COMPARATIVE ANALYSIS OF POLYLACTIDE THERMAL DESTRUCTION IN THE PRESENCE OF LAYERED SILICATES CLOISITE NA AND CLOISITE 30B

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Abstract: The effect of mineral fillers with a nanostructure on the mechanism of thermal destruction of polylactide (PLA) was studied. The layered silicates Cloisite Na and Cloisite 30B were used, differing in the cation contained in the interlayer space: inorganic — Na^+ and organic — quaternary ammonium salt. To study the effect of fillers, the compositions with three different concentrations for each filler were prepared. The PLA/nanoclay compositions were obtained by drying solutions of components in methylene chloride. Pyrolysis of solid composites was carried out in a flow tubular reactor and volatile decomposition products were condensed in methylene chloride. Analysis by gas chromatography with mass spectrometric detection showed a significant effect of each of the fillers on the mechanism of thermal destruction of PLA. Based on the obtained results, a mechanism of thermal transformations of PLA in the presence of nanoclays is proposed.

Keywords: polylactide; nanoclays; thermal destruction; pyrolysis; gas chromatography – mass spectrometry

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Figure Captions

Figure 1 Chemical structure of the Cloisite 30B cation where T is an alkyl substituent ($\sim 65\%$ C_{18}, $\sim 30\%$ C_{16}, and $\sim 5\%$ C_{14})

Figure 2 Total ion current chromatograms of pyrolysis products: PLA without additives (*a*) and PLA / Closite Na composite (*b*)–(*d*) with a filler content of 1%, 5%, and 10%, respectively

Figure 3 Total ion current chromatograms of pyrolysis products: PLA without additives (*a*) and PLA / Closite 30B composite (*b*)–(*d*) with a filler content of 1%, 5%, and 10%, respectively

Figure 4 Scheme of possible directions of lactides formation and cyclic oligomers during PLA pyrolysis: thermal decomposition of the polymer chain with free end groups (*a*) and the hindrance of these decomposition directions after interaction with nanoclays (*b*)

Figure 5 Scheme of 1,3-dimethyldioxalan-4-one's formation in the case of free end groups of PLA (*a*) and the difficulty of this direction after interaction with nanoclays (*b*)

Table Captions

Table 1 Pyrolysis products of PLA and its composites PLA / Closite Na with indication of yield times and percentage content of mixture components calculated using Eq. (1) relative to the total peak area

Table 2 Pyrolysis products of PLA and its composite PLA / Closite 30B with indication of yield times and percentage content of mixture components calculated using Eq. (1) relative to the total peak area

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