STUDY OF GAMMA-IRRADIATED BIOPHARMACEUTICAL FILMS

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Preventing cross-contamination, saving costs and increasing configuration flexibility make the adoption of single-use technologies very attractive for the biopharmaceutical industry. The integrity and the security of bags are due to appropriate flexible and barrier polymeric materials, such as polyethylene (PE) or ethylene vinyl acetate (EVA) and polyethylene-co-vinyl alcohol (EVOH), which are barrier to water vapor and oxygen, respectively. Conventional stainless steel tanks are sterilized by steam sterilization by the end-users, whereas plastic containers are sterilized by gamma-irradiation before delivery. The major advantage of radio-sterilization is the penetration power of the γ-radiation. It is known that γ-sterilization of polyolefin based polymer leads to alterations of the material: changes in the additives or potential damage to the polymer, as reported in the literature. Irradiation of polymeric materials has been proven to initiate radiation chemical reactions inside the polymeric material, leading to either an increase or a decrease in the polymer molecular weight. The effects of γ-irradiation on polymers are well known whereas the effects of γ-irradiation on multilayer films have been little investigated. In the case of multilayer films, the acidity of the stored solution increased after gamma irradiation for instance. In another case oxidation of the solution occurred. Such observations denote the presence of acidic and oxidant compounds, which are issued either from modification of surface of the film or from the migration of by-products from core to surface.

A global investigation on γ-irradiation on multilayer films is performed to investigate the γ-irradiation based modifications on PE(Polyethylene)/EVOH(Ethylene Vinyl Alcohol)/PE film and EVA(Ethylene Vinyl Acetate)/EVOH/EVA film to assess the multilayer film robustness. Several approaches could be used to study the impact of γ-irradiation on multilayer films, as ESR (Electron Spin Resonance) to observe the radicals formation, ATR-FTIR (Attenuated Total Reflection-Fourier Transform Infrared) and Raman spectroscopies to observe the structural modifications, the measurement of yellowing, the measurement of O₂ transmission rate (O₂TR) and water vapor transmission rate (WVTR), the measurement of pH to follow the acidity change of solution contained in the bag and the mechanical test to evaluate the toughness of film. Due to the number of data recorded, chemometric methods, such as Principal Component Analysis (PCA), are applied to enhance the weak variations brought to the γ-irradiation of the multilayer films in the different data sets. Results show that films undergo modifications at microscopic level and that they are not altered from macroscopic and application viewpoints. Results are equivalent from batch to batch assuring then a reproducibility of the films behavior for their integration in single-use systems.