THERMOPLASTIC STARCH- $LA(OH)_3$ NANOCOMPOSITES: PREPARATION AND PROPERTIES

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ABSTRACT

Nanostructured lanthanum (III)-oxide (La_2O_3) particles were prepared by a polymer complex solution (PCS) method and further used for the preparation of lanthanum hydroxide ($La(OH)_3$) nanoparticles. The obtained $La(OH)_3$ nanopowder was used as filler for glycerol-plasticized maize starch films. The structural and morphological properties of the $La(OH)_3$ nanoparticles were studied using transmission and high resolution transmission electron microscopy (TEM and HRTEM), and X-ray diffraction techniques. The pure thermoplastic starch (TPS) and the TPS-$La(OH)_3$ nanocomposite films were conditioned at various relative humidities (35, 57, 75 and 99% RH). The physical properties of the films were investigated with respect to moisture content and the concentration of the filler (1, 2 and 3 wt.%). After conditioning at 99% RH, the pure TPS films exhibited higher affinity towards water than the nanocomposites. DSC measurements showed that, due to retrogradation effects, the melting enthalpies of the films increased with increasing relative humidity. On the other hand, at fixed RH, the crystallinity of the films increased in the presence of nanoparticles, while at the same time the melting peaks were shifted towards higher temperatures. Dynamic mechanical analysis (DMA) revealed that the mechanical properties in the linear range strongly depend on both the humidity conditions and the concentration of the filler. The results also show that $La(OH)_3$ nanoparticles are good reinforcement for TPS films. For example, the nanocomposite film with 1 wt.% $La(OH)_3$ conditioned at 57% RH showed significant increases in elastic modulus and tensile strength. At higher relative humidities (75% RH), the reinforcement effects of the filler became less pronounced.