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## Formation of Shell-Shaped Carbon Nanoparticles through Critical Transition in Irradiated Acetylene

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**Key Words :** shell-shaped carbon nanoparticle( ), critical transition( ), laser irradiation( ), flame synthesis( )

### Abstract

Shell shaped hollow carbon nanoparticles are synthesized in the oxygen-hydrogen diffusion flame with C<sub>2</sub>H<sub>2</sub> as precursor when it is irradiated with CO<sub>2</sub> laser of certain power. Below this power of laser, we couldn't get any other but amorphous soot. This shell shaped hollow carbon nanoparticles shows outer wall of high degree of crystallinity with void space inside of itself. And size distribution of these nanoparticles is measured with TEM image analysis. Also the structural comparison between this carbon nanoparticle and soot is done by Raman and XRD measurement. These results show this carbon nanoparticles are of grapheme structure, which means it has good crystallinity when compared with soot.

1. [4] 가 [5] 가 [6] 가

가<sup>[1,2]</sup>  
[3]

가 [7]

가

2.

0.1 lpm

0.35 lpm , 1 lpm , 0.5 lpm

†

가

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, CO<sub>2</sub>

\*

CO<sub>2</sub>

3 mm

2500 W 가  
 가 . TEM (restructuring)  
 [8,9]  
 TEM grid  
 . TEM  
 가  
 가  
 Raman  
 3.  
 Fig. 1 가

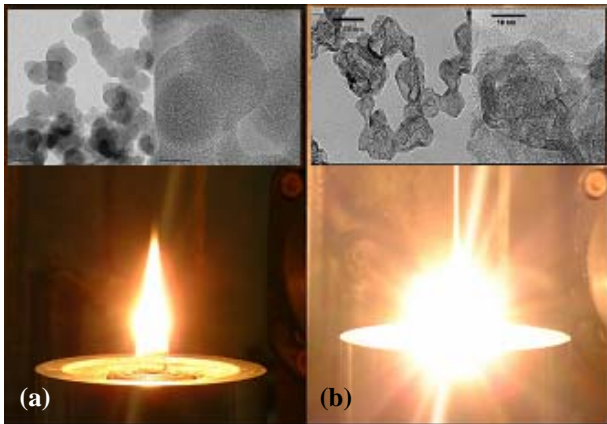


Fig. 1 Flame images with laser irradiation at (a) 15 mm, (b) 10 mm

2300 W 가  
 Fig. 1(a) 15 mm Fig. 1(b)  
 9 mm 가 Fig. 1  
 9 mm  
 가 ( 1700 W ) 가  
 가  
 (BSU, Basic Structural Unit)가

mm

(restructuring)

Fig. 2  
 multi-color method<sup>[10]</sup>  
 Fig. 2

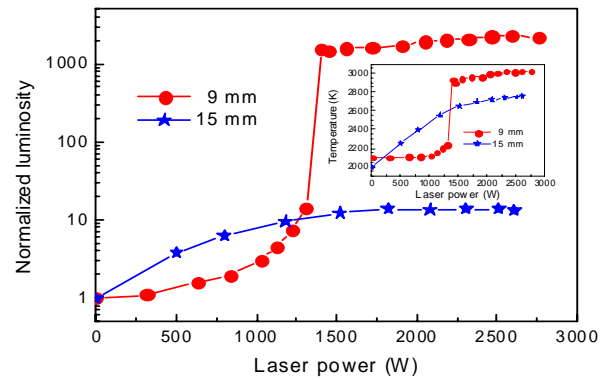


Fig. 2 Flame luminosities and flame temperatures as a inset.

Fig. 2 가  
 가

Fig. 3

가 1700 W  
 (bimodal)

가

10~40 nm  
 20~60 nm 가  
 Fig. 4 XRD Raman  
 . XRD

. Raman  
 1300 cm<sup>-1</sup> D-peak 가 1530  
 cm<sup>-1</sup> G-peak 가 peak

15

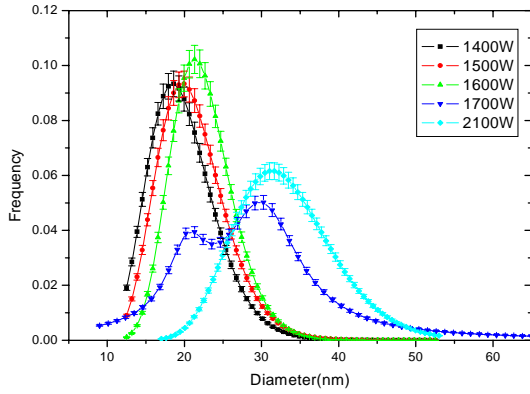


Fig. 3 Primary particle size distribution

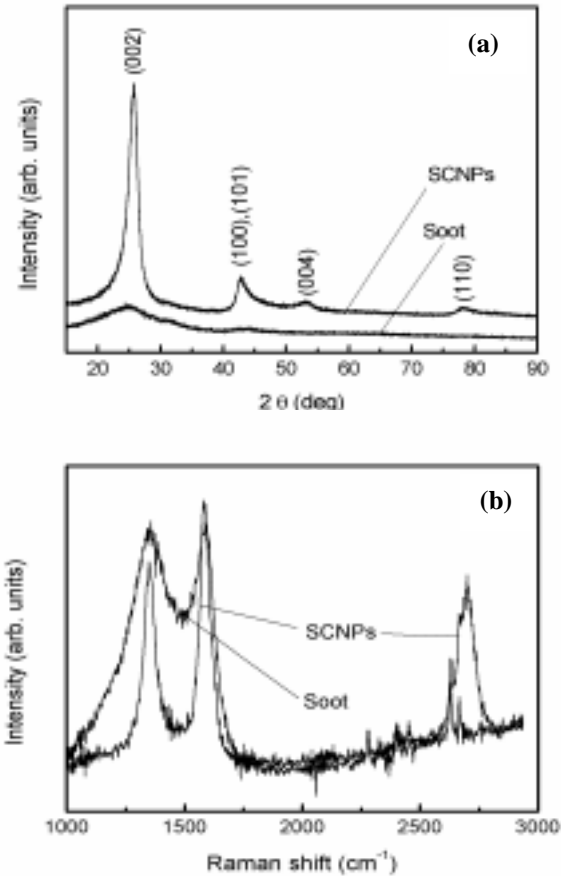


Fig. 4 (a) X-ray diffractograms of soot and shell-shaped nanoparticles. (b) Raman shift of soot and shell-shaped nanoparticles.

Fig. 5

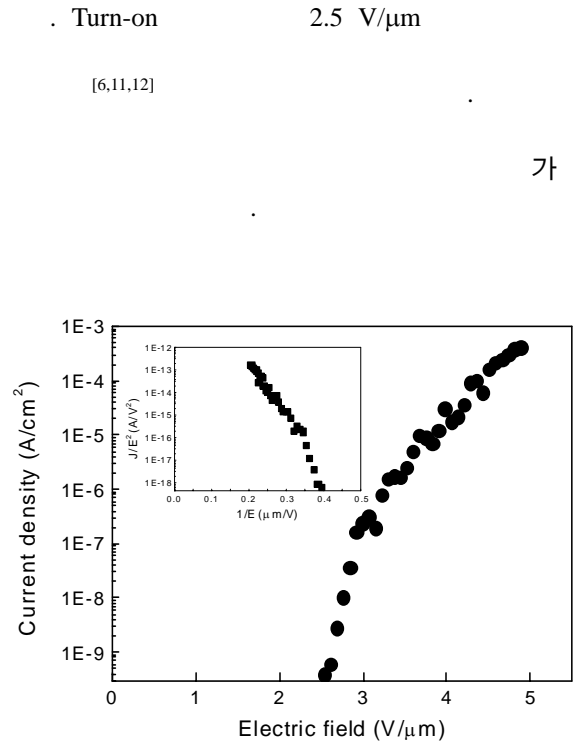


Fig. 5 Typical field emission characteristics of shell-shaped carbon nanoparticles. The turn-on electrical field is about 2.5 V/μm. The inset shows the Fowler-Nordheim plot

6.

CO<sub>2</sub>

가 가 가

가

가

가

가

TEM

sp<sup>2</sup>

sp<sup>3</sup>

XRD

Raman

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