Infrared Absorption Spectrum of Boron Carbide

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Boron is dissolved in boron carbide at high temperature[1] and the ratio of boron and carbon in boron carbide prepared by reaction of boron oxide with carbon always becomes greater than four[2-4]. Although lattice dimension of boron carbide increases with dissolving boron, a detail of the structural change has not yet been explained. In this communication, the infrared absorption spectra of boron carbide having various B/C ratios are presented with the result of X-ray examination of the change of lattice dimension.

Samples of boron carbide employed were fabricated by the reaction of boron oxide with carbon black at about 2800°C by means of 40 kW closed electric furnace. Crystalline boron (purity, more than 99 percent; tetragonal) was provided from Borax Consolidated Ltd. (England). The infrared absorption spectra were observed by using potassium bromide pellet techniques.

The infrared absorption spectra of boron carbide and boron in the range between 1600 and 700 cm^{-1} are shown in Fig. 1 and they agree with the results reported by Brame[5]. The absorption bands at 1158, 1084, 798 and 781 cm^{-1} remain unaffected by the difference of composition, and are the same as that of elemental boron. On the other hand, the band at 1578 cm^{-1} moves gradually toward to small wave number region with the increase of the B/C ratio. It is evident from Fig. 2 that the variation of the wave number with carbon content has some regularity, and the knee point is found at 17.5 percent of carbon. The result of the examination of these carbides by X-rays is shown in Fig. 3, values of 2θ of the (603) reflections are plotted against atom percent of carbon. The carbon content of the reflection point shown in Fig. 3, which agrees with the result found in Fig. 2, may show the limitation of solubility of carbon into boron carbide. The structural unit of boron carbide is linear chain of three carbon atoms and a group of twelve boron atoms arranged at the vertices of a regular icosahedron, and these are distributed approximately in an NaCl type of structure[6]. The shift of the absorption band at 1578 cm^{-1} by dissolving boron may be closely related to the change of the structure; the central carbon of the linear chain of three carbons connecting between boron icosahedron is replaced by a boron atom, which is 14 percent larger than carbon in atomic radius.

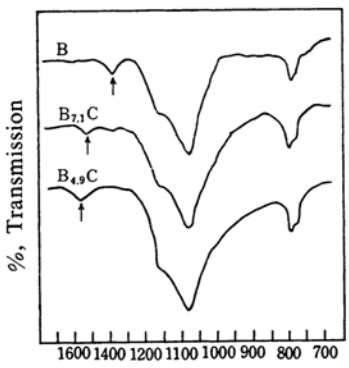

Fig. 1. Infrared absorption spectra of boron and boron carbide.

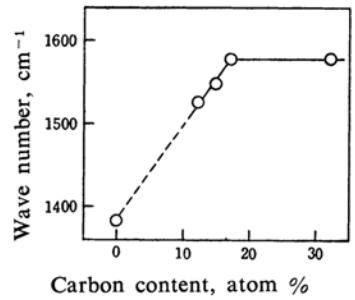

Fig. 2. Characteristic absorption band of boron-carbon system.

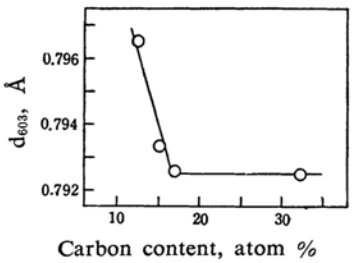

Fig. 3. Interplaner distance of (603) reflection of boron-carbon system.

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