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Green High-Density Polyethylene/Hydroxyapatite Nanoparticle composite (G-HDPE/HA): Mechanical and thermal performance

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Polymeric composites with hydroxyapatite have been studied for application in the manufacture of human implants. For this purpose, high density polyethylene (HDPE) is a widely used polymer due to its high mechanical strength, non-toxicity and excellent processability. In turn, hydroxyapatite is a ceramic material based on a calcium phosphate structure, which favors the recalcification processes in human implants. In this study, hydroxyapatite nanoparticles were incorporated into a Green HDPE matrix by extrusion process, and this new composite was named G-HDPE/HA. The effect of different concentrations of maleic anhydride grafted polyethylene (PE-g-MAH) and hydroxyapatite nanoparticles were evaluated on the mechanical performance of the G-HDPE/HA composite. Young's modulus, maximum stress, bending stress and impact strength were studied and the best mechanical responses were estimated and related as a function of composite formulations. Thermal analyzes were performed for the different compositions and the degree of crystallinity and the respective enthalpy values for the melting and crystallization transitions of the G-HDPE matrix were determined. Additionally, hydrolytic degradation tests were performed to evaluate the biological stability of the G-HDPE-HA composite, and the surfaces were analyzed by scanning electron microscopy (SEM) and by energy dispersive X-ray spectroscopy (EDS). The results showed that the addition of hydroxyapatite nanoparticles significantly increases the degree of crystallinity and improves the mechanical properties of the polymer matrix, but the impact strength decreases. The G-HDPE/HA composite was not degraded by the hydrolytic process. The results are excellent indications that the G-HDPE/HA composite is a promising material for the fabrication of biomedical devices from green polymers associated with hydroxyapatite nanoparticles.