Characterization of 6H-SiC Single Crystals grown by Sublimation Method

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Silicon Carbide(SiC) possesses excellent thermal and electrical properties for the application of the semiconducting and optoelectronic device. The current interests in SiC for power semiconductor device materials and blue light emitting diodes(blue LEDs) are based on its characteristics such as high breakdown voltage, high saturation velocity, high operation temperature, high thermal conductivity and high chemical stability[1,2].

We have grown the 6H-SiC single crystals by sublimation method. The principle of the sublimation grown method[3,4,5] is as follows; SiC-seed substrate is located at the top and SiC powder for source are in the bottom. Temperature gradient shown in left hand side are very important to find optimum growth conditions. When the graphite crucible is heated to enough temperature to sublime SiC to Si_2C, SiC_2, Si etc. They are recrystallized on the substrate which is cold region. The growth rate and the crystal quality grown are dependant on the growth temperature of the seed-substrate and starting powders, temperature gradient, and partial pressure of the atmosphere.

Optimum growth conditions for 6H-SiC single crystal are as follows; The temperature of the starting SiC powder was above 2150~2250℃. The difference in temperature between two regions was about 150~250℃. Growth pressure inside of the chamber was 50~200 torr and growth rate was 300~700 μm/hr.

Using above growth conditions, SiC single crystal was grown. Fig. 1 show the 6H-SiC single crystal ingot and both side polished wafer. The wafer diameter was about 33mm and thickness was about 300μm. Fig. 2 shows the typical internal defects in 6H-SiC wafer[6, 7]. Hexagonal planar defects and micropipes were seen. The demension of these defects were $50/cm^2$ and $10^2/cm^2$. Electrical propperties of undopped 6H-SiC wafer were measured by Hall

effects measurements. Carrier concentration of undopped SiC wafer was $10^{16} \sim 10^{17}/cm^3$ and doping type was n-type. The difference of crystallinity between 6H-SiC wafer grown by sublimation growth and Acheson seed was measured by Raman spectroscopy and Double Crystal X-ray diffraction shown Fig. 3. Crystallinity of 6H-SiC wafer was rather than of Acheson seed. Fig. 4 is optical transmittance spectra obtained from the FT-IR measurement. As seen in this figure, the transmittance of the wafer of the grown SiC crystal was about less than 20%. In the wavelength region of 2500~500 cm^{-1}, the absorption band was thought to be originated from the Si-C lattice vibration and the strong absorption edge between 1500~500cm^{-1} is attributed to the mixing of the lattice vibration.

Summary of this paper is as follows.

6H-SiC single crystals were sucessfully grown by the self-designed sublimation apparatus and the optimum growth condition was established. The grown SiC crystals were about 33mm in diameter and 10mm in length. Carrier concentration and doping type of undopped 6H-SiC wafer grown by sublimation method were $10^{16} \sim 10^{17}/cm^3$ and n-type. Crystallinity of grown 6H-SiC wafer was better than of Acheson seed by data of Raman spectroscopy and Double Crystal XRD.

We continue to characterize the grown 6H-SiC wafer in more detail and so we will grow the high-quality 6H-SiC single crystal wafer.

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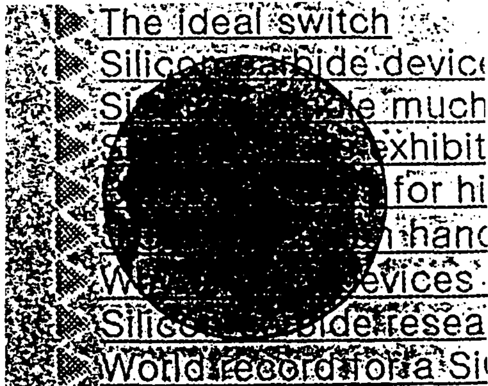

Fig. 1 SiC Bulk Crystal and wafer grown by the Sublimation Method

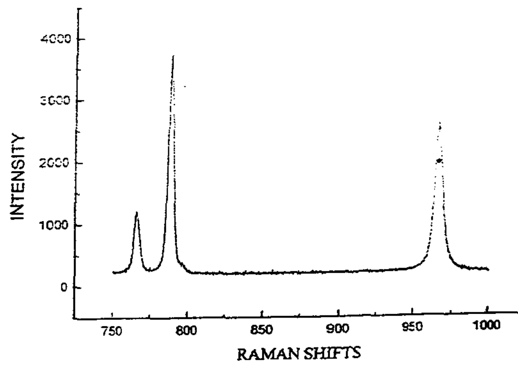

Fig. 3 Crystallinity of 6H-SiC wafer.

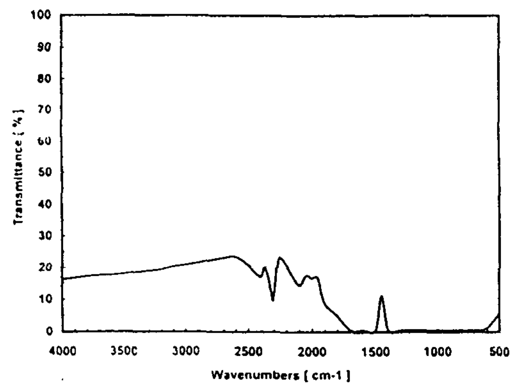

Fig. 4 The FT-IR Curve from 6H-SiC Substrate

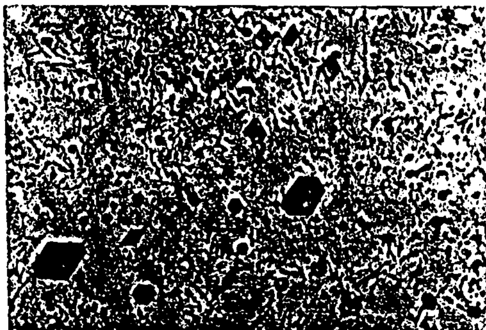

Fig. 2 Typical internal defects in 6H-SiC wafer