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Advancing Non-Woven PPE Materials: Heat-Resistant Stereocomplex PLA

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State of art

Polylactide (PLA) is extensively used in various applications, including medicine, and more recently, in the industrial sector, such as for packaging and 3D printing. It's worth noting that PLA exhibits lower heat resistance. When subjected to hot processing, the ester bonds break, leading to the formation of a carboxyl group, which subsequently undergoes self-catalytic degradation during the thermal degradation of PLA.[1]
Research has shown that stereochemistry plays a significant role in determining the material properties of PLA. Increasing the content of D-lactide when copolymerizing with L-lactide results in a decrease in the polymer's melting point and crystallinity. However, this behavior is not observed when physically mixing poly(L-lactide) (PLLA) and poly(D-Lactide) (PDLA).[2]
PLA stereocomplexation, driven by the strong interaction between L-lactyl and D-lactyl unit sequences, is expected to enhance various properties of PLA-based materials and introduce innovative methods for their preparation. Despite the numerous reviews and feature articles on PLA, the PLA-based stereocomplex is only partially described in some of these publications.[3]

Scope and Objectives

- Development of formulations through the functionalization of recycled PET and biopolymers via extrusion, utilizing studies on additives and optimization of incorporation rates, along with the corresponding optimization of the production process.
- Development and optimization of extrusion processes, taking into consideration the incorporation of recycled PET and biopolymers for the production of non-woven textiles (TNTs).
- Demonstrating the potential application of PET fibers, produced from recycled and bio-based materials for reusable PPEs.

Figure 1 depicts the scope and objectives of this project in a schematic form.

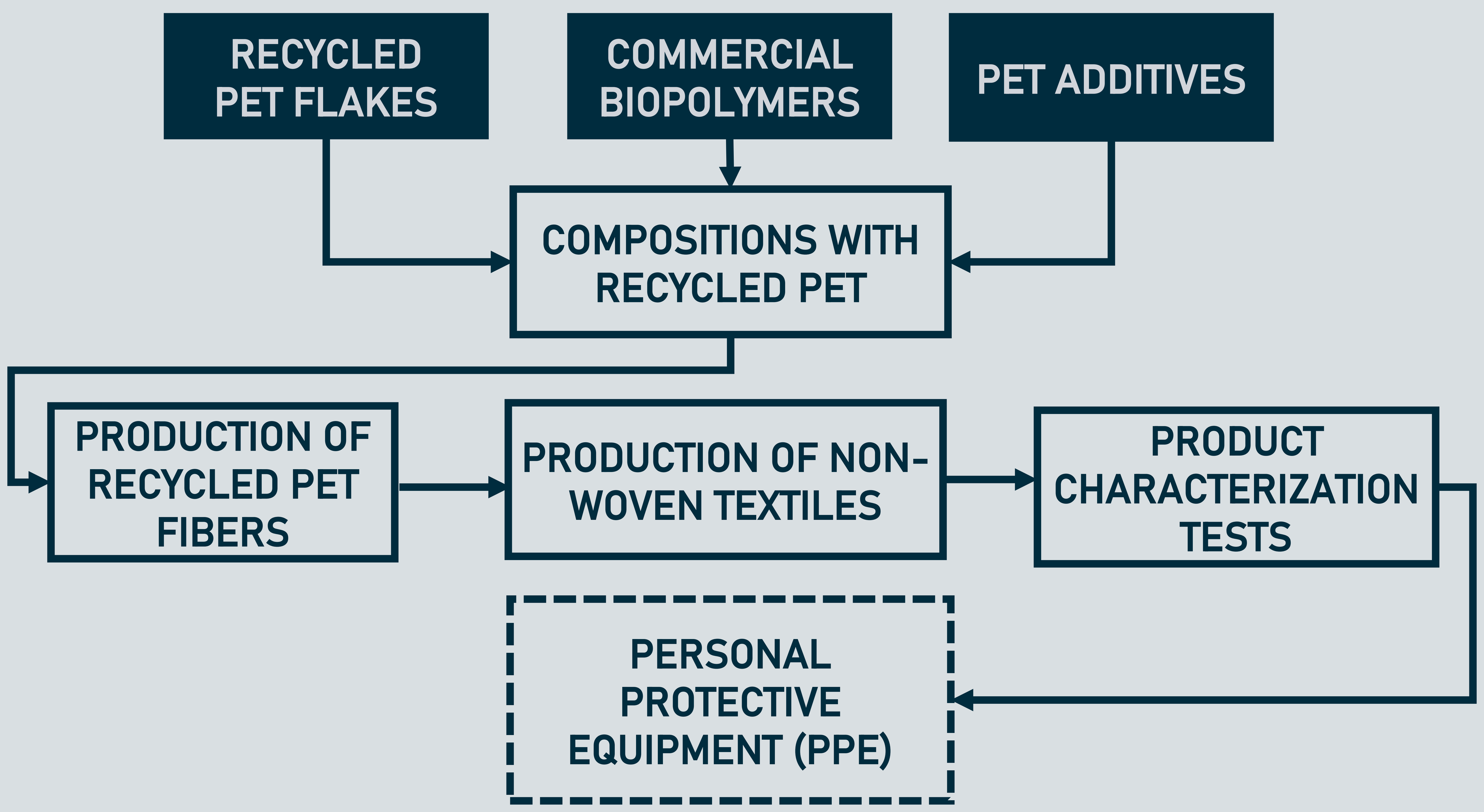

Figure 1. Scope and Objectives

Experimental

Stereocomplex PLA (Figure 2) will be produced through the blending of poly(L-lactide) and poly(D-lactide) using a co-rotating twin-screw extruder. Characterization will include Differential Scanning Calorimetry (DSC) and Thermal Deflection Temperature (HDT) analysis. After confirming increased heat resistance, the stereocomplex PLA blend will be integrated into rPET compositions.
The blend of rPET and stereocomplex PLA will incorporate appropriate antioxidants: primary antioxidants (phenolic-based) and secondary antioxidants (phosphite and HALS-based), in addition to an epoxy-based chain extender. The chain extender will react with hydroxyl groups formed during PLA degradation or present as moisture.

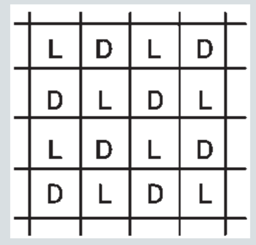

Figure 2. A stereocomplex (racemic) crystallite where L- and D-polymers are packed side by side

Antecipated results

The expected outcomes will establish the upper limit for blending stereocomplex PLA with PET, taking into account their distinct processing characteristics. Characterization will encompass extensional rheometry, DSC, and tensile strength analysis. This research strives to formulate a blend of rPET and stereocomplex PLA that fulfills the requirements for non-woven fiber production, especially in the PPE sector. Through the enhancement of heat resistance and the incorporation of essential additives, this study aims to accomplish its objectives.

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