Effect of electron beam irradiated CNT on dose rate

Shin ae Kim [a,b], Joon pyo Jeun [a], Yoonsun Chung [b], Young Chang Noh [a], Phil hyun Kang [a,*]
[a]*Korea Atomic Energy Research Institute, 29 Gumgu-gil Jeongeup-si, Jeonbuk, 580-185*
[b]*Department of Nuclear Engineering, Hanyang University, 222 Wangsimni-ro Seongdong-gu, Seoul, 04763*
[*]*Corresponding author: phkang@kaeri.re.kr*

1. Introduction

Carbon nanotube (CNT) have been studied actively in technology because they have excellent mechanical properties, thermal stability and electrical properties. However, residual metal impurities generated during the synthesis of CNT may degrade the excellent properties of CNT [1]. In order to improve the properties, study has been conducted to irradiate X-rays [2], Electron beam [3, 4].

In this paper, the effect of dose rate at high doses such as 5,000 kGy on the morphology and chemical structure of CNTs is described. If the change caused by the heat generated in the current is larger than the change due to the time difference, the high-speed purification can be possible by irradiating a relatively high current for a short time. However, it should be considered that the overloading of the over-current causes not only the physical properties of the CNT but also the surface of the CNT. Experiments were carried out with current parameters of 1, 2 and 4 mA in order to irradiate 5,000 kGy. As a result, it was confirmed that there was no significant effect on the dose rate.

2. Methods and Results

In this section some of the experimental used to compare several factor according to dose rate are described.

2.1 Material

CNTs used TUBALL™ (OCSiAl, Luxembourg) CNT powder of SWNT type without purification.

2.2 Electron Beam irradiation

CNTs were irradiated with electron beam using Electron beam accelerator in Daejeon. The beam were respectively irradiated with 5,000 kGy at 2.5 MeV (beam current 1, 2, 4 mA) by the integral method.

2.3 Analysis instruments

The analysis of morpholgy was analyzed through Scanning Electron Microscopy (SEM, SU8230, HITACHI). The chemical structure of CNTs was used as X-Ray Photoelectron Spectroscopy (K-alpha, Thermo VG Scientific) and peak separation was done using the Advantage program. Raman spectroscopy (NTEGRA, NT-MDT was measured to observe the shapes of Graphite band (G-band) and Defect band (D-band) generally appeared in Raman image of CNT.

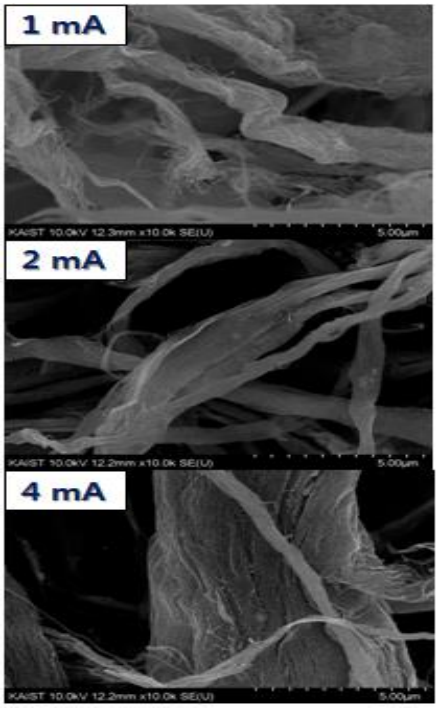

Fig. 1. SEM image were made to observe the morphology effects of 1, 2 and 4 mA currents, respectively.

Figure 1 is a morphology of CNT irradiated with electron beam with each currents. The CNT irradiated with electron beam did not show shrinkage or breakage, and showed no structural change with current.

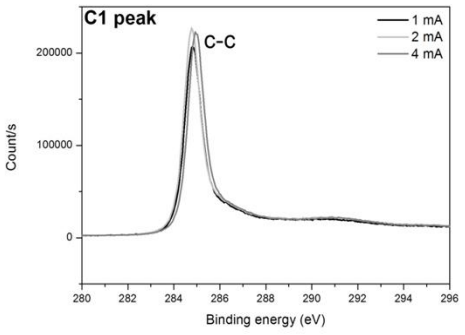

Fig. 2. C1 peak of XPS image were made to analysis the chemical structure of 1, 2 and 4 mA currents, respectively.

Figure 2 is a chemical structure of C1 peak. A strong C-C bond retained its bond even when irradiated with an electron beam, and a new structure was not coupled or separated depending on the current.

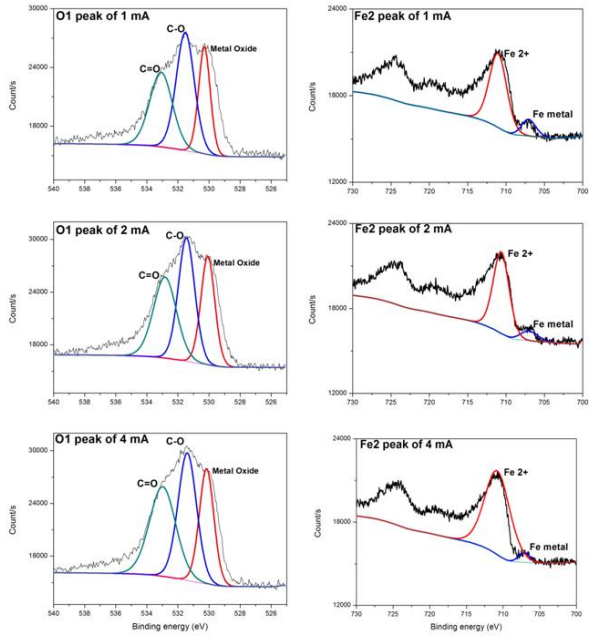

Fig. 3. O1 and Fe2 peak of XPS image were made to analysis the chemical structure of 1, 2 and 4 mA currents, respectively.

Figure 2 is a chemical structure of O1 and Fe2 peak. O1 peaks were separated using an advantage program. The O1 peaks were observed at 515.5 ~ 532 eV for C-O and 533 eV for C = O and 529 ~ 530 eV, respectively, with reference to the reference values shown in Table I. And then, Fe2 peaks were separated using an advantage program. The Fe2 peaks were respectively observed at 710.8 eV for Fe 2+ and 706.7 eV for Fe metal with reference to the reference values shown in Table Ⅱ.

Table I: Reference of O1 peak

Chemical state	O1 peak (eV)
C-O	531.5 ~ 532
C=O	533
Metal Oxide	529 ~ 530

Table Ⅱ: Reference of Fe2 peak

Chemical state	Fe peak (eV)
Fe 2+	710.8
Fe metal	706.7

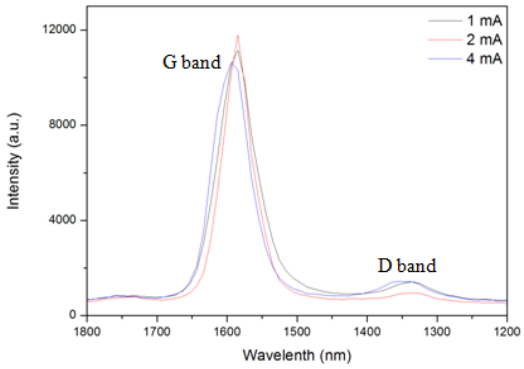

Fig. 4. Raman image were made to observe the shape of G-band and D-band basically appearing in CNT.

Figure 3 is a Raman image in order to observe the shape of G-band (1,650 nm) D-band (1,350 nm) basically appearing in CNT. The change of the BAND due to the current was not confirmed through the image.

3. Conclusions

In this study, experimental were carried out to find out the morphology and chemical structure of CNTs according to the irradiation dose rate. SEM, XPS and Raman analyzes were performed. We could not confirm the change of CNT according to the current through the SEM analysis. Also, in accordance with the morphology tendency, the XPS analysis did not bind the new chemical structure and the band which appeared in CNT was not changed either.

As a result, at 5,000 kGy, the effect of CNT on the electron beam current was irrelevant, indicating that the irradiation dose rate was also the same. It was found that essentially chemical steps such as acid treatment were needed to change the chemical structure of CNT, and it was found out that the effect on CNT purification could not be obtained by irradiating only with electron beam.

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