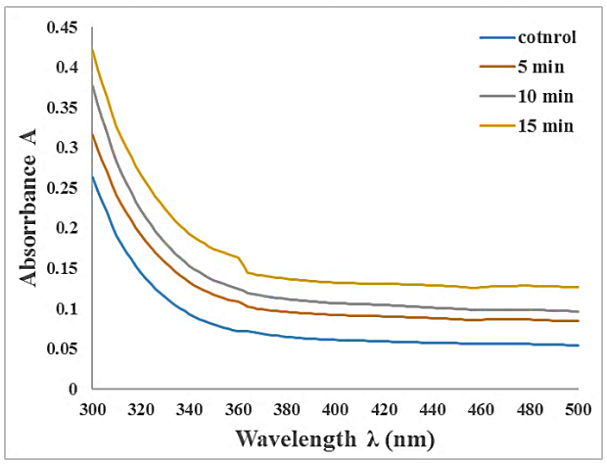


Fig.(6): UV-visible spectrum of CR- 39 detector control with different exposure time of He-Ne laser 5, 10, 15 min at power 10 mW, wavelength range from 300 nm to 500 nm.

2. Optical band gap energy

The optical ingestion system can provide data about the group of structure and vitality crevice in crystalline and non-crystalline materials [18]. The optical hole Eg of the CR-39 identifiers, could be found by Tauc's connection [19]:

$$\alpha(h\upsilon) = \frac{\beta\,(h\upsilon - E_g)^n}{h\upsilon} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where α is the ingestion coefficient that would is the vitality of the episode photons, such as is the estimation of the optical band crevice vitality between the lounged band and the valence band, and n is the whole number, which shows the electronic move, whether it is the immediate or round about amid the preservation procedure in the K-space. Exceptionally, n is 1/2, 3/2,2 and 3 for direct permitted, organize illegal backhanded permitted and round about prohibited moves, individually.

The factor β relies on the move possibility and thought to be regular inside the optical recurrence run. The conventional strategy for the confidence of the estimation of Eg includes plotting $(\alpha h\upsilon)^{1/2}$ and $(\alpha h\upsilon)^2$. In the present review, the most acceptable fit is gotten by plotting $(\alpha h\upsilon)^{1/2}$ and $(\alpha h\upsilon)^{2}$`as a component of photon vitality (hυ), considering the straight little of the central compression edge of the UV-visible spectrum [20].

The absorbance coefficient (α) could acquire from the accompanying connection:

$$\alpha = (2.323\ A)\ /d \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where A is the retention and d is a thickness of the examples. The carbon is the number per conjugated length (N) for a direct structure is given by Robertson connection [21]:

$$Eg = (2\pi\beta) / \sqrt{N} \quad \text{..... (3)}$$

where N is the quantity of carbon particles per conjugated length, 2β gives the band structure vitality of a couple of nearby π destinations.

The estimation of β is taken to be ~2.9 eV as it is connected with π-π* optical move in the (–C=C–) structure [22].

From the Robertson's connection group size, can be figured and afterward the accompanying connection can be utilized to compute the quantity of carbon iotas per band

$$Eg = (18.212) / \sqrt{N} \quad \text{..... (4)}$$

Table (1)
The variations of the optical energy band gap and number of carbon atoms of un-irradiated CR-39 detectors and irradiated with gamma rays at different doses. [22]

Gamma				
Dose (kGy)	**Indirect E_g (eV)**	**N**	**Direct E_g (eV)**	**N**
Control	3.9	77	5.7	36
300	3.4	102	5.4	40
500	3.3	108	5.3	42
800	2.9	140	5.2	44
1200	2.8	150	5.1	45
1600	2.7	161	5.05	46

Table (2)
The variations of the optical energy band gap and the number of carbon atoms of CR-39 detectors at different exposure time of He-Ne laser.

Laser					
P (mw)	**T (min)**	**Indirect E_g (eV)**	**N**	**Direct E_g(eV)**	**N**
1	5	3.8	81	5.1	45
	10	3.6	91	4.9	49
	15	3.4	102	4.8	51
5	5	3.45	99	4.9	49
	10	3	131	4.7	53
	15	2.9	140	4.6	56
10	5	3.5	96	4.8	51
	10	3.4	102	4.6	56
	15	3.3	108	4.5	58

Table (3)
The variations of the optical energy band gap and number of carbon atoms of CR-39 detectors irradiated with gamma ray at different dose and exposed to 15 min of He-Ne laser at 10 mW power.

Gamma + laser						
P (mw)	**T (min)**	**Dose (kGy)**	**Indirect E_g(eV)**	**N**	**Direct E_g(eV)**	**N**
10	15	300	3.35	105	5.35	41
		500	3.15	119	5.25	43
		800	3.05	126	5.2	44
		1200	2.9	140	5.1	45
		1600	2.8	150	5.05	46

3. FTIR spectral analysis

Fig.(7) to Fig.(11) show the FTIR spectrum of control and irradiated CR-39 detectors with different doses of gamma-rays, He-Ne laser and gamma + laser, respectively. From these optical spectrums, shifting in the bands peak position, it is stated that changes refer to change in CR-39 detectors configuration and structure, and on irradiated the detectors with differences dose of gamma ray. Also, an increase in absorption with increasing of the time exposure of laser, it is referring to infrared laser interactions with CR-39 detectors made thermal effects and lead to increase in the absorbance due to increase in the exposure time, that lead to changes in the structure and configuration of CR-39 detectors are shown an increase in intensity at 300 kGy, followed by random decrease in intensity with increasing dose of gamma radiation to 1600 kGy, was refer to degeneracy gamma radiation, while is shown a random decrease in intensity with increasing of dose of gamma ray to 1600 kGy with expose 15 min of laser at 10 mW power, was refer to degeneracy of gamma radiation.

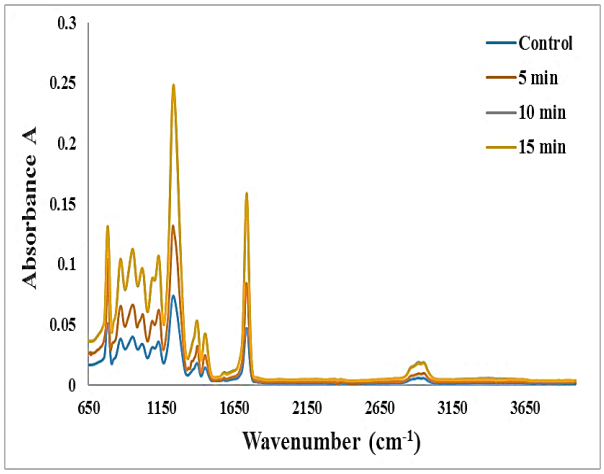


Fig.(7): FTIR spectrum of unexposed and exposure to different times of He-Ne laser of CR-39 nuclear track detector, at 1 mW laser power.

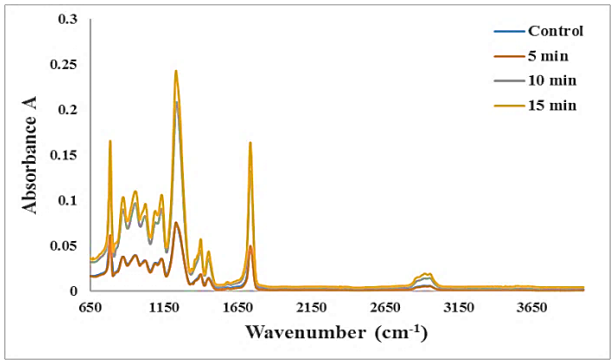


Fig.(8): FTIR spectrum of unexposed and exposure to different times of He-Ne laser of CR-39 nuclear track detector, at 5 mW laser power.

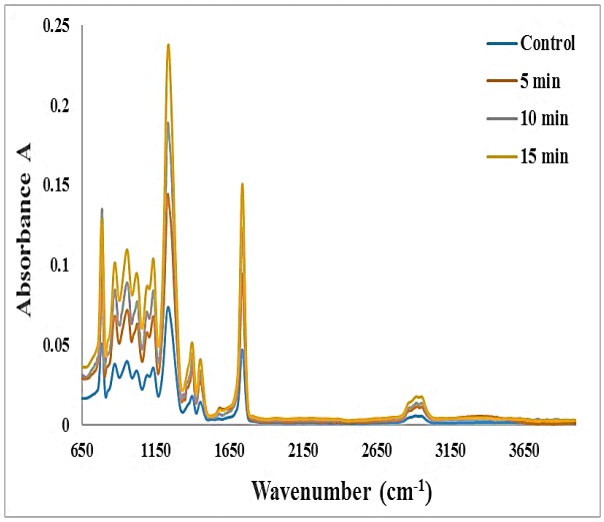


Fig.(9): FTIR spectrum of unexposed and exposure to different times of He-Ne laser of CR-39 nuclear track detector, at 10 mW laser power.

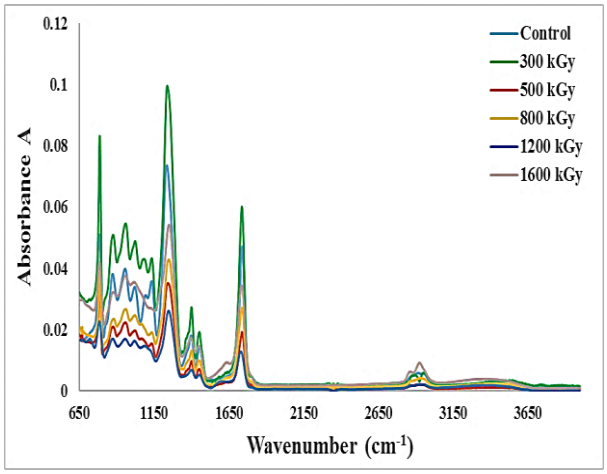


Fig.(10): FTIR spectrum of un-irradiated and irradiated of gamma ray of CR-39 nuclear track detector.

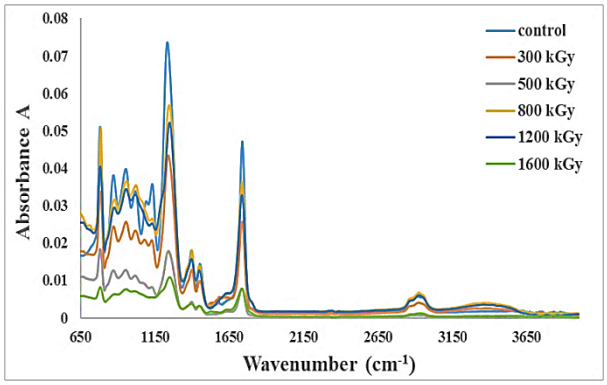


Fig.(11): FTIR spectrum of un-irradiated and irradiated of gamma ray of CR-39 nuclear track detector and exposed to He-Ne laser.

Conclusion

The effect of He-Ne laser and gamma ray on CR-39 detectors was studied by using UV-visible and FTIR spectroscopic techniques. These results show the UV-visible method is more sensitive than FTIR spectroscopic and the results that get from UV-visible are easy to study the analysis that shows symmetric increase on the absorbance within increasing on the gamma ray doses or exposure time of He-Ne laser, while show unsymmetrical values in the FTIR spectrum. The results show the decreasing in the optical band gap energy with increase in the gamma dose and exposure time of He-Ne laser.

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