Development of New Competitive and Sustainable Bio-Based Plastics

Co-blending PHB with PLA

An increasing consumers' awareness of 'green' solutions for the needs of everyday life leads to a growing market of sustainable packaging applications. A possible technical solution, developed with completely bio-based materials suitable for an industrial scale-up, may be the preparation of blends based on biopolymers, such as PLA and PHB. Within the frame of the NEWPACK project, the involved partners face the challenge of developing new bio-based and biodegradable blends for the packaging market sector.
These two biopolymers show both different properties and processing conditions. Blending them together can be a valuable approach to overcome the shortcomings of both PLA and PHB. Indeed, the developed blends can provide important advantages over the individual polymers in terms of both physical and mechanical properties and processability.

The production of PLA/PHB blends is one of the main aims of the project and one of the first experimental activity, which has to be performed. It starts at month 12 and Proplast is the main involved partner.

Figure 1: Lab scale mixing equipment

A preliminary experimental phase was performed on biopolymeric commercial grades, using a laboratory mixing equipment (**Figure 1**). Small amounts of PLA-PHB blends (in the order of hundreds of grams) were prepared and several reciprocal percentages of the two polymers were tested (some examples in **Figure 2**). This step was important in order to investigate the compatibility of the two materials and to have a preliminary indication of processing conditions to be used.
The obtained blends were compressed in thin sheets, in order to evaluate the transparency of the final blends. Indeed, transparency is one the most important parameters to be taken into account for a material for a food packaging application.

The use of a twin-screw extruder, which is a pilot scale equipment, constituted the second phase of the experimental activity. Several PLA/PHB blends were prepared and those formulations represent the output of a Design Of Experiment (DOE) statistical analysis. During this theoretical study, several parameters have been considered in order to set the statistical analysis. In particular, the ratio between the two biopolymers, the processing temperature and the use of a plasticizer have been taken into account, because of their probable strong effects on the properties of the final blends.

This project has received funding from the Bio Based Industries Joint Undertaking (JU) under grant agreement No 792261. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Bio Based Industries Consortium.

Figure 2: Preliminary PLA-PHB blends, prepared with a lab scale mixing equipment. In particular, PLA-PHB 80:20 formulation on the left and PLA-PHB 20:80 formulation on the right

DOE test returned ten different blends to be produced in a precise runs order. The results of a series of characterization tests on the prepared blends (thermal and rheological ones) were the DOE input data. This predictive instrument was useful in order to investigate the combined effects of the different considered parameters on the blends. Therefore, this step was preparatory to define precise formulations and it helped in individuating three possible diverse PLA/PHB blends, in which the presence of PLA is higher than PHB and in which small amounts of a liquid plasticizer additive have been used.

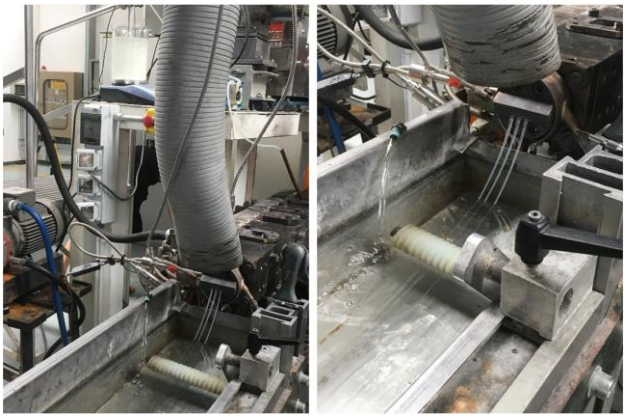

Figure 3: Experimental set-up for the preparation of PLA-PHB blends with a pilot scale equipment, a Leistritz 27D twin screw extruder

All the performed activities during this task are fundamental in order to define the compositions of the blends and in order to pass, in an easier way, to the blending phase with a commercial PLA and the experimental grade PHB, produced in the framework of the project by other involved partners.

This project has received funding from the Bio Based Industries Joint Undertaking (JU) under grant agreement No 792261. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Bio Based Industries Consortium.