Carbon nanowalls and related materials as electrodes in lithium-ion batteries and fuel cells

Masaru Tachibana
Department of Materials System Science, Yokohama City University, 22-2 Seto, Kanazawa-ku, Yokohama 236-0027, Japan

Vertically oriented two-dimensional carbon sheets so-called carbon nanowalls (CNWs) have been fabricated by plasma-enhanced chemical vapor deposition (PECVD). Each CNW exhibits domain structure which is composed of nanographite domains with several tens of nanometers. Such unique morphology and structure of CNWs are attracting much interest for various applications [1]. In this presentation, we will show structural feature of CNWs and their potential applications as electrodes in lithium ion batteries and fuel cells.

Lithium insertion behavior of CNWs was studied by cyclic voltammetry and charge/discharge measurements. It was found that CNWs had reversible capacity of more than 200 mAh/g like that of graphite. Especially, CNWs showed good response for lithium insertion/extraction reaction, whose rate is about one order as much as that for common graphite [2]. Thus, CNWs show great promise as a negative electrode in lithium ion battery for high rate use. For a catalytic electrode in fuel cell, the deposition of platinum (Pt) catalysts on CNWs was carried out by a solution reduction method. It was found that Pt nanoparticles with mean diameter of 3.5 nm were well-dispersed along domain boundaries in CNWs [3]. The high catalytic activity was also evaluated from cyclic voltammograms. Therefore, CNWs are also useful as a Pt catalytic support in fuel cell. Most recently, non-Pt carbon catalysts such as Fe-N-doped carbons were also synthesized by the PECVD with sputtering system [4]. The oxygen reduction reaction activity and its activity site will be also disucussed.

Acknowledgments:

These works were carried out under the collaboration with IHI Corporation. They was also supported by JSPS KAKENHI and Strategic Research Project in YCU.

References:

[1] M. Tachibana, “Structure characterization of carbon nanowalls and their potential applications in energy devices,” in Two-Dimensional Carbon: Fundamental Properties, Synthesis, Characterization, and Applications, edited by Y. Wu, Z. Shen, and T. Yu (Pan Stanford, Singapore, 2014), Chap. 6, pp. 121–152.

[2] O. Tanaike, N. Kitada, H. Yoshimura, H. Hatori, K. Kojima, and M. Tachibana, Solid State Ionics **180**, 381 (2009).

[3] A. Ashikawa, R. Yoshie, K. Kato, K. Miyazawa, H. Murata, K. Hotozuka, M. Tachibana, J. Appl. Phys. **118**, 214303 (2015)

[4] K. Hodozuka, R. Yoshie, H. Murata, A. Tateno, G. Ito, N. Kawaguchi, T. Matsuo, H. Ito, I. Kinoshita, M. Tachibana, Chem. Phys. Lett. **679**, 71 (2017)

Email: tachiban@yokohama-cu.ac.jp