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Non Destructive Radiation Dosimetry Using Diffuse Reflectance Spectroscopy

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Ultra-high molecular weight polyethylene (UHMWPE) is one of the polymers belongs to polyethylene (PE) family having monomer $-CH_2-$ and average molecular weight is approximately 3-6 million g/mol. Due its chemical, mechanical, physical and biocompatible properties, it has been extensively used in the field of electrical insulation, medicine, orthopedic, microelectronics, engineering, chemistry and the food industry etc. In order to alter/modify the properties of UHMWPE for particular application of interest, certain various procedures are in practice e.g. treating the material with high energy irradiation like gamma ray, e-beam, and ion bombardment. Radiation treatment of UHMWPE induces free radicals within its matrix, and these free radicals are the precursors of chain scission, chain accumulation, formation of double bonds, molecular emission, crosslinking etc. All the aforementioned physical and chemical processes are mainly responsible for the modification of polymers properties to use them in any particular application of our interest e.g. to fabricate LEDs, optical sensors, anti reflective coatings, polymeric optical fibers, and most importantly for radiation dosimetry applications. It is therefore, to check the feasibility of using UHMWPE for radiation dosimetry applications, the compressed sheets of UHMWPE were irradiated at room temperature ($\sim 25^\circ\text{C}$) for total dose values of 30 kGy and 100 kGy, respectively while one were kept un-irradiated as reference. Reflectance data (from 200 nm to 1200 nm) of gamma ray irradiated UHMWPE were measured by using diffuse reflectance spectrometer setup. As a result significant changes occur in the absorption behavior of irradiated samples. To analyze these (radiation induced) changes in polymer matrix Urbach edge method and modified Tauc's equation has been used. The results reveal that optical activation energy has the direct relation with absorbed radiation dose. A similar trend was found for direct and indirect energy band gaps with irradiation due to variation of C=C unsaturation in clusters. We believe that the reported results would open new horizons for radiation dosimetry applications.

Country/Organization invited to participate

Pakistan

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