

Effects of gamma irradiation on 3D-printed polylactic acid (PLA) and high-density polyethylene (HDPE)

Authors: A. Alsabbagh, R. Abu Saleem, R. Almasri, S. Aljarrah & S. Awad

Abstract: Effect of gamma radiation on the mechanical and structural properties of polylactic acid (PLA) and high-density polyethylene (HDPE) is analyzed. Samples were irradiated in ambient conditions with doses in the range of (0?175 kGy) using ⁶⁰Co gamma irradiation facility. Experimental results showed a clear effect of gamma radiation on polymer properties through the action of crosslinking, chain scission and oxidative degradation. Tensile testing results for both polymers showed a decrease in the tensile strength and ductility at high irradiation doses, suggesting that the effect of both chain scission and oxidative degradation is dominant over crosslinking for higher doses. Results from Fourier transform infrared (FTIR) spectroscopy show that signature peaks of both PLA and HDPE were present after irradiation indicating that exposure to gamma radiation does not lead to diminishing their corresponding structural modes. Nevertheless, new peaks were observed upon irradiation of HDPE samples. These new peaks are attributed to modes of different oxygen bonds in oxidation products such as carbonyl groups and alcohol groups. Finally, X-ray diffraction (XRD) results show that both polymers exhibit increased crystallinity with increased radiation exposure due to chain splitting that is stimulated by oxidative reactions.