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Composite materials with polylactide matrix

Abstract

Within the frame of the doctoral thesis, composite materials with polylactide (PLA) matrix were obtained and studied. Various fillers were used: waste cotton fibers, cellulose fibers, organically modified montmorillonite, calcium carbonate unmodified and modified with calcium stearate or stearic acid. Calcium carbonate with different grain size, 40 nm and 90 nm, as well as submicron size, was used. Moreover, hybrid composites containing cellulose fibers and nanograins of calcium carbonate, modified with calcium stearate, or organically modified montmorillonite were prepared and examined. Structure as well as thermal and mechanical properties of the composites were investigated. In general, the properties of the composites with amorphous matrix were analyzed, although in the case of the composites with calcium carbonate also the influence of matrix crystallinity on the properties was studied. In all cases the dispersion of fillers in the PLA matrix was examined. The influence of the fillers on glass transition temperature and on cold crystallization of the polymer matrix as well as on its thermal stability was determined. The mechanical properties of the composites were tested during uniaxial drawing, and additionally a dynamic mechanical thermal analysis of these materials was carried out. While the glass transition temperature of the PLA matrix in the composites did not change significantly, the cold crystallization was influenced by ability of the fillers to nucleate this process. Although the thermal stability worsened, except for the composite containing only montmorillonite, a significant weight loss occurred at a temperature higher than the temperature of PLA processing. The mechanical properties depended on the type and content of the fillers. Although the tensile elongation at break of the composites with waste cotton fibers was less than that of pure PLA, slight improvement of the tensile strength was achieved. Moreover an increase of the storage modulus by approx. 50% was reached. The tensile properties of the hybrid composites were dominated by the presence of cellulose fibers. The composite with these fibers as well as the hybrid composites broke at low elongation. However, the hybrid composites exhibited the storage modulus by approx. 45-50% higher than

that of PLA. In the case of composites with calcium carbonate, an increase of the tensile elongation at break, maximum two-fold, was achieved only for the amorphous matrix nanocomposites with stearic acid-modified calcium carbonate nanograins, which was accompanied by only a slight decrease of the tensile strength. However, the absence of modification, which worsened the dispersion, the submicron grain size and crystallinity of the matrix resulted in a fracture at low elongation. The presence of the fillers and matrix crystallinity caused a slight increase of the elastic modulus, by up to approx. 15%.