CHARACTERISTICS OF PAULOWNIA CHAR BY AIR TREATMENT AND GAMMA-IRRADIATION

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Introduction

Previous studies [1] have shown characteristics of gamma-irradiated and carbonized wood chars of Japanese cypress, Japanese cedar, hemlock, paulownia, and spruce. And, among all of them, paulownia char shows the smallest values on carbon yield and specific surface areas.

In the present paper, the carbonization process and carbonized materials of paulownia shavings were studied with gamma irradiation at three different temperatures.

Gamma irradiation at 200 and 210 ℃ induced increases of char yield, surface area and strengrh. Thus this method is a good way to improve low quality chars.

Experimental

Materials: Paulownia shavings, thickness 0.3mm or less.
Carbonization:Because the paulownia shavings were bulky, we decreased the volume by 2-step carbonization. The first step was to heat the shavings from room temperature to 400 ℃. The second step was to add several batches of the first step together and heat it up to 800 ℃. Char yields in the tables show the overall values of the 2-step carbonization.

γ -irradiation : irradiated by the 4.1 PBq Co-60 unit of the JEARI with three conditions,

1)at room temperature in air, and total dose was 2.5×10^3, and 2.5×10^4 C/kg.
2) at 200 and 210 ℃ in flowing air and nitrogen for 5 hours with a dose rate of 200 C/kg.
3) at 400 ℃ in flowing nitrogen for 3, 8 , and 16 hours with a dose rate of 200 C/kg.

In the Co-60 irradiation room, smoke and microparticles were strictly prohibited, so the paulownia shavings were heated to 400 ℃ before use.

Apparent surface areas : measured by 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

In Figure 1, the TG curve of paulownia shavings is shown. Rapid weight loss starts around 270℃ and ends around 350 ℃, so the gamma-irradiation temperatures should be at 200, 210 and 400 ℃.

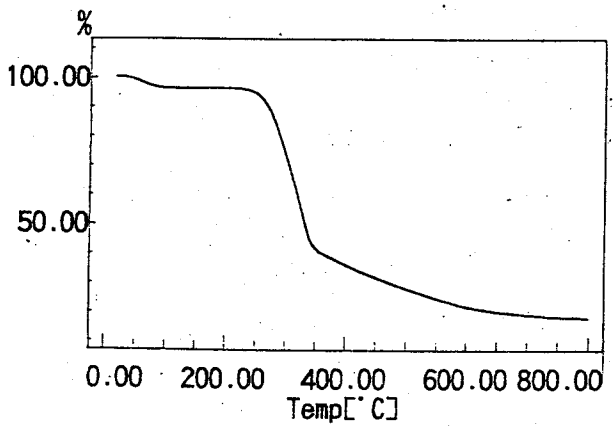

Figure 1. TG curve of paulownia shaving.

In Table 1, char yields and specific surface area of gamma irradiated paulownia shavings at room temperature in air and carbonized at 800 ℃ are summarized. Char yield increased with the gamma-ray dose, but the surface area increase was not so clear.

Table 1 gamma-irradiated at room temperature in air and carbonized at 800 ℃.

Dose (C/kg)	Char yield (%)	Surface area (m2/g)
0	21.6	453
2.5x103	23.7	417
2.5x104	25	446

In Table 2, char yields and specific surface area of

gamma irradiated paulownia shavings at 200 and 210 ℃ in a controlled atmosphere and carbonized at 800 ℃ are summarized. Char yield and surface area values are both greater in Table 2 than in Table 1.

Table 2. Gamma irradiated under controlled atmosphere at 200 and 210 ℃ for 5 hours and carbonized at 800 ℃.

	Atmosphere	Char yield (%)	Surface area (m2/g)
200	nitrogen	25.1	439
	air	25.4	477
210	nitrogen	25.3	453
	air	27.6	480

In Table 3, char yields and specific surface area of gamma irradiated paulownia shavings at 400 ℃ in a nitrogen atmosphere and carbonized at 800 ℃ are summarized. Char yield remained about the same with the first 3 dosage increases, but the surface area increased. Char yield and surface area values are both smaller in Table 3 than in Table 2.

Table 3. Gamma-irradiated in nitrogen atmosphere at 400 ℃ and carbonized at 800 ℃.

Dose (C/kg)	Char yield (%)	Surface area (m2/kg)
0	21.4	395
3	22.5	430
8	21.6	431
16	30.7	471

In Figure 2, the SEM pictures of paulownia shaving chars carbonized at 800 ℃ are shown.
a) This corresponds to Table 1. Gamma rays strengthen and maintain the wood structure.
b) This corresponds to Table 2. Air causes part of the wood structure to oxidize and to deteriorate.
c) This corresponds to Table 3. Gamma rays strengthen and maintain the wood structure.

Conclusions

1) We studied gamma irradiation of Paulownia shavings at room temperature, at 200 ℃、 and at 400 ℃. The best conditions are at 200 ℃ in flowing air.
2) Irradiation by gamma rays strengthen and maintain the wood structure.
3) Gamma irradiation at 200 ℃ is a good method of improving char yield, surface area, and strength of chars of low quality wood.

Reference

1. Nakayama Y. Ikeda T. and Satomura S. Study of wood carbonization process using γ -irradiation and partial oxidation in air. Extended abstracts, International symposium on carbon science and technology for new carbon. Chuo Univ. (Tokyo. JAPAN): 1998;638-639 .

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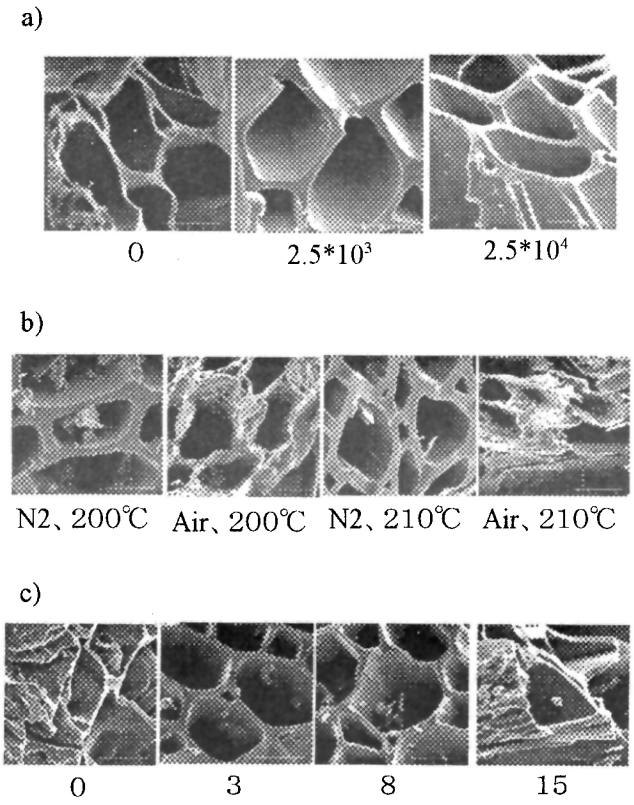

Figure 2. SEM pictures of Paulownia shaving chars carbonized at 800 ℃.
a) irradiated at room temperature in air. This corresponds to Table 1.
b) irradiated at 200 ℃ and 210 ℃ under flowing nitrogen or air for 6 hours at a dose rate of 200 C/kg·h. This corresponds to Table 2.
c) irradiated at 400 ℃ under flowing nitrogen for 3, 8 and 15 hours at a dose rate of 200 C/kg·h. This corresponds to Table 3.