CHAPTER 6
CHAPTER-6

CONCLUSION AND FUTURE PERSPECTIVES

6.1 CONCLUSION :- The present investigations have revealed that several physico-chemical changes occur in polymers due to gamma exposure. Chapter-5 contains the details about the modifications that takes place in seven different polymeric detectors by gamma radiation. Some important properties like bulk-etch rate, track-etch rate, transmittance of uv-vis, thermal stability etc. are greatly influenced by gamma radiation. There is also indication of some structural modifications through bond cleavage. The modifications or changes observed in irradiated polymers are summarized below :-

(1) The properties viz. track, optical, thermal resistance and chemical structure of the Triafol-TN and Triafol-BN are found to remain unchanged upto the dose of $10^5$ Gy of gamma radiation. But at the dose of $10^6$ Gy, both Triafol-TN and Triafol-BN polymers became brittle and fragile. Triafol-TN turned into powdered form at such high doses. This brittleness of the polymer is probably due to the destruction of anti-oxidant present in the polymeric film.

(2) The purple dye present in the polymeric film (Triafol-BN) got destroyed to an appreciable extent by a gamma dose of $10^6$ Gy and therefore, the colour of the Triafol-BN films disappeared.
(3) The thermal stability for the Triafol-BN decreases at $10^6$ Gy of gamma dose and it starts losing weight at lower temperature (220°C).

(4) There are also indications about CO$_2$ formation through the destruction of ester or ether groups in Triafol-BN polymeric film at $10^6$ Gy gamma dose.

(5) This destruction in Triafol-BN leads to a decrease in average molecular weight of the polymer and consequently increases the bulk-etch rate.

(6) It has been observed that the bulk-etch rate increases with gamma doses for Triafol-BN detector, but the activation energy for bulk-etching does not change significantly.

(7) Bulk-etch rates of Makrofol-E, Lexan and Polycarbonate are not altered to an appreciable extent by exposing to high doses of gamma radiation ($10^6$ Gy). This may be due to the presence of two benzene rings in the monomer units of these polymers which provide resistance to radiation induced damage due to delocalization of the excitation energy.

(8) From the UV-VIS studies one may conclude that, for dosimetric applications of these polymers (Makrofol-E, Lexan and Polycarbonate) gamma doses of $10^4$ Gy and above are suitable.

(9) Thermal resistance has not been modified by different doses of gamma radiation for Makrofol-E and Lexan polymers. But for
Polycarbonate, thermal resistance decreases at higher doses ($10^6$ Gy) and the weight loss starts at lower temperature ($410^\circ$C).

(10) ESR study for Makrfol-E, Lexan and Polycarbonate give the information about the cleavage of C-H bond of Benzene ring. The radical which is formed on carbon atom delocalizes in the ring system. The hydrogen radical formed probably combines with other hydrogen radical to produce hydrogen gas.

(11) For PADC polymeric films upto the doses of $10^5$ Gy, neither bond scissioning nor cross-linking has taken place. But at the dose of $10^6$ Gy, etch-rate increases due to the consequence of bonds cleavage.

(12) At the dose of $10^6$ Gy, it has been observed that the bonds joining polyallyl chains with diethyleneglycol in PADC (American Acrylics) have been possibly raptured due to passage of gamma rays and produce following radicals:

\[
\text{Under gamma radiation (at } 10^6\text{ Gy)}
\]

\[
2 \left[ \begin{array}{c}
\left(\text{CH}_2\right)_{n} \text{CH}_2 \\
\end{array} \right] + \begin{array}{c}
\cdot \text{C} \text{O} \text{C}_2\text{H}_4 \text{O} \text{C}_2\text{H}_4 \text{O} \text{C} \text{O} \end{array}
\]
(13) In the case of PADC (American Acrylics) the etch rates remain invariant for both pre- and post-mode of gamma exposure, whereas for PADC (Homalite), the post gamma exposure enhances etch-rates value as compared to pre-gamma exposure. This is presumably due to the deposition of additional energy for post-gamma exposure at the latent damage trails created by fission fragments in the material.

(14) It have been observed that the bulk-etch rate increases for both the PADC detectors with gamma doses, but the activation energy does not change significantly.

(15) UV-VIS study reveals that the dosimetric applications of PADC (American Acrylics), are suitable for gamma doses higher than $10^3$ Gy.

(16) The appearance of colour (Yellow) in exposed PADC (American Acrylics) at high doses is due to the presence of radicals. These are formed and trapped in the detector matrix and are responsible for imparting colour to the transparent sample.
6.2 FUTURE PERSPECTIVES :- On the basis of the results of the present experiment, it is established that this area of research has a wider scope for further studies. Following activities may augment the present studies for a deeper understanding of the radiation induced modifications of the polymers:

(1) It will be useful to study the change in the track properties in PADC by gradual increase of gamma dose from $10^5$ to $10^6$ Gy, for its possible use as dosimeter.

(2) Studies at higher doses (above $10^6$ Gy) will be significant in the case of Makrofol-E, Polycarbonate and Lexan, for understanding and quantifying the etching response of these materials under gamma exposure.

(3) Both for Triafol-TN and Triafol-BN polymers, it is necessary to study the effect of gradual increase in gamma dose in the range between $10^5$ - $10^6$ Gy on its bulk-etch properties.

(4) Low temperature irradiation followed by ESR study will be useful for trapping the radicals formed by chain scission.

(5) UV-VIS study can be used to find out the effect of different doses of gamma rays on the optical band gap and accordingly the size of carbon cluster formed by radiation damage.

(6) Several commonly used polymers (viz. PET, PI, PP, PVC, PVDF etc.) and newer materials such as SR-86, SR-90, LR-115 etc. should be studied for their response to gamma exposure.
(7) XRD studies can be done to observe the structural changes (amorphization, dilation, distortions) caused by gamma radiation in these polymers.

(8) Heavy ion induced modifications of these polymers may also be carried out. The SEM, TEM study will be useful for understanding the surface damage induced by heavy ions on these polymers.

(9) Some other studies like Conductivity, Thermoluminesence, Annealing and Hardness measurements are also important to evaluate radiation induced modifications in these polymers.