

Poly lactide-based Materials: from Macro- to Nanocomposites

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The market for biodegradable polymers is growing every year and important demands can be expected for those applications where biodegradability offers clear advantage for customers and environment. In this context, polylactide (PLA) is undoubtedly one of the most promising candidates; it is not only biodegradable but also produced from renewable resources (sugar beets, corn starch, etc.). Because PLA has been recently considered as alternative in replacing petrochemical polymers, there is a strong demand to enlarge the range of PLA properties.

For further applications, the profile of PLA properties and its price can be changed by combining this matrix with different dispersed phases: fillers or reinforcements, (nano)additives, other polymers. Therefore, several types of mineral (nano)fillers (e.g., clays, calcium phosphate, hydroxyapatite, etc.) can be incorporated into PLA in order to obtain (nano)composite materials. For some applications where the property of transparency is not strictly needed, the use of PLA with mineral (micro)fillers can be an interesting solution to reduce the global cost and to improve some specific properties such as rigidity, heat deflection temperature, processability, isotropic shrinkage, etc.

In this objective, two products with the same source as origin, i.e., *issued from the production and use of lactic acid*, PLA and one main byproduct - calcium sulphate, have been first mixed by melt-compounding to prepare new polymer composites. The calcium sulphate microfiller was previously dried during one hour at 500 °C, to isolate the anhydrite II form (AII), which was specifically used for any further melt-compounding processes. Various amounts of AII (10 to 50 wt%) were mixed together with PLA pellets at 190 °C. Interestingly, remarkable AII filler dispersion could be achieved even at high filler loadings resulting in a very good stiffness *vs.* toughness compromise. Other properties like durability, thermal stability and gas barrier properties have been evaluated as well and proved efficient with respect to the starting unfilled PLA.

The thermo-mechanical performances of these novel PLA/gypsum compositions have been further tuned up via the addition of plasticizers, toughening polymeric agents and nanofillers like organo-clays. Indeed, the field of polymer nanocomposites based on clays, such as montmorillonite, has given rise to a steadily increasing interest from scientists and industrials, as the nanoscale distribution of such high aspect ratio fillers brings up some large improvements to the polymer matrix in terms of mechanical, fire retardant, rheological, gas barrier and optical properties, especially at low clay content (as tiny as 1 wt%). As a result, novel ternary formulation, i.e, PLA filled with both AII and selected organo-clays, have been produced by melt blending yielding unequal thermo-mechanical properties, e.g., significantly improved flame retardancy behavior.

Keywords: biodegradable; polyesters; nanocomposites; organoclays; blends.

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