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Development Of Nanocomposites Based On PLA And Functionalized Graphene Oxide

Raúl Quijada[1*], Remilson Cruz[1], Humberto Palza[1], Mehrdad Yazdani-Pedram[2], Héctor Aguilar-Bolados[3]
[1]Universidad de Chile, Beauchef 851, Santiago, Chile
[2]Universidad de Chile, Olivos 1007, Independencia, Santiago, Chile
[3]Universidad de Concepción, Edmundo Larenas 129, Concepción, Chile
raquijad@ing.uchile.cl

Extended Abstract

Poly(lactic acid) (PLA), is an aliphatic polyester that comes from renewable resources and is biodegradable [1]. PLA exhibits mechanical and physical properties comparable to some petroleum-derived polymers. However, its barrier properties need to be improved so that PLA can be used in food packaging [2,3]. In this context, the preparation of PLA-based composites by adding nanomaterials as fillers is a strategy that would improve their barrier properties.

Graphene oxide (GO) is an attractive material for use in the preparation of composites due to its laminar morphology, high specific surface area and high aspect ratio that favor the increase of barrier properties. This work reports the functionalization of GO with two types of aliphatic alkylamines that, due to their nature, would improve the interaction of the filler with the polymer and would facilitate its exfoliation. The two selected alkylamines differ in the extension of the aliphatic chain that could have an impact on the properties of the resulting nanocomposites.

Using X-ray diffraction (XRD), the interlayer distances of graphene oxide and graphene oxides functionalized with aliphatic alkylamines, namely, octadecylamine (ODA), and decylamine (DA), were determined. The functionalized graphene oxide with ODA was designated as GO-ODA and the graphene oxide functionalized with DA was named as GO-DA. The functiolization reactions were carried out at 25 °C and 80 °C and the obtained fillers were designated with the numbers 1 and 2, respectively. GO presents an interlayer distance of 0.76 [nm], while after functionalization the interlayer distance increases to 2.05 [nm] and 1.24 [nm] for the reactions carried out at 80 °C (GO-ODA2, GO-DA2), and 1.47 [nm], 0.99 [nm] for reactions at 25 °C (GO-ODA1, GO-DA1). This increase is attributed to the presence of aliphatic chains between the GO layers.

The composites that were prepared containing graphene oxides functionalized with aliphatic alkylamines showed a slight decrease in mechanical properties compared to PLA that has a Young's modulus of 2278 MPa. For the composites based on PLA and GO-ODA2 (PLA-GO-ODA2), a decrease of 11.56% of the modulus was recorded for a load of 0.7% of GO-ODA2. The decrease in the mechanical properties of the composites based on PLA and GO-DA2 (PLA-GO-DA2) were slightly lower, registering a decrease of 6.13% for a 2% loading of GO-DA2, which can be attributed to the slight decrease in crystallinity. In addition, the thermal degradation of the composites due to their melt processing is another factor that could influence [4].

The oxygen barrier properties of PLA was improved with the addition of the nanoparticles. The permeability decreased by 30.3% from 0.0888 Barr to 0.0619 Barr for a load of 0.7% GO-ODA2. However, for higher loads a slight increase was observed, which can be attributed to the better compatibility of the nanoparticles for low loads and certain agglomerates were formed for high loads. In the case of composites loadede with GO-DA2, the decrease in permeability is progressive with their increase. A decrease of 28.6% was recorded, from 0.0888 Barr to 0.0634 Barr for 2% loadings of GO-DA2.

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