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Study on incorporation of nanozeolite ZSM-5 in thermoplastic starch.

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Abstract – Since its discovery zeolites have been studied in several fronts of science, its ability to ion exchange, adsorption, hydrophilicity and other qualities of the zeolite is a potential material to be used as nanocomposites in polymer systems, where the demand for increased production, replacement of polymer based synthetic oil by biodegradable is one of the main thoughts today.

The current demand of the domestic and international food market makes the Brazilian agribusiness constantly seek improvements in food production processes and storage, aiming at improving competitiveness and reducing waste. Thus, in the packaging field, several researches using biodegradable polymer systems have been studied. The starch, which is a polymer from agricultural sources, comes as a possibility to replace the synthetic polymers. The thermoplastic starch has poor mechanical performance and high hygroscopicity, which complicates its use in large scale[1]. One of the strategies to improve these properties is the introduction of nanocomposites in the polymer matrix. Therefore, this study proposed the incorporation of nano-zeolites in the matrix of starch in order to promote improvement especially in relation to water permeability. Six compositions containing thermoplastic starch were prepared: 0, 2, 4, 6, 8 and 10% in zeolite weight ZSM-5. The mixtures were prepared in Haake with the following conditions: 160°C, 200rpm for 6 minutes. At the end of the process were made specimens for testing mechanical strength, DMA and TGA.

The result of TGA analysis of the samples (Fig. 1) shows that the samples lose remaining water up to 160°C in different ways, which may indicate that the zeolite is coordinating the water inside the polymer structure. At a temperature next to 320°C the maximum loss of volatiles happens and, as shown in Figure 1, there was no change in the mass loss mechanism, because there is no curves displacement. The analysis of DMA (Fig. 2) for the samples clearly show the formation of two peaks, the first around -55°C is characteristic of glycerol that is used to plasticize the starch, in this peak for the samples from 6 to 10% there is a slight shift to more negative temperatures, which may indicate a coordination of glycerol by the zeolite in the polymer matrix, the second broader peak corresponds to the Tg (glass transition temperature) characteristic of amorphous starch.The result of mechanical strength (Fig. 3) shows the same trend from the past performances, up to 6% there were gain in mechanical properties, over that amount the opposite happens, indicating that the zeolite in a polymer matrix may be behaving as a failure in the structure lowering its resistance.

We can conclude that it is possible to use the zeolite in the polymer matrix even in reasonable quantities without loss of mechanical properties, an important fact is that we can incorporate molecules in zeolites, due to its ion exchange capacity and controlled release to prevent contamination of products which use packaging made of TPS.

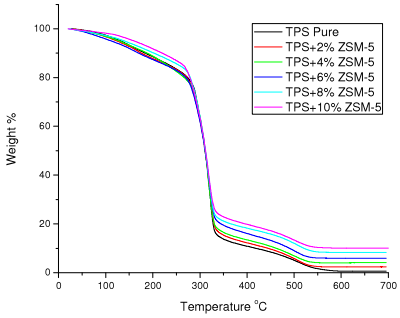

Figure 1 – *Analysis of TGA, showing no change mechanism of mass loss.*

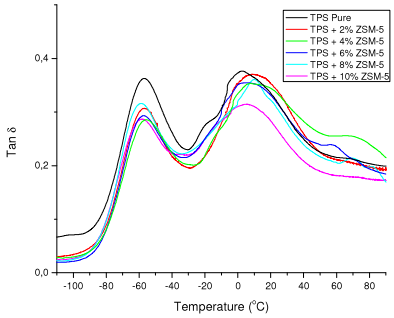

Figure 2 – *Analysis of DMA, showing the transitions of glycerol (≈–55°C), and peek glass transition of amorphous starch.*

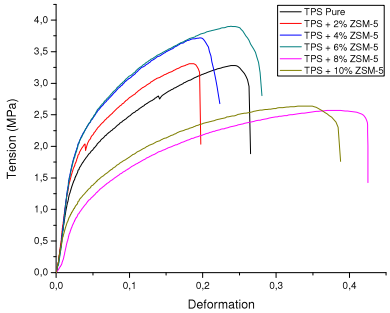

Figure 3 – *Testing of mechanical traction, showing the tendency of the system TPS/zeolite, after gaining up to 6% more than this value the zeolite present may be behaving as failed.*

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[1] CORRADINI, E., TEIXEIRA, E.M., AGNELLI, J.A.M., MATTOSO, L.H.C.; Amido termoplástico – São Carlos: Embrapa Instrumentação Agropecuária, 2007. 27 p. (Documentos Embrapa Instrumentação Agropecuária; 30).