# Growth of carbon nanotubes on the surface of SiC powder by controlling pressure and gas atmosphere

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Carbon nanotube (CNT) is a material with cylindrical structure of graphene, and has high thermal conductivity, electrical conductivity and large specific surface area. Closely-packed CNTs thin film can be produced by the thermal decomposition of SiC [1]. The nanometer-scale structure after thermal decomposition of SiC varies depending on the heating atmosphere, such as pressure and oxygen concentration. CNT/SiC composite particles have large specific area, so they are promising candidates for use to support catalyst in them. In this study, we optimized the CNT growth conditions from the SiC particles.

Averaged diameter of the SiC particles was about 2 μm. As a pretreatment, the powder was ground with a mortar and pestle. It was then introduced into a rotating container and was heated to 1500℃. The powder was heated under either $N_2$ : $O_2$ = 79 : 21 or pure $O_2$ atmosphere, with the flow rate of 0.05 sccm. The pressure during heating was maintained to $10^0$, $10^1$, $10^2$, or $10^3$ Pa. To ensure continuous exposure of the surface to gas, the container was rotated with the speed of 6 rpm, in the temperature range from 1200 to 1400 ℃. The samples were observed by JEM-2100-type transmission electron microscope (TEM).

Figure 1 shows TEM images of the sample which were heated under $N_2/O_2$ gas at $10^0$ or $10^2$ Pa. Under both conditions, linear contrast parallel to the surface of the particle was observed, indicating the formation of graphite covering the SiC particle. According to the previous studies, it is due to the lack of oxygen needed for CNT growth [2,3]. Figure 2 shows TEM images of the samples which were heated under pure $O_2$ gas at $10^0$ or $10^2$ Pa. In the sample which was heated at $10^0$ Pa, linear contrast parallel to the surface of the particle was observed, similar to those in Figure 1, indicating the formation of graphite covering the SiC particle. This is also attributed to the insufficient oxygen supply. In contrast, in the sample which was heated at $10^2$ Pa, linear contrasts perpendicular to the surface of particle was observed, indicating the growth of CNTs. However, their orientation was poor. These results suggest that appropriate control of the oxygen supply is necessary for the formation of highly orientated CNTs.

[1]M. Kusunoki, *et al*., Chem Phys. Lett. **366**, 458(2002).
[2]W. Norimatsu, *et al*., Chem Phys. Lett. **468**, 52(2009).
[3]M. Kusunoki, *et al*., Appl. Phys. Lett. **77**, 531(2000).

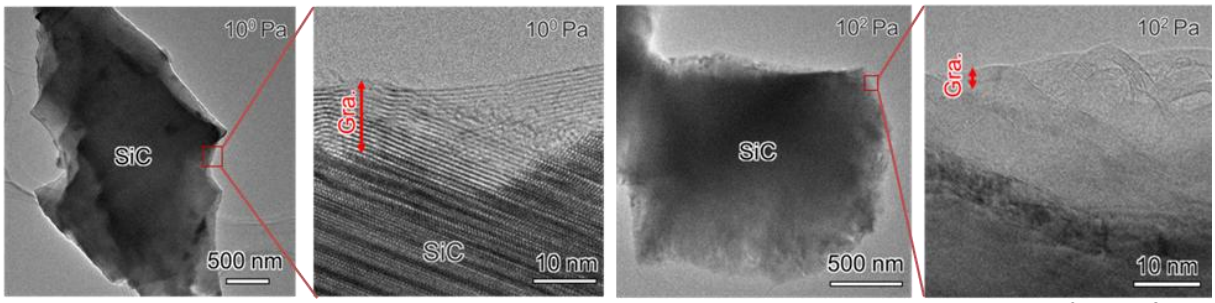


**Fig. 1** TEM images of the samples which were heated under $N_2/O_2$ mixed gas at $10^0$ or $10^2$ Pa.

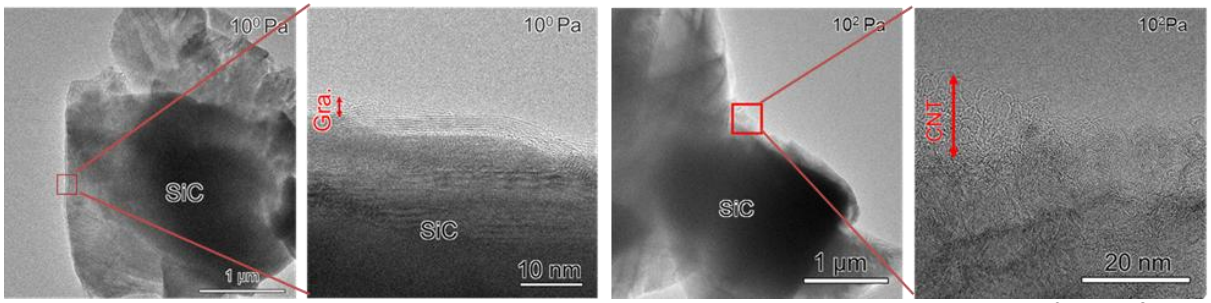


**Fig 2** TEM images of the samples which were heated under pure $O_2$ gas at $10^0$ or $10^2$ Pa.