A Study of the Carbonization of Ramie Cellulose by means of X-Rays and the " Net Density Method "

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Abstract

The carbonization of ramie cellulose at low temperatures was studied by X-rays and the " net density method "; and it was found that the perfect carbonization from cellulose to amorphous carbon occurred at about 290°C, and that no preliminary change in the lattice form of cellulose took place by heating it at lower temperatures than about 290°C before it was transformed into amorphous carbon.

Very recently, Y. Matsunaga[1], from his investigation on sugar charcoal and pitch cokes with X-rays and the " net density method ", came to the conclusion that amorphous carbon having the net density of 1,475 really exists, and that the ordinary carbon obtained by carbonizing organic substances is a mixture of this amorphous carbon (net density 1,475) and graphite (net density 2,268).

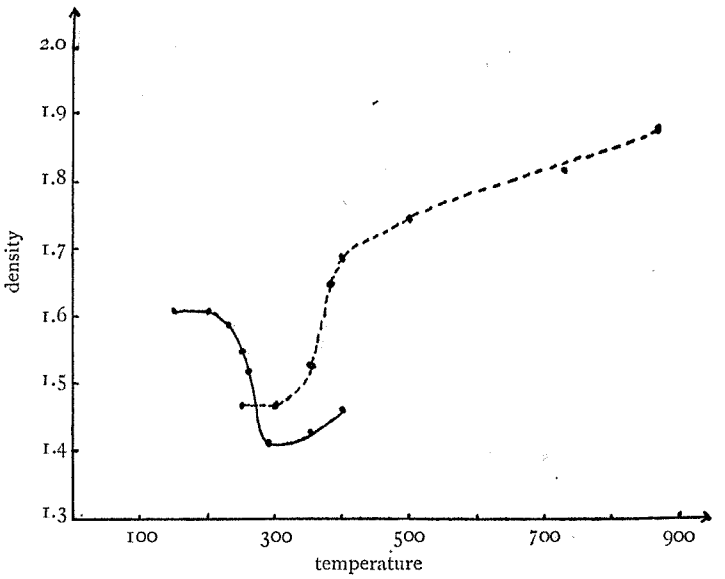
The writer first used X-rays to discover whether heating causes any preliminary change in the lattice of the crystals of ramie cellulose before it is transformed into amorphous carbon. But contrary to his expectation he failed to find any such preliminary change in the lattice form of the ramie cellulose.

The writer carbonized the sample contained in the bottom of a glass tube of about 25 cms in length and 2 cms in diameter, by heating it at various temperatures for 5 hours. The relation between the carbonizing temperature and the net density of the specimens thus obtained is shown by the curve plotted in full line in Fig. 1. As is seen from the curve in Fig. 1, the net density of the sample decreased at first with increase of the carbonizing temperature, and then increased from a temperature of about 300°C.

The sudden decrease of the net density from the value of about 1,6 at temperatures between 260°C and 280°C means that the greater part of ramie crystallites is destroyed and transformed into amorphous carbon at these temperatures. The writer also tested the samples carbonized at 260°C, 280°C and 290°C with X-rays. With the specimen carbonized at 260°C the X-ray diffraction pattern peculiar to the ramie

1. Y. Matsunaga: These Memoirs, **18**, 215 (1935).

Fig. 1



fibre appeared clearly; but with the specimen carbonized at 280°C the diffraction pattern due to the ramie fibre became very faint, and the diffraction band due to the amorphous carbon appeared prominently; and with the specimen carbonized at 290°C the diffraction pattern appearing on the photograph consisted entirely of the diffuse band peculiar to amorphous carbon, while that due to the ramie fibre could not be detected. This shows that the ramie cellulose is transformed entirely into amorphous carbon at this temperature.

Here it must be noted that the net density of the specimen was measured by the evacuation method[1] devised by Professor U. Yoshida and Mr. B. Takei.

The writer chiefly examined the net density of ramie celloluse carbonized at lower temperatures, and Y. Matsunaga studied that of sugar charcoal carbonized at higher temperatures. The results obtained by Y. Matsunaga for sugar charcoal carbonized at various temperatures for 3 hours are shown by the curve plotted in dotted line in Fig. 1. Though perfect connection between the two curves in Fig. 1 was not obtained, which would mainly be due to the difference of the original materials, yet the general tendency for the minimum net density to occur at about 290°C seems to be clearly shown by these two curves.

1. U. Yoshida and B. Takei: These Memoirs, **15**, 1 (1932).

This seems to indicate that the organic substances are transformed into amorphous carbon rather perfectly at a carbonizing temperature of about 290°C, but that at higher carbonizing temperature some of the amorphous carbon is transformed into graphite. This latter point was also tested by the writer with X-rays generated from the Cr target. With the carbon obtained by carbonizing ramie cellulose at temperatures of 600°C and 700°C, clear diffraction rings due to the graphite were detected on the background of the broad amorphous ring peculiar to amorphous carbon.

In conclusion, the writer wishes to express his sincere thanks to Professor U. Yoshida for his kind guidance, also to Lecturer, Dr. K. Tanaka and Mr. H. Tanaka for the facilities afforded to him during the present experiment.