The quality investigation of 6H-SiC crystals grown by conventional PVT method with various SiC powders

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Abstract : Silicon carbide is one of the most attractive and promising wide band-gap semiconductor material with excellent physical properties and huge potential for electronic applications. Up to now, the most successful method for growth of large SiC crystals with high quality is the physical vapor transport (PVT) method [1, 2]. Since further reduction of defect densities in larger crystal are needed for the true implementation of SiC devices, many researchers are focusing to improve the quality of SiC single crystal through the process modifications for SiC bulk growth or new material implementations [3, 4]. It is well known that for getting high quality SiC crystal, source materials with high purity must be used in PVT method. Among various source materials in PVT method, a SiC powder is considered to take an important role because it would influence on crystal quality of SiC crystal as well as optimum temperature of single crystal growth, the growth rate and doping characteristics. In reality, the effect of powder on SiC crystal could definitely exhibit the complicated correlation.

Therefore, the present research was focused to investigate the quality difference of SiC crystal grown by conventional PVT method with using various SiC powders. As shown in Fig. 1, we used three SiC powders with different particles size. The 6H-SiC crystals were grown by conventional PVT process and the SiC seeds and the high purity SiC source materials are placed on opposite side in a sealed graphite crucible which is surrounded by graphite insulation[5, 6]. The bulk SiC crystal was grown at 2300℃ of the growth temperature and 50mbar of an argon pressure. The axial thermal gradient across the SiC crystal during the growth is estimated in the range of 15~20℃/cm. The chemical etch in molten KOH maintained at 450℃ for 10 min was used for defect observation with a polarizing microscope in Nomarski mode. Electrical properties of bulk SiC materials were measured by Hall effect using van der Pauw geometry and a UV/VIS spectrophotometer. Fig. 2 shows optical photographs of SiC crystal ingot grown by PVT method and Table 1 shows electrical properties of SiC crystals. The electrical properties as well as crystal quality of SiC crystals were systematically investigated.

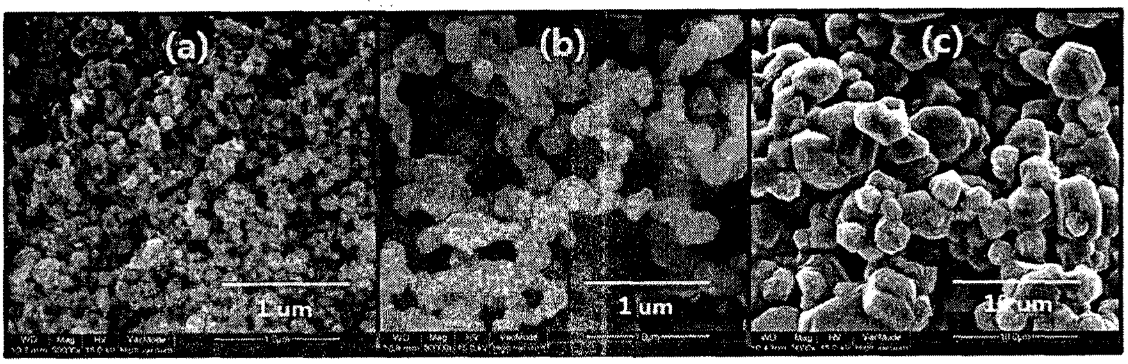

Fig. 1. The optical pictures and SEM images of three SiC Powders with different particle size. (a) 50nm (b) 100~200nm and (c) 1~10μm.

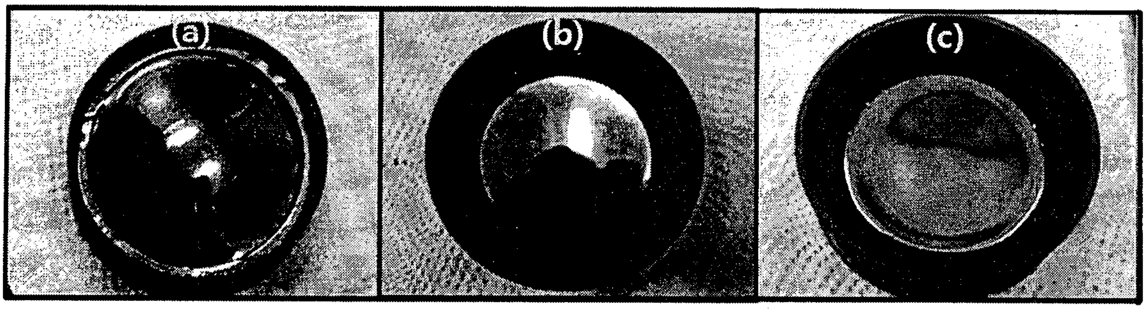

Fig. 2. Optical photographs of SiC crystal ingot grown by conventional PVT methods. (a) 50nm (b) 100~200nm and (c) 1~10μm.

Table. 1. The electrical properties of SiC single crystal grown with various SiC powders.

	a	b	c
Type	n-type	n-type	n-type
Carrier Concentration [/㎤]	2.34×10^{17}	1.41×10^{17}	1.09×10^{17}
Resistivity [Ωcm]	0.13	0.23	0.13
Mobility [㎠/Vs]	255.90	191.90	40.06

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