

Surface modification of cellulose nanowhiskers with organofunctional silanes and their incorporation into polylactide matrice

Mots clés : poly(L-)lactide, cellulose nanowhiskers (CNW), organosilanes, surface modification, nanocomposites.

During the last years, the use of biosourced (nano)fillers in polymer matrices has been of wide interests in the frame of sustainable development. In this context, natural fibers, particularly cellulose fibers, have been the object of many studies, aiming at producing biocomposites with improved performances. In fact, cellulose fibers provide several advantages such as their low density (resulting in lighter composites), and their widespread availability at low cost in a broad variety of natural resources (wood, annual plants, agricultural residues, and so on). Recently, a new class of cellulosic materials has emerged as reinforcing (nano)fillers for both synthetic and natural polymers. These so-called cellulose nanowhiskers are selectively extracted by controlled hydrolytic treatments of cellulose. This leads to cellulose nanowhiskers with large specific surface area, high aspect ratio and excellent mechanical properties that make them as exceptional reinforcing nanofillers to polymeric materials at very low content.

Among these polymeric materials, poly(L,L-lactide) (PLLA) is of increasing interests due to its renewability, biodegradability, and excellent mechanical properties comparable with petroleum-based polymers. Developing cellulose nanowhiskers/PLLA nanocomposites will lead to environmentally friendly materials with high-performance properties. However, the hydrophilic character of cellulose nanowhiskers is one of the main drawbacks when they are incorporated in a non-polar polymer like PLLA. It is well-established that the quality of the polymer-nanofiller is a key-parameter, ensuing the significant improvement in mechanical properties of the nanocomposites. This is why the surface modification of these cellulose nanowhiskers is fundamental in order to achieve the maximum interfacial compatibility, and therefore good mechanical adhesion.

Hence, the aim of this work is to study the organomodification of cellulose nanowhiskers with silane coupling agents, and to incorporate them as nanofillers in PLLA by extrusion in order to prepare bionanocomposites with high-performance properties. Silane coupling agents represent a privileged class of reagents industrially used to modify the surface of different fillers for their versatility of functionalities. In this work, trialkoxy silanes with various organic moieties (alkyl, amino, and (meth)acrylic) have been used to chemically modify the surface of cellulose nanowhiskers. These organic moieties are selected upon possible interactions, up to the formation of covalent bondings, with the polyester chains. These modified cellulose nanowhiskers were subsequently incorporated into PLLA by melt-extrusion.