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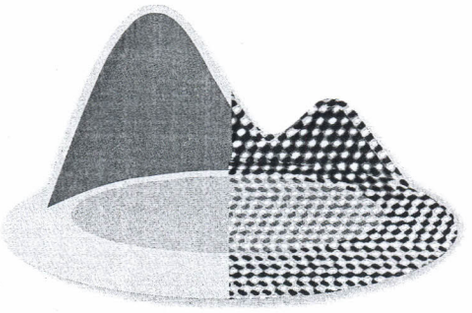

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Cotton Fibers and Cellulose Cotton Whiskers: Thermal Stability

E. M. Teixeira[(1)], M. A. Martins[(2)], A. C. Corrêa[(1)], M. Ferreira[(2)], L. H. C. Mattoso[(1)*]

(1) LNNA, Embrapa Instrumentação Agropecuária, Rua XV de Novembro, 1452, 13560-970, São Carlos/SP, eliangela@cnpdia.embrapa.br, mattoso@cnpdia.embrapa.br
(2) CCNH, Universidade Federal do ABC, Rua Santa Adélia, 166, 09210-270, Santo André/SP, maria.martins@ufabc.edu.br, mariselma.ferreira@ufabc.edu.br
* Corresponding author.

Abstract – Cotton fiber is one of the most important raw materials. The cellulose whiskers obtained from natural fibers have attracted significant attention during the last decade. The purpose of this work was to evaluate the thermal behavior (TGA/DTG) of commercial cotton fibers and cotton whiskers. Both, cotton fibers and cellulose whiskers showed decrease of thermal stability in oxidative atmosphere, although, cotton whiskers have shown similar behavior up to 300 °C. The decomposition changes from a one step process to a three step process, when moving from an inert to an oxidative atmosphere. The cotton fibers and cotton whiskers showed crystallinity index of 77% and 91%, respectively.

Cotton (*Gossypium hirsutum* L.) fiber is one of the most important raw materials for the textile industry. For this reason, cotton plants are widely grown in many areas throughout the world. Cotton is typically composed of 88-96% cellulose, the remainder being protein, pectin materials and wax [1]. The cellulose whiskers have attracted significant attention during the last decade. The interest is due to their renewable nature, abundance, good mechanical properties and large specific surface area. More recently, there is an increased use of whiskers as reinforcement in nanocomposites [2]. The purpose of this work was to evaluate the thermal behavior of commercial cotton fibers and cellulose whiskers obtained.

Cellulose whiskers were prepared by acid hydrolysis of commercial cotton fibers. The acid hydrolysis was carried out with sulfuric acid solution 6.5M at 45 °C and 60 °C under vigorous stirring for 75 min. Following, cotton whiskers were dried using an oven and freeze drying. Thermogravimetric analysis was obtained in a TA Instrument Q500, from 25 °C to 800 °C, at 10 degree/min in inert (nitrogen) and oxidative (synthetic air) atmospheres. The X-ray diffraction patterns were measured using an X-ray diffractometer (VEB CARL ZEISS-JENA URD-6 Universal Diffractometer), CuKα radiation (λ=1.5406Å) at 40kV and 20 mA.

The DTG and TG curves of cotton fibers showed an initial peak between 50 and 100 °C which correspond to vaporization of watter in the all sample. After this peak, in inert atmosphere, TG curve has only one large plateau and the DTG curve has one degradation peak, indicating that thermal degradation of fibers is a one-stage reaction. This peak at about 300 °C is attributed to thermal depolymerization of hemicellulose, lignin, and α-cellulose decomposition (wt loss 80%). The temperature of the maximum mass loss rate or the peak temperature of the DTG curve is around 365 °C and at 350 °C in oxidative atmosphere. Cotton whiskers showed two separated pyrolysis within a wider temperature range. Both, cotton fibers and cellulose cotton whiskers showed decrease of thermal stability in oxidative atmosphere, although, cotton whiskers have shown similar behavior up to 300 °C. The decomposition process changes when moving from an inert to an oxidative atmosphere. The X-ray diffractograms of the cotton fibers and cellulose cotton whiskers showed that crystallinity index (I_C) obtained were 77% and 91%, respectively.

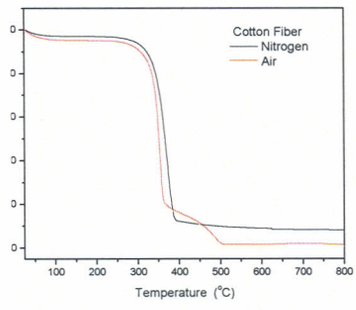

Figure 1: TGA curves of cotton fibers

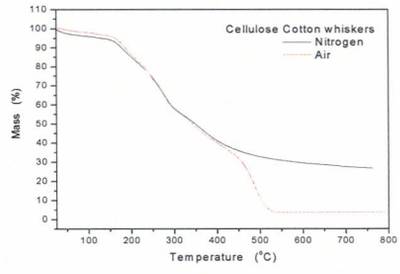

Figure 2:. TGA curves of cotton whiskers

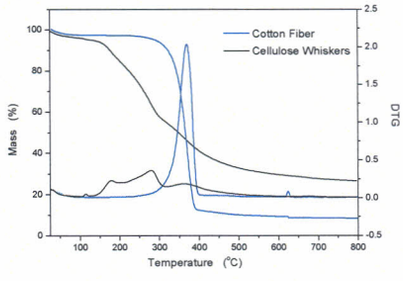

Figure 3: TGA/DTG curves of cotton fibers and cotton whiskers, inert atmosphere

[1] A. Jeihanipour, M. J. Taherzadeh, Bioresource Technol 100 (2009) 1007-1010
[2]. J. Yi, Q. Xu, X. Zhang, H. Zhang, Polymer 49 (2008) 4406-4412.