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Nanocarbon Based PolyLY(Ethylene-Terephtalate) Nanocomposites and Various Irradiations

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Background of the study
Ionizing and UV radiation produce reactive species in irradiated material. The concentration and distribution of those species depends on the linear energy transfer rate of a corresponding radiation type. Electromagnetic radiation like gamma or X-rays has high penetration but relatively few reactive species form relatively far apart. Particulate radiations like protons produce high concentration of ionizations and break a lot of chemical bonds along their tracks but have much lower penetration. All ionizing radiation types have enough energy to break any type of chemical bonds while UV can induce breaking only of some less stable chemical bonds. The type of radiation and its quantity, dose, are not the only factors that determine the response of polymers and (nano)composites. It depends also on the chemical structure of the polymer matrix so the overall outcome can be degradation, cross-linking and/or latent track formation.
Poly(ethylene terephtalate) (PET) is widely used thermoplastic polymer with excellent engineering properties and its radiation stability is expected increase on addition of appropriate (nano)fillers.
Methodology
Pure PET film and two of its nano-carbon containing nano-composite films, one with nano-diamonds (ND) and the with other combination of nano-diamonds and graphene nanoplatelets (NGP) were studied. One group of samples was irradiated with 60-Co gamma radiation in range between 0.2 and 1. 05 MGy at a dose rate of 2.5 Gy/s, in contact with air. The other group was irradiated with a 3 MeV proton beam delivered by the 1.0 MV Tandetron (at the fluences of 1014 p/cm2 and 1016 p/cm2) in vacuum. The third group was exposed to UVC radiation (wavelength 254 nm, the lamp intensity 9 mW). Irradiation effects were studied using thermal and spectroscopic methods.
Results
Thermal analysis by DSC showed that the crystallinity of PET was just minimally affected by introduction of nanofillers. Various irradiation types produced different outcomes. DSC revealed that ordered amorphous phase of irradiated samples was more influenced than its mobile segment and crystalline was the least affected. Only slight changes were observed in PET and the nanocomposites irradiated up to 0.5 MGy with gamma irradiation. Proton irradiation produced much more damage. Graphene containing nanocomposite was more resistant to proton irradiation than the one containing only nano-diamonds. On the other hand UV radiation produced the most significant degradation in all samples and particularly in graphene containing nanocomposite.
Conclusions
The irradiation outcome of PET and its nano-carbon containing nano-composites depended primarily on the radiation type while nanofiller had only slight influence. The most sensitive part was ordered amorphous phase of PET matrix. All samples were relatively stable to gamma-radiation. Pure PET was significantly degraded by proton irradiation while UV produced the most degradation in graphene containing nanocomposite.

Country/Organization invited to participate

Croatia

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