# THERMAL PROPERTY OF CARBON NANOTUBE/NANOFIBER LOADED CARBON/CARBON COMPOSITES

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## Introduction

Carbon nanotubes exhibit many excellent properties such as electrical, thermal, chemical and mechanical properties, which make them applicable as multi-functional filler in various nano-composites. Especially, it is reported that theoretically calculated thermal conductivity of carbon nanotube was up to 3000 W/m・ K [1]. In this study, we try to understand what factors affecting on the thermal conductivity of simply fabricated fibrous carbon incorporated carbon composites in terms of the variation of microstructure.

## Experimental

We utilized three types of fibrous carbons, VGCF (150 nm) (SDK), CNT20 (20nm) (CNRI), cup-stacked type carbon nanofibers (GSI) as filler (see typical transmission electron microscope images in Fig.1 (a), (b) and (c)). For the case of matrix, air-oxidized pitch is selected because this simple process suppresses the evolution of gases during carbonization, resulting in high carbon yield. Fabrication procedure of pellet is as following: (1) dispersion of filler (1, 3, 5 wt%) in ethanol under the sonication, (2) adding the matrix to the solution and dispersed, (3) heating at 100$^{o}$C using hot stirrer in order to evaporate the solvent, (4) pressing the powder into the pellet about 300MPa using hand press. These pellets were heated to 1000$^{o}$C for 30 minutes in an argon atmosphere, and then graphitized at 2800$^{o}$C for 30min.

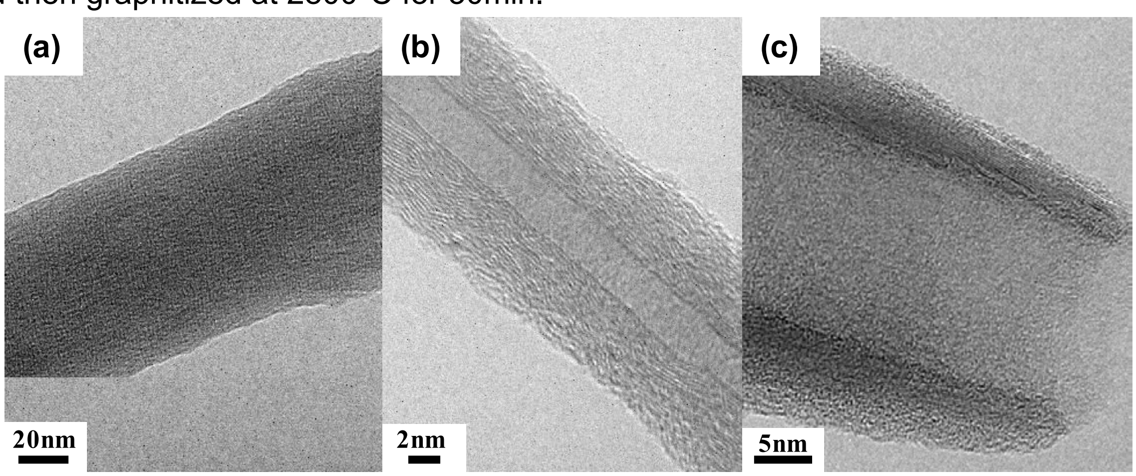


**Fig.1 High resolution TEM image of (a) VGCF (b) CNT20 (c) Carbere24ps**

## Results and Discussion

Figure 2 (a) and (b) exhibits the variation of density for VGCF- and CNT20-incoporated composites as a function of heat treatment temperature (HTT), respectively. It is natural that bulk density of composites show decreased tendency with increasing HTT, due to consecutive carbonization through the evolution of oxygen-, nitrogen- and hydrogen-containing gases. As shown in Fig. 2 (c), higher real density of VGCF-incorporated composite is derived from higher crystalline property of nanofiber itself as compared with that of CNT20/C composite. The variations of specific heat, thermal diffraction and thermal conductivity for three samples are shown in Fig. 3. Increased specific heat of filler incorporated composites is partly due to closed pore. The formation of three-dimensional network by fibrous filler helps clearly thermal transport of fibrous carbon/carbon composites. In this study, we try to correlate the variation of microstructures by heat treatment (XRD and Raman) with thermal properties of composites.

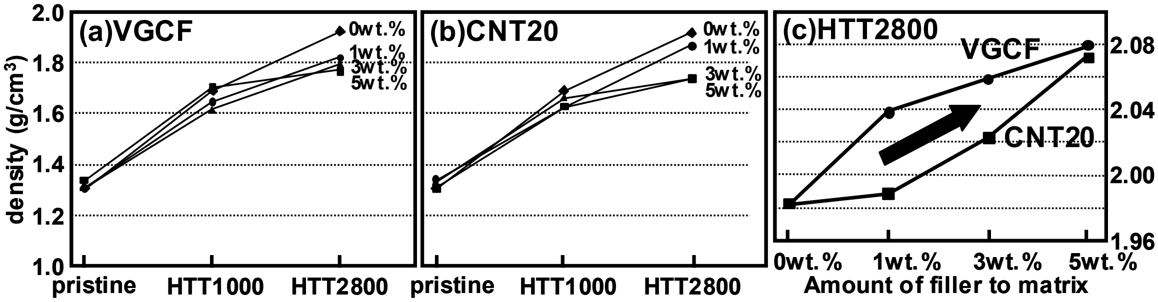


Figure 1 Variations of bulk density of (a) VGCF- and (b) CNT20-incorporated carbon composites, and (c) variation of real density for samples heat treated at 2800$^{o}$C.

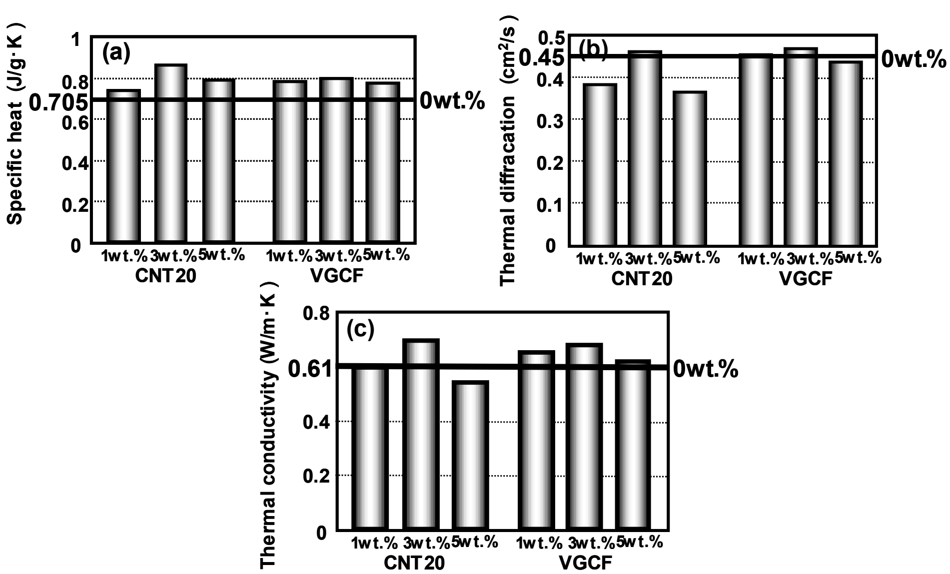


Figure 2 (a) specific heat, (b) thermal diffraction, and (c) thermal conductivity for samples heat treated at 2800$^{o}$C

## References

[1] S. Berber, Y. K. Kowon, D. Tomanek, Phys. Rev. Lett. 84, 4613 (2000).

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