Ar+CH_4 プラズマで作製したカーボンナノ粒子の堆積の時間変化

Time Evolution of Deposition of Carbon Nanoparticles Synthesized by Ar+CH_4 Plasmas

[1] 九州大学, [2] 自然科学研究機構,
○黄　成和[1], 鎌滝　晋礼[1], 板垣　奈穂[1], 古閑　一憲[1], 白谷　正治[1]
[1]Kyushu Univ., [2]NINS, ○Sung Hwa Hwang[1], Kunihiro Kamataki[1], Naho Itagaki[1],
Kazunori Koga[1, 2], and Masaharu Shiratani[1]
E-mail: sh.hwang@plasma.ed.kyushu-u.ac.jp

Among many methods for synthesizing carbon nanoparticles (CNPs), plasma is a promising method that continuously produces high purity size-controlled CNPs and uniformly deposits onto substrates [1]. So far, we have succeeded in controlling their size by the gas residence time in discharge regions [2]. However, for their application to nano-technologies, understanding deposition of CNPs and its control are important. Here we have measured the time dependence on CNPs deposition quantitatively.

Experiments were carried out using a multi-hollow discharge plasma chemical vapor deposition (MHDPCVD) method. During the discharge with 40 W of 60 MHz power supply, Ar/CH_4 gas ratio, total flow rate and working pressure were kept at 6:1, 100 sccm and 2 Torr respectively. High resolution TEM grids and N type Si substrates are set at 100 mm away from the electrode in the downstream region. The deposition time was controlled from 1 min to 90 min. Deposited CNPs were randomly observed by TEM. The sample area was 356 nm^2. Raman spectroscopy (532 nm laser excitation) and an optical emission spectroscopy were used to analyze the CNPs structure and plasma conditions, respectively.

Figure. 1 shows the deposition time dependence on the flux and the size of CNPs. The monolayer deposition of CNPs start to be observed above 15 min and their flux slightly decreased from 22.5 to 18.0 until 60 mins. After 60 min, deposited CNPs agglomerated with each other. In addition, the mean particle size was kept at around 25 nm throughout the deposition time. One possible reason is that the density of carbon clusters in the gas phase changes before the flux becomes in the steady state.

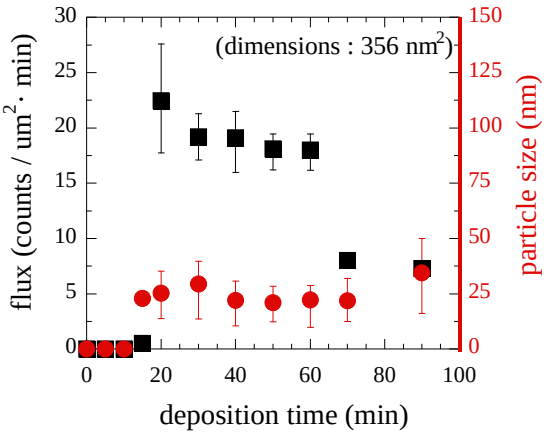

Fig. 1. Deposition time dependence on flux and particle size of CNPs.

References

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