Chapter

GAMMA IRRADIATION: PROPERTIES, BEHAVIOR AND APPLICATIONS

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ABSTRACT

Gamma radiations are used for sterilization processes in medical devices, food industry as well as in nuclear power plants or aerospace. Gamma irradiation is a very convenient tool for the modification of polymeric materials. The irradiation of polymeric materials with ionizing radiation (γ–rays, X-rays, accelerated electrons, ion beams, etc.) lead to the formation of very reactive

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intermediates, free radicals, ions and excited states. These intermediates can follow several reaction paths that result in disproportion, hydrogen abstraction, arrangements and/or the formation of new bonds. The degree of these transformations depends on the structure of the polymer and the conditions of treatment before, during and after irradiation. Through control of all of these factors facilitates the modification of polymers by radiation processing. Nowadays, the modification of polymers covers radiation crosslinking, radiation-induced graft polymerization, radiation curing and the degradation of polymers. The success of radiation technology for the processing of synthetic polymers can be attributed to two reasons, namely the easiness of processing in various shapes and sizes and secondly, most of these polymers undergo crosslinking reaction upon exposure to radiation. On the other hand, naturally occurring polymers were difficult to process and degraded when exposed to high energy radiation either in solid state or in dilute aqueous solution. For example: polyethylene in general crosslinks on irradiation, although there is a chain scission mechanism as well; aromatic polymers (e.g., with benzene rings) are radiation resistant; polymers such as PET, PU, PSU, PC, etc. can easily sterilized due to presence of benzene ring; aliphatic polymers exhibit degrees of resistance depending upon their levels of unsaturation and substitution; highly amorphous materials are generally radiation resistant then semi-crystalline polymers; polymers with butylene backbone such as ABS, PBT, etc. lose impact strength on irradiation; thermosets such as phenol formaldehyde and urea formaldehyde are both reasonably suitable for irradiation sterilization; polyvinyl chloride is suitable for single-dose radiation sterilization both in its unplasticized and plasticized forms. Certain polymers such as fluoropolymers (PTFE, PVDF), polypropylene, etc. however, do not stand up to γ–radiation exposure well for sterilization polyacetals.

Keywords: γ–rays, properties, behavior, application, γ–decay, γ–ray production