Abstract

An appropriate radiation shielding material is necessary to protect the life of electronic component from degrading due to the harmful radiations such as; x rays, γ rays, neutrons etc. emitted from unshielded sources. High density materials such as lead bricks or high density concrete are often used for this purpose.

Polymers, polymer blends and composites are largely used in electronics industries for various applications. Polymers are transparent to radiation. Due to poor radiation absorption characteristics of polymer and composite materials, they are not used as shielding enclosures for electronic devices. This drawback has encouraged the development in the research for radiation hardened polymers. Radiation hardened composite materials can absorb radiation and prevent failure of shielded electronic device under radiation environment and thus enhance the life time of the device.

The objective of the present work is to develop composite materials which can be used for absorption of gamma and neutron radiation, to protect electronic devices or components under nuclear environment. Absorption characteristics is the most important characteristic of the radiation hardened composite materials to be developed. Another important characteristic of such newly developed radiation hardened materials is its life time to sustain under radiation environment.

Based on literature survey, epoxy based polymer was selected to modify it and make it radiation hardened composite material. Hence, Epoxy/graphite powder, epoxy/lead powder, and epoxy/boron nitrided nano powder composites using two different combinations of HALS as primary stabilizer and UV absorber or TVP as secondary stabilisers were prepared using simple gravity casting method.

The prepared composite materials were exposed to 10 to 50 kGy gamma radiation. The samples were further cured by thermal treatment for different time periods. Tensile strength at break and % elongation was measured before and after exposure to radiations. A comparative study was carried out and the best composition among all prepared materials is proposed.

Absorption characteristics of the developed composites materials were tested with Linear Absorption Coefficient (LAC) analysis. To find out linear absorption coefficient for neutrons, an
experiment was carried out using Am-Be neutron source and Monte Carlo simulation is used to predict the LAC for gamma radiations using same parameters as neutron radiations. The half value layer (HVL) of eight different composite materials were calculated and compared.

Thermal stability was measured using DMA Deflection Temperature Under Load (DTUL) and TGA methods. The mechanical response at DTUL is found between 80° C to 100° C for all samples. TGA results show that all samples are thermally stable upto 300° C.

The lifetime of the samples is estimated using kinetics study using the TGA instrument. The lifetime for all the developed samples was calculated by exposing them to 50° C temperature; and it ranges from 10 to 45 years for different samples. TML and CVCM results are also found satisfactory for satellite application in space.

SEM images show better curing in irradiated and aged samples and uniform filler dispersion. Thermal conductivity of the material prepared is found between 0.2 W/m.K to 0.25 W/m.K.

The two selected materials were also tested for space application test of Total Mass Loss (TML) and Collected Volatile Condensable Materials (CVCM) from outgassing in a vacuum environment by using standard test methods.

Thus the indigenous radiation hardened polymer composite for shielding application is prepared and characterized. Such material can be used to absorb radiation in nuclear environment or for any other applications where radiation exposure is expected.

**Key words:** Epoxy resin; composite; gamma radiation; neutron radiation; graphite; lead; boron nitrided nano powder; hinder amine light stabiliser; UV absorber; trivalent phosphorous; linear absorption coefficient; half value layer; life time prediction.