Annexure – IX

UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI – 110 002

PROFORMA FOR SUBMISSION OF INFORMATION AT THE TIME OF SENDING THE FINAL REPORT OF THE WORK DONE ON THE PROJECT

1	Title Of The Project	Gamma Induced Modifications Of Polymeric Nuclear Track Detectors
2	NAME AND ADDRESS OF THE PRINCIPAL INVESTIGATOR	Dr. Dipak Sinha Department of Chemistry Nagaland University Nagaland-798627
3	NAME AND ADDRESS OF THE INSTITUTION	Nagaland University Lumami-798627 Nagaland
4	UGC APPROVAL LETTER NO. AND DATE	42-267/2013 (SR); dated 25th March, 2013
5	DATE OF IMPLEMENTATION	1st April, 2013
6	TENURE OF THE PROJECT	From 1st April, 2013 to 31st March, 2017
7	TOTAL GRANT ALLOCATED	Rs. 8,88,800/
8	TOTAL GRANT RECEIVED	Rs. 8,16,800/-
9	FINAL EXPENDITURE	Rs. 8,44,834/-
10	TITLE OF THE PROJECT	Gamma Induced Modifications Of Polymeric Nuclear Track Detectors
11	OBJECTIVES OF THE PROJECT	The objective of the present proposal is to study the effect of gamma irradiation on modifications of physical and chemical properties of polymeric track detectors. In general their characterization requires more than just one techniques and thus the objectives broadly proposed for this ongoing project was • Study of modifications on thermal properties of track detectors due to different doses of gamma irradiation • Study the modifications in track properties due to gamma irradiation • Gamma irradiation effect on electrical properties of polymeric track detectors • Study of surface and morphological modifications due to gamma irradiation All this studies is expected to bring a complete understanding about the modifications that takes place due to irradiation of high doses of gamma radiation.
12	WHETHER OBJECTIVES WERE ACHIEVED (GIVE DETAILS	The polymeric detectors like Polyallyldiglycol carbonate (PADC), Polycarbonates (PC), Polyethylene terepthalate (PET) Polyvinyl Alcohol, Polyacetate are already exposed to gamma radiation of different doses. The exposure is already been done in Pondichery University. The exposure is done till the dose of 10^7 Gy. Thermal studies had been done for Polycarbonate detectors,

		Polyethylene terepthalate (PET) and also for PADC detectors. Different types of thermal studies like TGA/DTA/DSC are done for irradiated samples and are compared with the pristine one. IR study for PET, PC and Polyacetate, Macrofol-E are being done for samples irradiated with different doses to understand the structural modifications due to gamma irradiation. Dielectric measurements had been for three types of polycarbonate, PET and for also polyimide samples. . XRD studies has started and yet to finish. Effect of gamma radiation on track properties has started Two papers are to be published soon
13	ACHIEVEMENTS FROM THE PROJECT	Attached as Annexure-I
14	SUMMARY OF THE FINDINGS (IN 500 WORDS)	Attached as Annexure –II
15	CONTRIBUTION TO THE SOCIETY	Since polymeric track detectors are used by several studies in high gamma back ground areas, understanding the dose dependant effect on these detectors would be very useful for other researchers. Further, structural modifications, thermal stability modifications is expected to give very useful information
16	WHETHER ANY PH.D. ENROLLED/PRODUCED OUT OF THE PROJECT	Initially one Ph.D. students was enrolled for this project work.
17.	NO. OF PUBLICATIONS OUT OF THE PROJECT	Attached

24/6/18

(PRINCIPAL INVESTIGATOR)

24-06-18

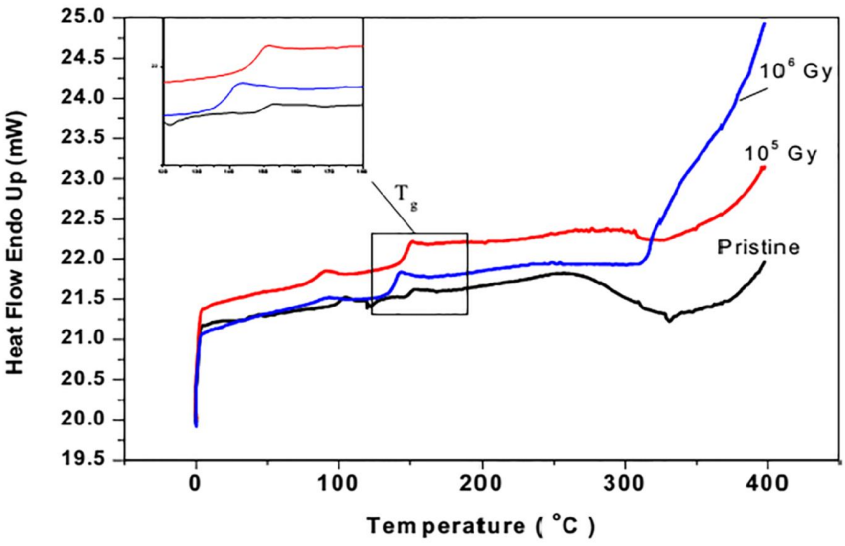
(REGISTRAR)

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Nagaland University
लुमामी / Lumami - 798627

Achievements from the project

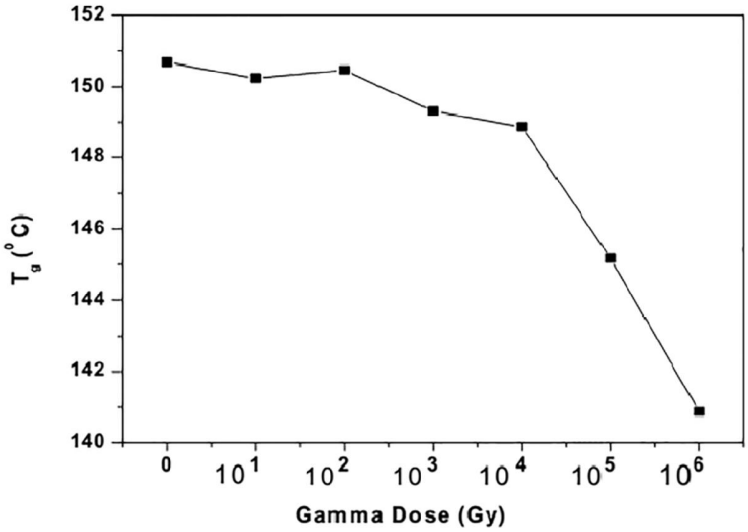
Annexure-I

Differential Scanning Calorimetric studies for lexan polymer signifies a prominent broad exothermic peak starts around 250^0C and finishes around400^0C. This exothermic peak is due to melting of the Lexan polymer. Morphology of Lexan polymer is such that it has both amorphous and crystalline arrangement of chain in the polymer matrix. The broad melting behavior of the polymer signifies the partial amorphous nature of the polymer. Comparing the DSC thermograms of pristine and irradiated samples, it is observed that the board exothermic behavior of the polymer remains till the dose of 10^5Gy. Only at the dose of 10^6Gy, the board melting peak of the polymer reduces and almost ceases to exist. This disappearance may be due to the fact that due to scissioning of the chains and rearrangement of the broken segments, amorphous behavior of the polymer reduces and the polymer becomes more crystalline in nature.



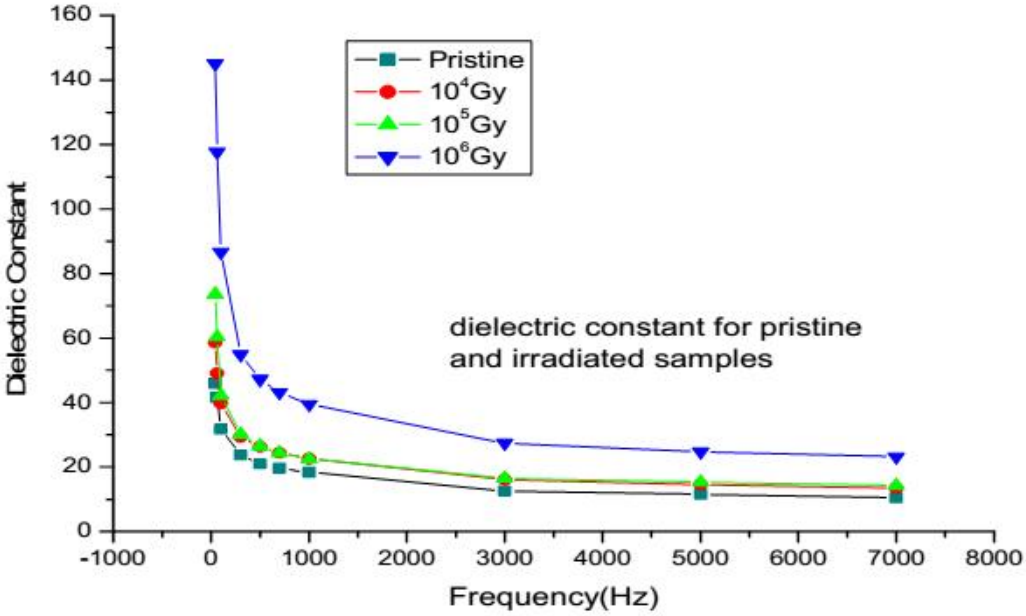
DSC curve at different dose showing $T_g$of polycarbonate polymer

Glass transition studies were also evaluated which shows that glass transition temperature of the pristine polymer is found to be around 150^0C for the pristine Lexan polymer. However on comparing the glass transition temperature (T_g) of the pristine polymer with the irradiated one, it can be seen that the T_g decreases with increasing gamma dose. This decrease in T_g is observed only above the gamma dose of 10^4 Gy.



Dose dependent variation of T_g gamma irradiated Lexan polymer

Due to gamma exposure the dielectric constant of the polyacetate polymer increases at a dose higher than 10^4Gy .The increase is visible in the lower frequency region i.e. in the range of 42-1000Hz. The increase in dielectric constant value is probably due to irregularity in the polymer chains caused by irradiation. This irregularity gives rise to a hopping mechanism which enhances the polarization in the polymer matrix at a dose higher than 10^4Gy On the basis of the study the following conclusions were made; Due to gamma exposure the dielectric constant of the polyacetate polymer increases at a dose higher than 10^4Gy; The increase is visible in the lower frequency region i.e. in the range of 42-1000Hz; The increase in dielectric constant value is probably due to irregularity in the polymer chains caused by irradiation. This irregularity give rise to a hopping mechanism which enhances the polarization in the polymer matrix at a dose higher than 10^4Gy.



A comparison of dielectric constant value of pristine and Irradiated sample at different frequencies

Summary of the findings

Annexure-II

The summary of the findings are given below

1. Lexan polymer irradiated till the dose of 10^4 Gy shows similar pattern of thermal decomposition i.e a double step decomposition pattern. However, when the gamma dose becomes 10^5Gy and higher, the second step of decomposition disappears.
2. Differential Scanning Calorimetric studies for gamma irradiated Lexan polymer indicates that due to scissioning of the chains and rearrangement of the broken segments, amorphous behavior of the polymer reduces and the polymer becomes more crystalline in nature.
3. Glass transition temperature T_g of Lexan polymer decreases with increasing gamma dose only above 10^4 Gy. It is observed that the T_g decreases from 150^0C for pristine sample to 140^0C at the highest does of 10^6 Gy.
4. Thus it is probable that formation of a phenolic group in the polycarbonate polymer matrix takes place at dose of 10^6 Gy due to the breakage of ester group. Scissioning of ester linkage leads to the formation of oxygen radicals which easily combine with hydrogen radicals and forms phenolic groups.
5. Due to gamma exposure the dielectric constant of the polyacetate polymer increases at a dose higher than 10^4Gy .The increase is visible in the lower frequency region i.e. in the range of 42-1000Hz. The increase in dielectric constant value is probably due to irregularity in the polymer chains caused by irradiationAnother work is on dielectric studies of polycarbonate

When irradiated with gamma radiation, it is observed that the dielectric constant increases which signifies that polarization in the polymer increases with gamma exposure. The increase in the dielectric constant due to irradiation is probably due to increase in carrier polarization indicating that charge carriers move by discontinuous hopping movements between localized sites. The irregularity in the polymer chains due to irradiation give rise to a hopping mechanism which will enhance the polarization in the polymer matrix. It is apparent from figure 9 that dielectric constant increases with irradiation and this increase is apparent at a dose of higher than 10^4Gy. Also it is observed that dielectric constant becomes almost constant at a

frequency of 300Hz and higher. It is found that Dielectric constant increases with gamma exposure.

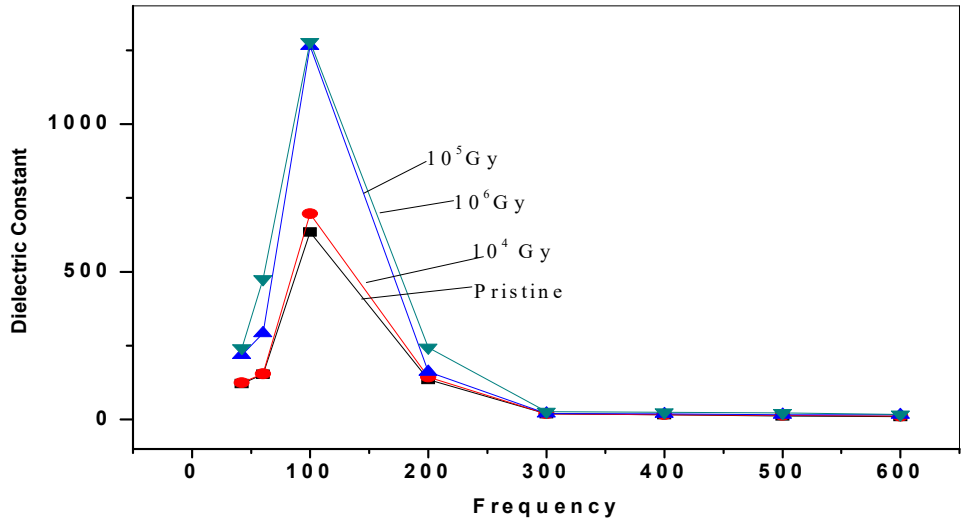


Fig. 9: Comparison of dielectric constant of polycarbonate polymer irradiated at different doses

6. Gamma irradiation effect on optical propertiesproperties of polymeric track detectors

The optical absorption spectra in the wavelength region of 200-800 nm. The optical band gap of the material was determined from the UV-Vis spectra using the Tauc's ex-pression.

$$\omega^2 \varepsilon_2 = \left\{\left(\frac{h}{2\pi}\right)\omega - E_g\right\}^2$$

whereε_2 is the optical absorbance at wavelength λ The values of $\sqrt{\varepsilon_{2/\lambda}}$ are to be

plotted against 1/λ to find out the gap wavelength (λ_g). The gap wavelength can be found out from the intersection of the extrapo-lated curve on the abscissa. The band gap is then de-rived by the relation

$$E_g=hc/\lambda_g.$$

The UV-Vis spectra of non-irradiated and irradiated samples show an increase in the absorption with the increase in the radiation dose towards the longer wavelength region. Figure10 shows the UV-visible spectra recorded for gamma irradiated CR-39 samples at different doses by using the UV-visible spectrophotometer.

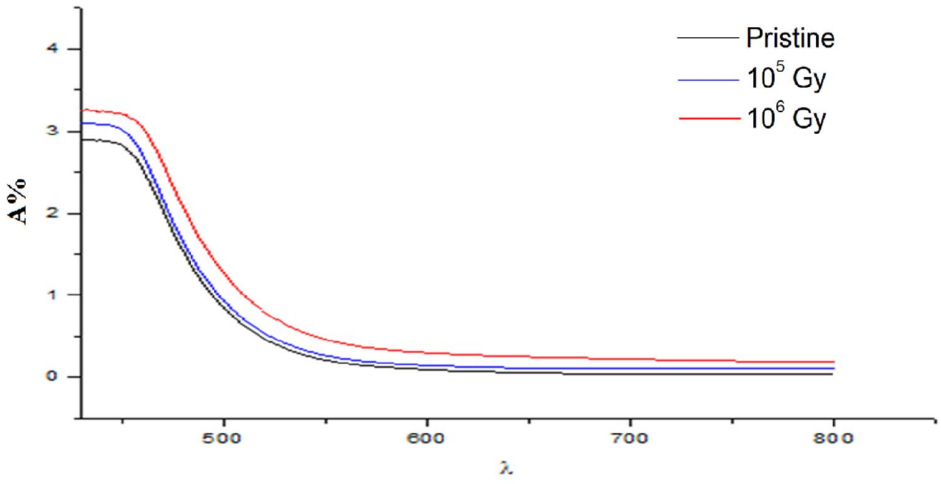


Fig.10: UV-Vis Spectra of pristine and gamma irradiated CR-39