

高温処理による熱水炭素球の構造進化及び圧縮応力下での電気特性

Structural Evolution of Hydrothermal Carbon Spheres Induced by High Temperatures and Their Electrical Properties under Compression

信州大¹, 法政大², マレーシア・サバ大³ ○王志朋¹, 緒方 啓典², Gan Jet Hong Melvin³, 小畑 美智子¹, 森本 信吾¹, Josue Ortiz-Medina¹, Rodolfo Cruz-Silva¹, 藤重 雅嗣¹, 竹内 健 司¹, 村松 寛之¹, 林 卓也¹, Mauricio Terrones¹, 橋本 佳男¹, 遠藤 守信¹
Shinshu Univ.¹, Hosei Univ.², Univ. Malaysia Sabah³ ○Zhipeng Wang¹, Hironori Ogata², Gan Jet Hong Melvin³, Michiko Obata¹, Shingo Morimoto¹, Josue Ortiz-Medina¹, Rodolfo Cruz-Silva¹, Masatsugu Fujishige¹, Kenji Takeuchi¹, Hiroyuki Muramatsu¹, Takuya Hayashi¹, Mauricio Terrones¹, Yoshio Hashimoto¹, Morinobu Endo¹

E-mail: zp_wang@shinshu-u.ac.jp

Recently, spherical carbons have attracted extensive interest in some fields, such as lithium ion batteries, supercapacitors, catalyst supports, gas adsorption because they possess some unique chemical and physical properties, which strongly depend on the size, microstructures, and crystallinity. Based on their sizes, spherical carbons can be classified into carbon onions with 2-20 nm in diameter, carbon spheres (CSs) with 50 nm-1 μm , and carbon beads with the diameter over than 1 μm [1]. For the CS synthesis, there were various techniques, e.g. chemical vapor decomposition of carbonaceous sources, arc discharge or laser ablation of high purity graphite, polymerization-carbonization of polymer precursors, pyrolysis of hydrocarbons, and hydrothermal carbonization of carbon-rich precursors [2]. Among them, hydrothermal technique is regarded as a simple, economical, and green process for the synthesis of CSs with controllable sizes and microstructures. The crystallinity of the CSs can be adjusted by the heat-treatment temperatures. It has been reported that the CSs, which obtained from the pyrolysis of tetrahydrofuran [3] and hydrocarbons [4], presented morphology change from smooth to polyhedral shape and increased the crystallinity with the enhanced performance in the application of lithium ion batteries [1] after high temperature treatment (HTT). However, to our best knowledge, the hydrothermally-assisted CSs under HTT have not been systematically investigated so far.

In this work, we employed the CSs, which were synthesized from the hydrothermal carbonization of glucose, for heat treatment from 1200 to 2900 $^{\circ}\text{C}$ in Ar atmosphere. After HTT, the morphologies, microstructures, and crystallinity of the treated CSs were investigated using scanning (SEM) and transmission electron microscopes (TEM), and Raman spectroscopy, respectively. Figure 1 show SEM images and their respective TEM images of the hydrothermal CS with and without HTT. It is obvious that the microstructures have been changed gradually with increasing temperatures. Additionally, we have also investigated the electrical conductivity of the treated CSs under compression. All of results and discussion will be presented in the coming conference.

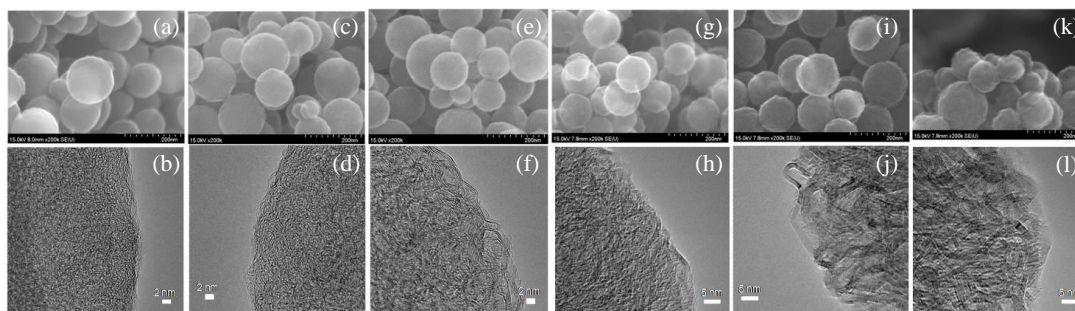


Figure 1 SEM and TEM images of hydrothermal CSs with and without HTT: (a)-(b) received CSs, (c)-(d) 1200 $^{\circ}\text{C}$, (e)-(f) 1800 $^{\circ}\text{C}$, (g)-(h) 2100 $^{\circ}\text{C}$, (i)-(j) 2500 $^{\circ}\text{C}$, (k)-(l) 2900 $^{\circ}\text{C}$.

References

- [1] Y.Z. Jin, Y.J. Kim, C. Gao, Y.Q. Zhu, A. Huczko, M. Endo, et al., *Carbon* 44, (2006) 724.
- [2] A.D. Roberts, X. Li, H. Zhang, *Chem. Soc. Rev.* 43, (2014) 4341.
- [3] B. Zhang, S. Bai, H.-M. Cheng, Q.-K. Cai, *J. Mater. Res.* 9, (2006) 2198.
- [4] Y.Z. Jin, C. Gao, W.K. Hsu, Y. Zhu, A. Huczko, M. Bystrzejewski, et al. *Carbon* 43, (2005) 1944.