Hard Carbon Negative Electrodes for Rechargeable Na-Ion Batteries: Dependency of Their Performance on Electrolyte Solution

T. Ishikawa¹, W. Murata¹, Y. Matsuura¹, N. Yabuuchi¹, A. Ito², Y. Ohsawa², and S. Komaba¹

¹Department of Applied Chemistry, Tokyo Univ. of Science, 1-3 Kagurazaka, Shinjuku, Tokyo 162-8601, Japan
²Nissan Motor Co., Ltd., 1 Natsushima, Yokosuka, Kanagawa 237-8523, Japan
komaba@rs.kagu.tus.ac.jp

Recently, the demand for the post-lithium batteries as energy storage system is rapidly growing. Among the several candidates, sodium-based system is of great interest, because the electrochemical potential of sodium is the most advantageous following lithium. However, we hardly find any reports on acceptable cycle performance of negative electrodes while Dahn’s and Tirado’s groups reported that disordered carbons show high reversible capacities during several cycles.[1,2] Recently, we have found that their charge-discharge properties, especially cycleability, are significantly improved by the careful selection of electrolyte solution.

Figure 1 shows the reversible capacity retention of hard carbon negative electrodes. All electrolyte solutions deliver high reversible capacities more than 200 mAh g⁻¹ in the initial cycle. In the case of EC:DMC (1:1) and EC:EMC (1:1) electrolyte solutions, capacity degradation is observed after a few cycles. In contrast, excellent cycle performance over 100 cycles is achieved using EC:DEC and PC electrolyte solutions. It is found by FT-IR spectroscopy that electrolyte decomposition is suppressed for EC:DEC and PC electrolyte solutions even after long cycling tests, while the decomposition evidently occurs for EC:DMC and EC:EMC.

Figure 1. The reversible capacity retention of the hard-carbon negative electrodes galvanostatically cycled at a rate of 25 mA g⁻¹ in EC:DMC (1:1), EC:EMC (1:1), EC:DEC (1:1), and PC solutions containing 1.0 mol dm⁻³ NaClO₄. The Na cells were cycled at room temperature.


Acknowledgement: This work is supported by the Funding Program for NEXT Program, JSPS.