CHARACTERISTICS OF FIBER-LIKE NON- AND γ -IRRADIATED RAMIE, FLAX AND COTTON CHAR

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Introduction.

Previous studies [1, 2, 3, 4] have shown that γ -irradiated almond shell, olive stone, wood, bamboo cellulose and rayon cloth undergo an alteration in carbonization process, carbon yield, and sintering character.

In the present paper, the carbonization process and carbonized materials of γ -irradiated fibers of ramie, flax, and cotton were studied. After the γ -irradiation the following changes were observed: color went from white to yellow, oxygen content increased, decomposition temperature decreased, and carbon yields increased on all fibers. Apparent surface areas show different pattern among fibers.

Experimental

Commercial fibers (Tray-Fine Chemicals CO., INC.) of ramie, flax, and cotton were used without further treatment. The samples were irradiated by the 4.1 PBq Co-60 unit of the JEARI in air, and total dose was 2.5×10^3, 2.5×10^4 and 7.5×10^4 C/kg.

A thermal analysis was carried out using a Shimadzu DTG-30 up to 800 ℃ with flowing nitrogen (99.9995%, 2.4 l/h), a heating rate of 300 ℃/h and 0.5 hour soaking time.

Apparent surface areas were obtained with a Micromeritics Shimadzu Flowsorb II 2300 by the single point BET method at liquid nitrogen temperature. (the flowed gas composition: nitrogen 30% and helium 70%)

Results and Discussion

Usually, in the FT-IR spectra, peak appear around 1730 cm^{-1} and peak become stronger with γ -irradiation. The fibers have original peaks around 1730 cm^{-1}, and can not recognized new peak clearly.

In TG curves of the fibers, rapid weight loss started at 335, 336, and 290 ℃ for ramie, flax, and cotton, respectively. The fibers treated with a higher dosage began decomposing at lower temperatures. Differences between the non- and $7.5x10^4$ irradiated fibers are 74, 69, and 62 ℃ for ramie, flax, and cotton, respectively. These results on the decomposition process suggest that fibers suffer damages, largely.

After heated at 800 ℃ for 30 minute in nitrogen, the fibers changed to fiber-like chars. Char yields of all samples at 800 ℃ were calculated and the results are summarized in Table 1.

Table 1. Char yields of non-and γ -irradiated ramie, flax, and cotton char (carbonized at 800℃, 300℃/h..,in N_2) %

dose C/kg	0	$2.5x10^3$	$2.5x10^4$	$7.5x10^4$
ramie	13	19	22	26
flax	16	19	19	23
cotton	21	22	23	27

Char yields of the fibers varied in ranges of 13% for ramie to 21 % for cotton. Char yields of γ -7.5 x 10^4 irradiated fibers increase to 26%, 23%, and 27 % for ramie, flax, and cotton, respectively. Carbon content in the fibers are about 42.5% for both non- and γ -irradiated fibers. Char yields calculated based on the carbon contents(42.5%) are 31%, 38%, and 50% for non-irradiated one and 62%, 54%, and 64% for $7.5x10^4$ irradiated fibers for ramie, flax, and cotton,

respectively.

Apparent surface areas of fiber chars which carbonized at 800 ℃ were obtained and the results are summarized in

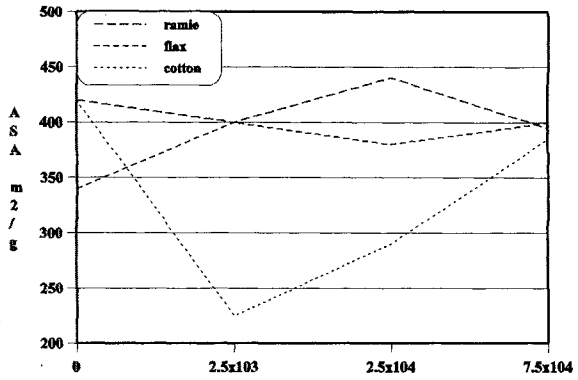

Figure 1. Apparent surface area of non- and γ -irradiated ramie, flax, and cotton chars.

Figure 1. Ramie and flax chars show about 400 m^2/g for all dosage. Cotton chars show minimum values of 225 m^2/g at $2.5x10^3$ char and increased to 385 m^2/g for $7.5x10^4$ char.

Why cotton char shows such changes ?

SEM pictures of the chars show that both ramie and flax chars have rigid sheath, cotton char shows long narrowly twist structure and have no sheath. And cotton chars of $2.5x10^3$ and $2.5x10^4$ irradiated show more twisted than the others, the formation of pores were disturbed by the twisted structure and the apparent surface area decreased.

Why carbon yields increase with γ -irradiation?

Using elemental analysis data of raw and γ -irradiated fibers and chars, calculated a atomic ratio of hydrogen and oxygen to carbon and normalized as carbon atom is 6. Results summarized in Figure 2. In the Figure, γ -irradiated fiber samples show faster decreases of hydrogen and oxygen ratio, suggested lower temperature dehydrogenation induced larger carbon yields.

Conclusions

1. γ -ray irradiation induced molecule cleavage of -C-C- bonds and oxidation in fibers.
2. γ -ray irradiation induced lower temperature dehydrogenation reactions and higher γ -ray doses caused higher carbon yields.
3. Apparent surface areas of ramie and flax chars do not show clear changes. Twisted cotton char show decreased at $2.5x10^3$ and $2.5x10^4$ C/kg char.

References

1. Nakayama, Y., Shimizu, Y., Hosokawa, Y., and Rodriguez-Reinoso, F., . in Carbon'93 (Ext. Abstr., 21st Biennial Conf. Carbon), Buffalo, N.Y., 1993, pp. 361-362.
2. Nakayama, Y.,Ohsumi, R., Hosokawa, K., and Freeman, J., in Ext. Abstr., Carbon'94, Granada, Spain, 1994, 238-239.
3. Nakayama, Y., Koezuka, Y., Yamasaki, H., Fujita, K., and Hosokawa, K., in Carbon'95 (Ext. Abstr., 22nd Biennial Conf. Carbon), San Diego, CA, 1995, pp.426-427.
4. Souma, I., Niwa, K., Yamaguti, K., and Nakayama, Y., in Carbon'95 (Ext. Abstr., 21st Biennial Conf. Carbon), San Diego, CA, 1995, pp.424-425.

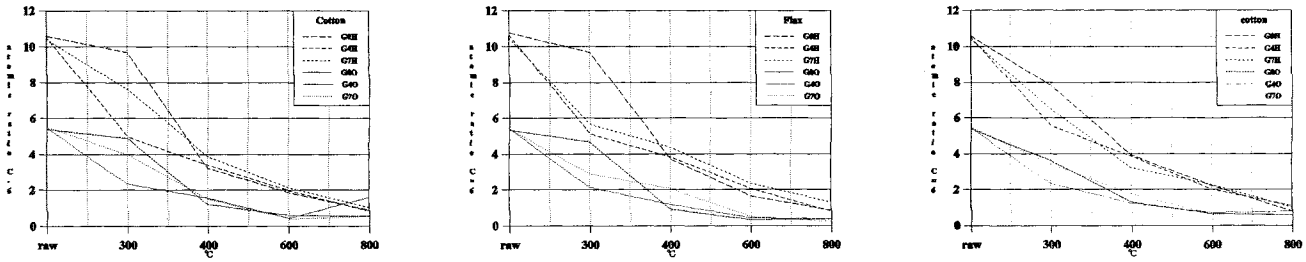

Figure 2. Changes of hydrogen and oxygen atomic ratio to carbon with heat treatment of non- and γ -irradiated fibers. (normalized as C=6). (H : Hydrogen, O : Oxygen, G0 : non--, G4: $2.5x10^4$, G7: $7.5x10^4$ C/kg) . Left : ramie, Center : flax, Right : cotton.