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ORIGINAL PAPER

TG/FTIR/MS study on the influence of nanoparticles content upon the thermal decomposition of starch/poly(vinyl alcohol) montmorillonite nanocomposites

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Abstract The effect of the nanoclay content on the thermal decomposition of nanocomposites based on poly(vinyl alcohol)/thermoplastic starch, as intercalated hybrids, has been established. The changes in the decomposition products distribution and their evolution have been investigated by coupled thermogravimetric analysis, Fourier transform infrared spectroscopy, and mass spectrometry. Detailed analysis of the in situ vapor phase showed that the poly(vinyl alcohol)/starch/clay nanocomposites display a completely different distribution pattern of degradation product, depending on nanoclay content. By in situ vapor phase FTIR and MS spectroscopic techniques, both decomposition compounds of the constituent polymers and some new ones, depending on the nanoparticles content, are identified. The effect of the increase in nanoparticles content consists mainly in variation of some volatile compounds evolution, such as formic acid, water, formaldehyde, propionic acid, methanol, acetic acid carbon dioxide, benzene, etc., which in the case of nanocomposites is very complex. Thus, a content of 2–4 wt% organically-modified montmorillonite hinders the decomposition of the poly(vinyl alcohol)/starch blend. Both characteristic temperature of evolution of the main compounds increases by increasing its content and evolution starting time is delayed; while the untreated nanoclay acts like a catalyst, which decreases characteristic temperatures and evolution time with increasing its content. The temperature dependence of the maximum evolution rate of various compounds on the nanoclay content is very complex as, in the case of nanocomposites, of both primary and secondary reactions and transport phenomena occur simultaneously. Generally, this behavior is related to the dispersion of nanoclays in the polymeric matrix.

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Introduction

The layered silicate materials used as nanoscale reinforcements represent a very interesting topic in the research and applications of polymeric materials. As generally known, incorporation of 1–5 wt% montmorillonite content into a polymer matrix significantly improves its mechanical resistance, due to the nanometric dimensions of the clay nanoparticles and high aspect ratio. Nanoscale phase distribution as well as the polymer-layered silicate synergism confers additional properties, such as flame retardation, enhanced barrier properties, and ablation resistance.

Thermal stability is one of the most important characteristics of nanocomposites. In particular, thermal stability, depending on their structure and morphology, was considered as an important factor in nanocomposites applications [1]. Generally, if processing temperature is higher than the thermal stability of the organic component used for montmorillonite modification, decomposition will take place, leading to variations in material's structure. All polymer/clay nanocomposites preparations require high temperatures for their fabrication, while most polymeric materials require prolonged service in air at high temperatures. Thus, determination of the onset temperature for thermal degradation, of the resulting products of thermal degradation and stability of polymer in the presence of