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Development of nanocomposites of polypropylene and polyethylene with chitosan

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Abstract - The study for the development of natural nanocomposites has a great importance, not only for superior properties of these materials, but also because of their multifunctionality due the combination of unique properties unachievable with traditional materials. The aim of this work is incorporate chitosan, a natural polymer with antibacterial effect in polypropylene and polyethylene matrix, aiming to the preparation of nanocomposites films for food packaging applications. Firstly the samples of commercial chitosan (Polymar®) will be characterized according to their chemical properties and thermal degradation and after it will be incorporated at PP and PE by extrusion following the US Patent 2008/0097003 A1, 04/24/2008.

As is well known, there has been substantial interest in the food packaging industries to obtain films with good properties, since many artificial additives and preservatives have to be incorporate in the food to improve its storage stability. The polymeric films used in packaging shall maintain the integrity of the product during handling, packaging and transport and also need to show strength, deformation capacity and temperature stability [1, 2]. Chitosan, poly-β(1,4)-2-amino-2-deoxy-D-glucose, is a natural polymer easily derived from chitin, mainly by extensive N-deacetylation with alkali. Widely existing in the nature, it is known by their antibacterial effect [3]. The mechanism of antibacterial activity of chitosan is based in the amino group of chitosan having a positive charge that works on the cell wall affecting the permeability and the cytoplasma leading to the cell extinction [4]. There are some limitations on the direct fabrication of chitosan films for packaging applications due its high water sensitivity [5]. As an alternative, a good strategy to overcome this disadvantage is the mixture of chitosan with a resistant polymer such as polyethylene (PE) and polypropylene (PP) [4]. More recent work showed an efficient and simple way of incorporating chitosan for preparation of polyethylene films for packaging food where chitosan powder is uniformly distributed in the films and it can be released slowly over time, allowing the water holding capacity and also maintaining the elongation and tensile strength properties of the film. In addition, the acquired film has an excellent antibacterial effect to prevent deterioration of food [2].

In this sense, this work is an attempt to systematically investigate the influence of the physical-chemistry parameters of chitosan in the tailored nanocomposite films properties. Measurements were undertaken preliminary in order to obtain values which could be compared with the data found in the literature for chitosan analyses. In this sense, different types of chitosan (Polymar®) were studied and tests of solubility, Differential Scanning Calorimetry (DSC), Thermogravimetric (TG / DTG) and ashes have been made. Solubility tests showed that the different types of chitosan are completely soluble in aqueous solution of acetic acid 1% (v/v), resulting in a transparent and homogeneous solution, that is affected by the degree of acetylation of chitosan. The ashes test showed a low ash content (calcium salts). Data of thermogravimetric analyses with N_2 flow show the process of dehydration followed by decomposition of chitosan, with generation of carbonized material. The same process is observed in DSC analyses with N_2 flow, that shows a endothermic peak, corresponding to the process of dehydration and a exothermic peak, corresponding the process of decomposition. These parameters were similar to those observed in the literature [6]. The thermal analysis showed that there is difference in water loss and the temperature of degradation among the different types of chitosan which is due to differences in crystallinity and the morphological characteristics of the chitosans. These results are promising, due to the study of the influence of different types of chitosan on the biological and mechanical properties of the films to food packaging to be prepared.

In order to obtain chemical structure information, degree of acetilation and molecular weight of the chitosans, RMN, Gel Permeation Chromatography and FTIR shall be conducted in the future works.

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