

Synthesis and effect of pulse duration on formation of hollow carbon nano-onions by the pulsed plasma in liquid

Emil OMURZAK

Priority Organization of Innovation and Excellence, Kumamoto University, 2-39-1 Kurokami, Kumamoto, 860-8555, Japan, Tel.fax: 096-342-3934, e-mail: emil@kumamoto-u.ac.jp

ABSTRACT

A number of carbon nano-onions (CNOs) synthesis methods such as arc discharge [1], laser ablation [2], plasma [3], and chemical vapor deposition [4,5], detonation and annealing of nanodiamonds [6] have been reported. There are drawbacks or limitations to the above methods such as the need for vacuum/cooling systems, high energy/temperature, catalysts/templates, or limitations due to high handling risks. We report energy and cost efficient preparation of hollow CNOs by the pulsed plasma [7] between graphite electrodes submerged in liquid. The effect of pulse duration on the formation of carbon nano-onions under the pulsed plasma in liquid conditions was studied. The sample synthesized using a 40-kHz frequency pulsed plasma with a pulse duration of 5 μs shows more carbon shells (10–30) than the sample prepared at 40 kHz with 12 μs (2 to 10). High Performance Liquid Chromatography (HPLC) and High Resolution Transmission Electron Microscopy (HRTEM) analyses confirm that the sample produced at 40 kHz with a pulse duration of 12 μs contains fullerene C_{60} , while the sample prepared at 40 kHz with 5 μs does not.

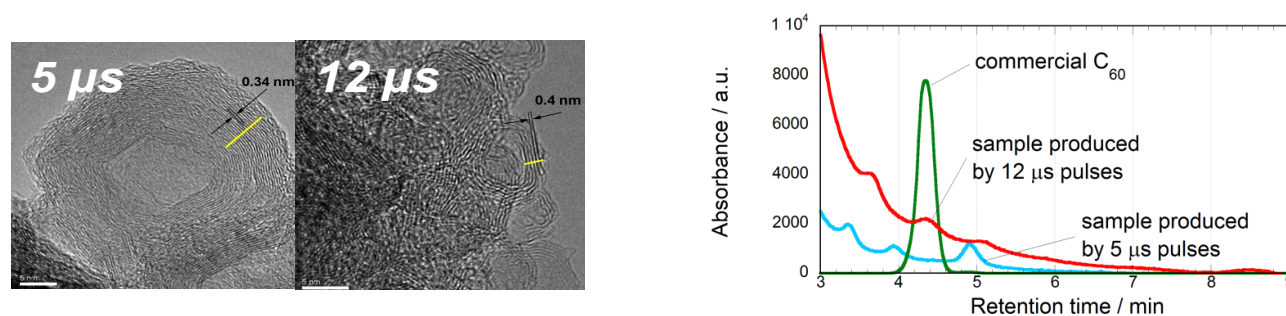


Fig. 1 HRTEM images and HPLC chromatogram for the produced samples by 5 and 12 μs pulses

References

- [1] S. Tomita, M. Nikita, S. Hayashi, K. Yamamoto. *Chem. Phys. Lett.* 316, 361 (2000).
- [2] G. Radhakrishnan, P.M. Adams, L.S. Bernstein. *Thin. Solid. Films.* 515, 1142 (2006).
- [3] G. Cota-Sanchez, G. Soucy, A. Huczko, H. Lange. *Carbon* 43, 3153 (2005).
- [4] Z.J. Qiao, J.J. Li, N.Q. Zhao, C.S. Shi, P. Nash. *Scr. Mater.* 54, 225 (2006).
- [5] C. Zhang, J. Li, C. Shi, E. Liu, X. Du, W. Feng, N. Zhao. *Carbon* 49, 1151 (2011).
- [6] Q. Zoua, M.Z. Wang, Y.G. Lia. *Exper. Nanosci.* 5, 375 (2010).
- [7] E. Omurzak et al. *J. Nanosci. Nanotechnol.* 7, 3157 (2007).