Transactions of the Materials Research Society of Japan. Vol. 20

Develpoment of Woodceramics (I)
- Examination of the Manufacturing Condition -

T. Okabe[a], K. Saito[a], J. Tsuji[b], K. Shibata[c] and R. Yamamoto[d]

[a] Industrial Research Institute of Aomori Prefecture,
80 Fukuromachi, Hirosaki, Aomori 036, Japan

[b] Gunma Polytechnic College,
918 Yamanacho, Takasaki, Gunma 370-12, Japan

[c] Aomori Polytechnic College,
171-2 Oino, Iizume, Goshogawara, Aomori 017, Japan

[d] Institute of Industrial Science, University of Tokyo,
7-22-1 Roppongi, Minatoku, Tokyo 106, Japan

Woodceramics is the new porous carbon material obtained by carbonizing wood or wood-based material impregnated with thermosetting resin such as phenol resin in a vacuum furnace. In this papar, we discuss about the manufacturing condition.

About the impregnation process, we found that the use of ultrasonic vibration during impregnation with resin increases the rate of impregnation and uniformity of the resulting impregnated substance. And about the carbonizing process, we found that the temeprature rise ratio for high productivity is 5°C/min

1. INTRODUCTION

Woodceramics is the new porous carbon material that have the characteristics of the traditinal carbon material "charcoal" and the advanced carbon materials. Moreover, Woodceramics has the characteristics of ecomaterials that were considered to give no influence to the environment at the steps of the production, ues and waste.

In this paper, we discuss about the manufacturing method of the new porous carbon material "Woodceramics" that was solved the problems of breakage caused by warps and fissures.

2. EXPERIMENTAL METHOD

2.1. Manufacturing method of Woodceramics

Manufacturing method of Woodceramics is shown in Fig.1. Wood-phenol resin composite was prepared by impregnating phenol resin into woods or wood-based materials using the ultrasonic impregnation system. After impregnating phenol resin for one hour under reduced pressure with ultrasonic vibration, woods were left overnight at atmospheric pressure. The phenol resin was hardened in an oven at temperatures of 70 to 135 °C. Woodceramics was obtained by carbonizing wood-phenol resin composite in the carbonization furnace.

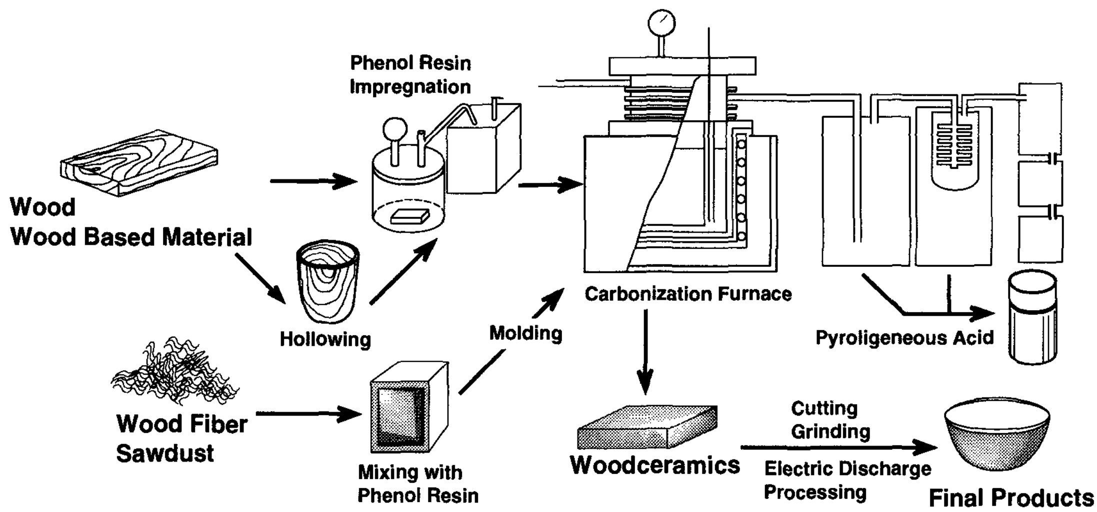

Fig.1 The manufacturing process of Woodceramics.

2.2. Specimens

In the experiment, the materials used were the heartwood of beech wood (air -dried specific gravity: 0.68, moisture content: 10%), medium-density fiberboard (air -dried specific gravity: 0.73, moisture content: 8%, abbreviation: MDF) made from Pinus radiata, and phenol resin (PX-1600 manufactured by Hone Corporation) for impregnation.

2.3. Ultrasonic impregnation tests

To examine the influences of ultrasonic vibration, we determined the relationship between impregnation time and degree of impregnation at reduced pressure with or without ultrasonic vibration using the MDF samples (120 X 120X 24 mm) .

2.4. Examination of the influence of temperature rise ratio.

The examination of the influence of temperature rise ratio was determined from the yield of

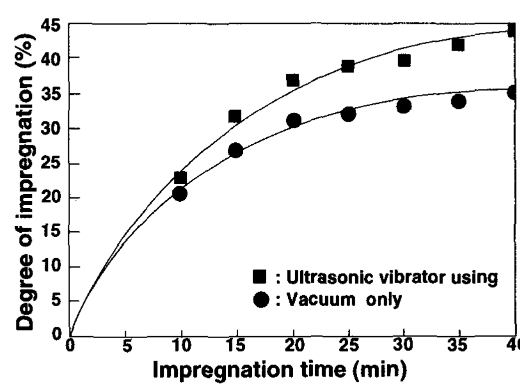

Fig.2 The relationship between impregnation time and degree of impregnation.

Woodceramics at the condition of 5, 10, 20, 30 °C/ minute in nitrogen gas or in air, using a Seiko Electric Inc. thermobalance (TG / DTA 200).

The relationship between temperature rise ratio and the yield of Woodceramics, bending strength and brinell hardness were determined at the condition of 1, 3, 5, 10, 20 °C / minute.

3. RESULTS AND DISCUSSION

3.1. Effect of ultrasonic vibration of impregnation

The most remarkable feature of this impregnation system is that ultrasonic vibration can be set up during impregnation. We tested how ultrasonic vibration influences impregnation by impregnating an MDF sample (12 X 12X 24 mm) in the impregnation tank at low pressure with and without ultrasonic vibration. Figure 4 shows the relationship between the impregnation time and the impregnation rate in the test. As shown in Figure 4, using ultrasonic vibration improves impregnation efficiency by up to approx. 10 % for impregnation times of from 10 to 40 minutes. Also, when we cut impregnated MDF samples in half, we observed unimpregnated zones in the cores of samples impregnated without ultrasonic vibration. We did not find unimpregnated zones in the cores of those samples impregnated with ultrasonic vibration. These findings indicate that ultrasonic vibration has two effects; it improves impregnation efficiency and ensures uniform dispersion and impregnation between wood fibers.

3.2. The influence of temperature rise ratio.

Fig.3 shows the measurement result of weight change with thermobalance of phenol resin impregnated MDF samples in the nitrogen atmosphere.

MDF showed sudden weight decrease because of a pyrolysis of wood and evaporation of pyrolysis products between 200- 400 °C. From the changes of weigth at temperatures 300 - 500 °C, increasing temperature rise ratio tends to increase the change of weight. For it, as for phenol resin impregnated MDF, the difference of weight change by a difference of temperature rise ratio isn't found to compare MDF, this is beacause glassy carbon of phenol resin origin raises yield. Therefore, it is considered that the generation of breaking and warping are controlled lower at the carbonization of phenol resin impregnated MDF.

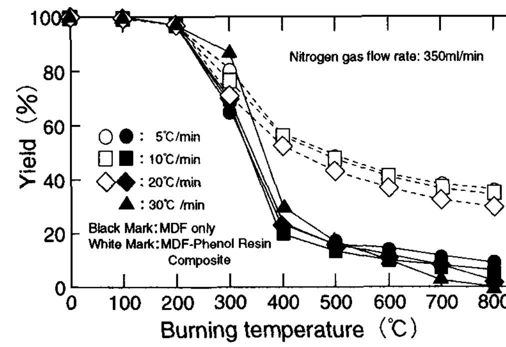

Fig.3 Relationship between burning temperature and yield.

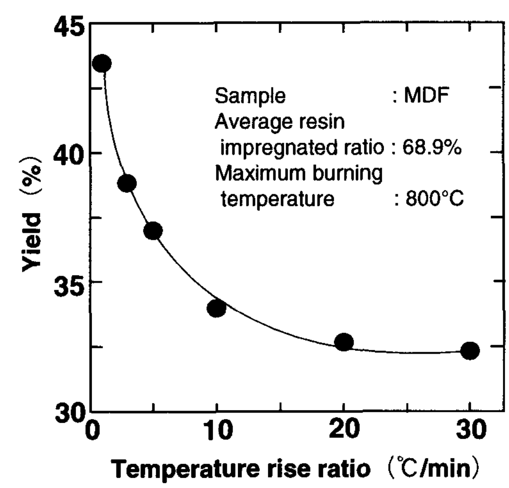

Fig.4 Relationship between temperature rise ratio and yield.

Further, to determine the effective manufacturing schedule of Woodceramics, we examined yield, bending strength and brinell hardness by changing temperature rise ratio.

Figure 4 shows the relationship between temprature reise ratio and yield, in the condition that maintained it by the highest temperature 800 °C for three hours.

The highest yield was 43.5 % showed at the temprature reise ratio of 1 °C / min, and the yield was lower according as the temprature reise ratio was faster. Furthermore, clear breaking were confirmed in the eyes faster than temprature reise ratio of 10 °C / min.

Figure 5 shows the relationship between temperature rise ratio and bending strength, and Fig.6 shows the relationship between temperature rise ratio and brinell hardness. Bending strength showed a tendency to decrease at the temprature reise ratio of 10 °C /min or slower, and a value to be almost fixed was shown in faster than it. And brinell hardness showed a tendency to decrease according to the temprature reise ratio was faster.

From these results, we determine that the temperature rise ratio for high productivity is 5 °C / min.

4. CONCLUSION

(1) When ultrasonic vibration is applied during resin impregnation, the impregnation efficiency is improved and resin is dispersed more uniformly throughout the wood tissue.

(2) For the purpose to examine the effective temperature rise ratio, we examined yield, bending strength and brinell hardness by changing temperature rise ratio, and was determined in 5 °C / min as the effective temperature rise ratio.

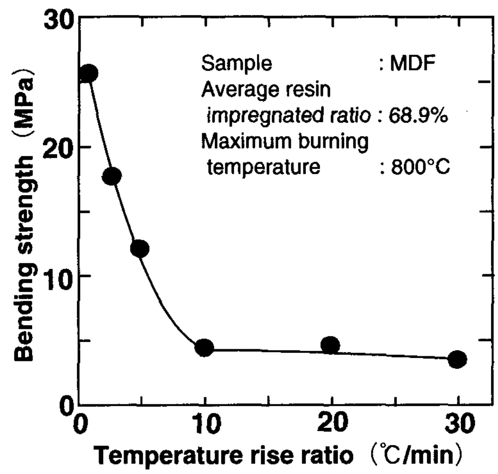

Fig.5 Relationship between temperature rise ratio and bending strength.

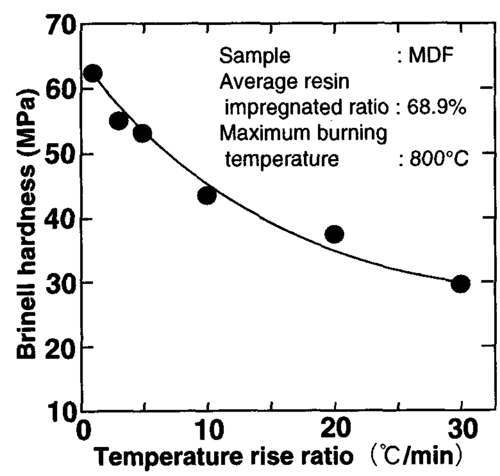

Fig.6 Relationship between temperature rise ratio and brinell hardness.