SUMMARY

Morphology and properties of polyethylene/silica nanocomposites with immobilized copper nanoparticles

The original method for obtaining nanosilica with increased resistance to micro-organisms, containing immobilized copper nanoparticles (Cu-SiO_2) was developed. Prepared by sol-gel process Cu-SiO_2 was incorporated into high density polyethylene (HD-PE). In order to improve the dispersion and increase the compatibility of the filler with the polymer matrix, high density polyethylene grafted with maleic anhydride (MPE-HD) was used as a compatibilizer. Many interdisciplinary research methods have been used to evaluate the properties of the new materials obtained, *e.g.*: atomic absorption spectroscopy (AAS), correlation photon spectroscopy (PCS), X-ray powder diffraction (XRD), scanning electron microscopy (SEM), X-ray energy dispersion spectroscopy (EDS), transmission electron microscopy (TEM), differential scanning calorimetry (DSC), dynamic-mechanical thermal analysis (DMTA) and thermogravimetric analysis (TGA) as well as bioluminescence and fluorescence staining methods. XRD results proved the presence of copper on the second oxidation stage in Cu-SiO_2. It has also been proven, that Cu-SiO_2 has 100 % biocide effect against *Escherichia coli* and *Staphylococcus aureus*, and its composites have bactericidal properties. Increased compatibility between filler and polymer matrix and uniform dispersion of Cu-SiO_2 were observed in the presence of MHD-PE. The composites were characterised by higher thermal stability, tensile and flexural strength, stiffness, as well as better barrier properties (lower oxygen permeability). The most favourable mechanical properties were obtained by introducing nanosilica with a particle size of 30 nm. However, the highest thermal stability was observed for the composite containing silica nanoparticles with a size of 60 nm.

Keywords: nanocomposites, high density polyethylene, nanosilica, copper nanoparticles