THERMAL PROPERTY OF SISAL FIBERS

by

Hong-Qin YU[a,b*], Jin-Jing CHEN[a,b], Hong LI[a,b], and Cheng-Jiao ZHANG[c]

[a] College of Textiles, Zhongyuan University of Technology, Zhengzhou, China
[b] Henan Key Laboratory of Functional Textiles Material, Zhengzhou, China
[c] Laboratory for Clothing Physiology and Ergonomics, National Engineering Laboratory for Modern Silk, Soochow University, Suzhou, China

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Alkali-urea treatment, organic silicon, and steam explosion treatment were used for modification of sisal fiber, thermal stability was studied experimentally.

Key words: *sisal fiber, modification, property tests, thermal stability*

Introduction

Natural fibers have wide applications in clothing, garment, and composite [1]. Recently there has been a renewed interest in the use of natural fiber as substitute for glass to reinforcement in fiber-reinforced composites because of the potential advantages of weight saving, lower raw price, recyclable and efficient stress transfer [2-4]. This paper is to study sisal fiber and its surface modification.

Experimental

Three methods were used in the experiments, they are alkali-urea modification, organic silicon modification, and steam explosion. Alkali-urea modification uses urea with different concentrations varying from 1% to 2.5% and alkali with concentration of 10.7%. The process of organic silicon modification is as follows: alkali was boiled for 2 hours after organic silicon treatment for 4 hours at 50 °C. Steam explosion is to treat sisal fiber at a high temperature of 120 °C for one hour.

Results and discussion

Table 1 shows that a higher urea concentration results in finer fineness and higher tenacity. Table 2 reveals that organic silicon has an inverse effect on modification. Table 3 demonstrates the modification effect after steam explosion.

A control sample was used for comparison, which was treated by alkali-urea method, steam-explosion, and organic silicon, respectively. The result was given in tab. 4, showing that all modification methods result in thinner fibers and lower tenacity.

Figure 1 reveals thermogravimetric analysis of all four samples. It is obvious that there are three stages in heat degradation of all samples. The first stage happens at about 100 °C attributing to moisture evaporation. The second turning point is about 270 °C, after that temperature all samples loss mass very fast, this is due to the break of glycosidic bonds, *i. e.*, C-O bonds and C-C bonds. The last stage occurs at about 370 °C resulting in degradation of residual structure of cellulose.

* Corresponding author; e-mail: nyyuhq@126.com

Table 1. Effect of urea concentration on fineness and tenacity of sisal fiber

Urea concentration [%]	Fineness [tex]	Tenacity [cNdtex^{-1}]
1	23.14	1754.35
1.5	20.36	2395.51
2	21.16	1664.40
2.5	19.54	2274.21

Table 2. Effect of organic silicon on properties of modified fiber

Organic silicon [%]	Fineness [tex]	Tenacity [cNdtex^{-1}]
5	23.29	1024.70
6.5	19.74	927.79
8	22.96	707.76
9.5	21.39	995.37

Table 3. Effect of alkali concentration on fiber properties treated by steam-explosion

Alkali concentration [%]	Fineness [tex]	Tenacity [cNdtex^{-1}]
5	22.27	900.34
7	17.75	835.92
9	18.69	816.13
11	15.76	783.02

Table 4. Properties comparison of treated fibers

Sample	Control sample	Fiber treated by alkali-urea	Fiber treated by organic silicon	Fiber treated by steam explosion
Fineness [tex]	25.23	19.54	19.74	17.75
Tenacity [cNdtex^{-1}]	3422.29	2274.21	927.79	835.92
Softness [twist/20 mm]	12.025	22.695	21.885	16.905

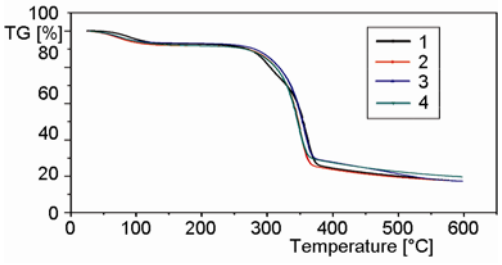

Figure 1. Thermogravimetric analysis of sisal fibers; *1 – control sample, 2 – fiber treated by alkali-urea, 3 – fiber treated by organic silicon, and 4 – fiber treated by steam explosion (for color image see journal web-site)*

Conclusions

Sisal fiber was modified with alkali-urea treatment, organic silicon and steam explosion, properties of treated fibers, such as fineness, tenacity, softness and thermal stability were tested to obtain an optimal treatment condition. The results show that alkali-urea is the best candidate for modification of sisal fibers.

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