Tungsten boride nanoparticle synthesis by pulsed discharge of compacted B powder

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Tungsten borides have been firstly reported by R. Kiessling et al. in 1947 [1]. Since then, many studies have been done to synthesize various kinds of tungsten borides, namely W_2B, WB, W_2B_5, WB_4. Also, these tungsten borides have been found useful in industrial application including abrasive, corrosive-resistant, and electrode exposed to harsh environment because of their excellent mechanical properties such as high hardness and corrosion resistance[2]. Tungsten borides have been synthesized by chemical vapor deposition[3], solid state reaction[4], and thermal plasma synthesis methods[5]. Generally, these methods utilize high temperature to enable the reaction between tungsten and boron. However, these methods require complicated and costly equipment. In this study, we propose a simpler and low-cost method to synthesize various kinds of tungsten boride by a large pulsed current. Especially, with a high heating rate, tungsten (W) and boron (B) were heated simultaneously into vapor and reacted with each other in only a few hundred microseconds. Moreover, with a high cooling rate as a characteristic of this method, due to supersaturation, tungsten boride vapor was nucleated and formed tungsten boride nanoparticle. With this method, by adjusting the amount of starting materials and/or varying the discharging energy, various phases of tungsten boride were confirmed. In this study, experiment was conducted with 6.2 kV charging voltage and capacitor 30μF in Ar gas at 100 kPa. Figure 1 shows the experiment set-up. Figure 2 shows the X-ray diffraction patterns of tungsten boride nanoparticle synthesized by pulsed discharge of compacted B powder. For the case of 5 mg B crystalline powder, main phase was WB_4 while for the case of 1.5 mg of similar powder, the amount of (α- and β-)W and WB increased, however, the amount of WB_4 decreased.

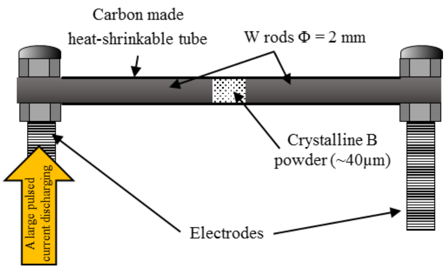

Fig. 1. Experiment set-up for tungsten boride nanoparticle synthesized by pulsed discharge of B powder.

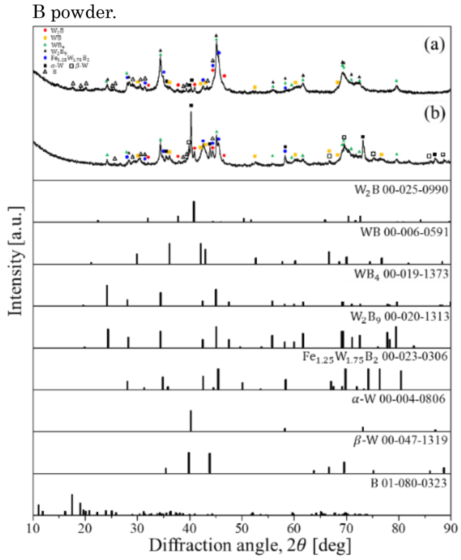

Fig. 2. X-ray diffraction pattern of tungsten boride nanoparticle synthesized by pulsed discharge of compacted (a) 5 mg B crystalline powder (b) 1.5 mg B crystalline powder.

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