Encapsulation of chitosan as an efficient flame retardant for Thermoplastic starch

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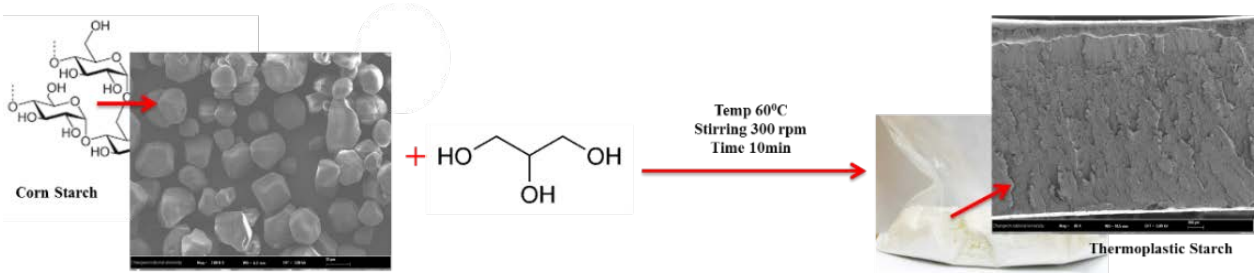
Keywords: Green composites, Starch, Flax fabric, Chitosan, Mechanical properties.

ABSTRACT

Present polymer industry and researchers have been looking to initiate green eco-friendly plastic materials (polymers) or composites disputes for defensible improvement as a natural bio-degradable renewable resources due to environmental pollution and decreasing/highly usage of carbonaceous oils. Agriculture products and bi-products are the most convenient and abundant resources for the renewable materials. Among plant derived materials, one of the most studied and promising raw materials for the production of biodegradable plastics is starch, which is a natural renewable plant biomasses polymer obtained from a great variety of crops throughout the world and compatibility with environment and human without toxic residues. Present the industrial starch production surpasses nearly 48.5 million tons per year in worldwide (7 million tons per year only in Europe), 60% of this production is used for nonfood applications, as paper sizing, adhesives, bio-fuels and bioplastics. Starch based materials is one of the most popular biodegradable plastic and is widely used due to the low cost and potential thermoplastic properties [1]. Flax fabric chosen for reinforcement to continuity of the biodegradability due to desirable properties such as low water absorption (around 7%), high mechanical strength compare with other natural fibers and competitive with glass fiber. For improving flame retardancy of the starch composites, chitosan used as a flame-retardant additive. Chitosan prepared industrially through deacetylation of chitin, which is the basic structural material in the endoskeleton of crustaceans such as crabs and shrimp and cell walls of fungi. It is renewable, non-toxicity, biocompatible and abundantly avilable, hence many researchers have been attention in different fields. The bulk hydroxyl groups present in the structure of chitosan helps to form dense char in combustion.



Scheme 1: Schematic representation of TPS preparation and morphology of Starch and TPS.

In the present research, Thermoplastic starch matrix (TPS) was prepared by gelatinization of regular corn starch with relatively low levels of glycerin-water mixture that are capable of hydrogen bonding with the starch hydroxyl groups as shown in scheme 1. The flame retardant green composites were prepared with thermoplastic starch reinforced with 0.37 mm thickness flax fabric (FF) by compression

moulding in 2-3 mm thick plate moulds. The flame-retardant efficiency of natrual flame retardant additive: chitosan (CS) [2] was incorporated to FF/TPS composites [3] and flammability properties were investigated by horizontal burning test as per ASTM procedure.

FF/TPS composite with 6 wt% CS could behave like fire proof material. However, neat TPS has short burning time and the flame retardancy is a few percentage increased in fabric loading. It has the ability to stable thermally as well as tensile strength due to the interaction formed between the hydroxyl groups of thermoplastic starch and cellulosic fabric. Encapsulating natural flame retardant resulted (CS) in making fully bio-degradable and fire-retardant composites with well-balanced stiffness and improved mechanical properties, which are competitive with petroleum based composite materials.

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