RHEOLOGY OF BIOCOMPOSITES

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ABSTRACT

The development of biocomposites has received a great deal of attention recently due to the concepts of sustainable development and circular economy. This is why biobased materials are more interesting to reduce their carbon footprint, especially when all the materials (matrix and reinforcements) are from a "natural" origin.

In this work, polylactic acid (PLA) was selected as the matrix because of its biodegradability and biocompatibility. But this biopolymer is seldom used alone and its properties can be improved by adding different plasticizers and fillers. In particular, spent coffee ground (SCG) is a valuable resource but still considered as a residue going to landfill. Due to its high amount generated every day, it would be interesting to valorize this material by introduction into a biopolymer and determine its effect in terms of mechanical and thermal properties.

So the main objective of this study was to determine the effect of SCG concentration (0, 10, 20 and 30 wt.%) on the properties of PLA-based biocomposites. As a first step, no other additive was added to limit the interaction and the raw materials cost, while producing a 100% biobased material.

The samples were first dried and compounded via twin-screw extrusion and pelletized before being molded by compression. From the sample produced, several characterizations were performed in terms of density, crystallinity and thermal properties to get a general overview of the main properties of the biocomposites produced. Then, a more specific analysis is performed on the rheological properties in the melt state (strain sweeps and frequency sweeps) at different temperature (180, 190 and 200 ºC) to relate the processing conditions with the formulation of the samples. To complete the analysis, rheological measurements in the solid state (strain sweeps, frequency sweeps and temperature sweeps) are also performed to determine the overall behavior under different conditions.

The results obtained showed that the biocomposites have a very complex behavior as their behavior represents a balance between the reinforcing effect of the solid SCG particles and the plasticizing effect of residual extractives inside these particles coming from the coffee making

process. Overall, it was found that 20 wt.% SCG provided the best balanced between all the properties investigated.

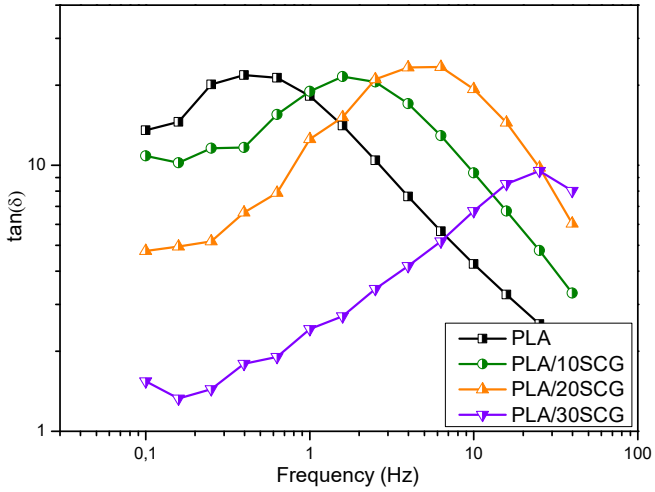

Figure 1: Loss tangent as a function of frequency for PLA biocomposites with different SCG content at 200 °C