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Radiation –Induced Oxidation in Gamma-Irradiated UHMWPE Modified with Hydroxyapatite

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The medical use of ultra-high molecular weight polyethylene (UHMWPE) as the bone replacement as well as the manufacture of sterile sealed cases and envelopes require detailed investigations on the chemical stability over long time wearing. To impart high similarity to substituted hard parts of osseous system, the addition of hydroxyapatite to the polymeric material is an attractive option. The present study investigates three polymer composites consisting of UHMWPE and LDPE to which hydroxyapatite (HAP) was added in the concentration of 10 %. Some of samples were stabilized with rosemary extract powder (0.5 %). Films and flat plates were obtained by melting in a BRABENDER Plastograph, under a mixing temperature of 180℃ for 10 min and screws rotation rate of 40 rpm followed by the thermal processing in a laboratory press type POLYSTAT 200 at the following conditions: temperature: 165℃, pressing time 3-6 minutes, pressure of 125-150 atm and cooling time of 30 minutes. Gamma exposure for the accelerated degradation was carried-out in air inside of Ob Servo Sanguis (Hungary) irradiator provided with 60Co source, whose dose rate was 1.1 kGy h-1. The stability and structural characterization were done by isothermal (180 oC) and nonisothermal (heating rate: 10 oC min-1) differential scanning calorimetry in inert and air environments and by ATR-FTIR spectroscopy. The influence of hydroxyapatite and rosemary powder is noticed by the improvement in the kinetic parameters: the decrease of oxidation rates and the extension of total oxidation periods. The progress in the ageing degree is described by the carbonyl index, whose variation is connected to the inhibition promoted by the large surface of hydroxyapatite particles playing the role of adsorbent of free radicals and by the scavenging activity of rosemary components, where the predominant active principle is carnosic acid. In spite of the difference in the behavior of polymeric components relative to the oxidative degradation the evolution of oxidation looks similarly in respect to the accumulation of initiators, hydroperoxyl radicals. The oxidation resistance of studied blends is ameliorated because the both polymeric components are regarded as sources of free radicals, but the addition of hydroxyapatite and rosemary powder makes possible the manufacture of products with long term applications. The contribution of HAP and rosemary additive is significant not only on the early stages of ageing, but also during the exposure to a severe energetic transfer.
The efficiency in the oxidation delay in UHMWPE/LDPE blends can be expected when the stress agents are less strong than ⍰-radiation. However, the comparative study involving indoor weathering degradation is foreseen, because the oxidation strength of these compositions including hydroxyapatite allows the extension of usage ranges in several areas as outdoor components of industrial devices.

Country/Organization invited to participate

Romania

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