The Melting of Glassy Carbon

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It has previously been reported[1] that carbon was melted at 4000°K under a pressure of 110 atm. and that the molten carbon had the same lattice constants as natural graphite, i. e., $c_0=6.707_8$ Å and $a_0=2.461_4$ Å. However, Bundy[2] has reported that the carbon which was melted under very high pressure and using the flash heating technique had a large lattice constant, 6.748 Å for c_0. In the present work, glassy carbon, which has been found to be a typical non-graphitizing carbon,[3,4] was melted in the same pressure vessel as has been reported on previously.[1]

Glassy carbon rods 4 mm. in diameter, which had previously been heat-treated at 2000°C, were melted by the passage of electrical current directly through them in argon under a pressure above 110 atm. The melting of carbon usually occurred in the middle part of the rod. With a coke-based carbon, the molten carbon formed a ball attached to a crater-type cavity.[1] With glassy carbon, the melting started in the inner part of the rod and made a molten mass of a thin spindle form along the central axis of the rod. Frequently, the molten carbon spouted out from the break of the cavity wall, and a narrow but long cavity of a spindle form was formed inside the rod. The spouted molten carbon was scattered in balls smaller than 0.5 mm. in diameter. When a glassy carbon rod 5 mm. in diameter was used, the spouted molten carbon had a cochleate appearance. Minute fragments of the molten carbon were also found on the inside wall of the cavity.

The molten carbon was soft and of a metallic luster. Its lattice constant, c_0, was 6.708 Å. The X-ray powder pattern for a rod specimen cut out from the molten carbon had only diffraction lines of the hexagonal modification of graphite, and none of the rhombohedral modification. By grinding the same carbon in a mortar, however, traces of the rhombohedral modification were detected from the X-ray pattern.

In one case, where no change in the appearance of the rod specimen was observed after the passage through of an electrical current, a cavity about 10 mm. long and about 1.5 mm. in diameter at the maximum was found in the central part of the rod. The wall of the cavity was composed of three layers, which

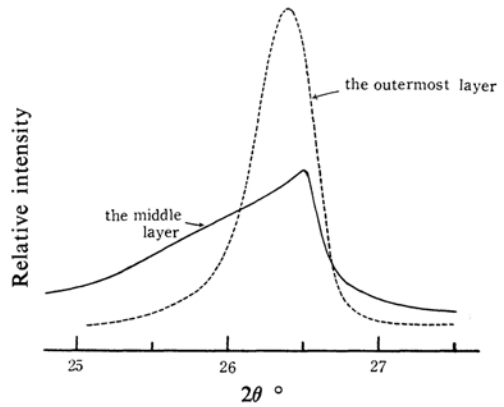

Fig. 1. Profiles of (002) diffraction for the outermost and the middle layers of the cavity wall.

1) T. Noda, "Proceeding of the International Symposium on High Temperature Technology," MacGraw-Hill, New York (1959), p. 286.
2) F. P. Bundy, *J. Chem. Phys.*, 35, 618 (1963).
3) S. Yamada, H. Sato and T. Ishii, presented at the Sixth Biennial Conference on Carbon, Pittsburgh, 1963.
4) T. Noda and M. Inagaki, This Bulletin, to be published

were clearly distinguished from each other in hardness and appearance. The innermost layer was the molten carbon, judging from its properties and its lattice constant, c_0. The outermost layer, which was about 0.05 mm. thick, was so soft that it could be whittled by a razor blade, but it had no metallic luster. Its lattice constant, c_0, was measured as 6.748 Å. It seemed that the graphitization of this part was promoted by the presence of a minute amount of oxygen mixed in the ambient gas phase of argon.[5] The carbon of the middle layer was very hard and showed a conchoidal fracture, which was one of the characteristics of glassy carbon. As is shown in Fig. 1, the profile of (002) diffraction for the middle layer was unsymmetrical, while the profiles for the other layers were symmetrical. This unsymmetrical profile shows that the non-graphitized part remained in the glassy carbon at the middle layer, even after heating at temperatures very near to the melting point of carbon. This phenomenon is somewhat similar to the finding that the crater part of the rod of a coke-based carbon had the lattice constant, c_0, of 6.714 Å.[1] It must be noticed that glassy carbon did not lose its characteristics, even at temperatures very near to its melting point.

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5) T. Noda and M. Inagaki, *Carbon*, to be published.