High resolution hard X-ray photoelectron spectroscopic study for the positive electrode surface of lithium-ion battery

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High power battery is a key technology for HEVs. For commercial usage, the estimation method of the cycle and calendar life has been demanded to develop the specifications of the batteries. In this study, we will report the relationships between the degradation of the cells and the sate of the surface of their electrode. The cylindrical cells of *ca* 400 mAh/g were used in this study. $LiNi_{0.8}Co_{0.2}O_2$-based material and hard carbon were used for positive and negative electrode, respectively. Each cell was characterized using standard battery tests procedure which was modified conditions given in the battery test manual [1]. The electrodes obtained from the cells before/after the tests and state of charge controlled were washed with DMC and then characterized by ICP and x-ray photoelectron spectroscopy (PES). High resolution hard x-ray ($h\nu$ = 8.0 keV) PES was performed at SPring-8:BL47XU with the approval of JASRI as Nanotechnology Support Project of the MEXT (Proposal No. 2005B0713).

Figure 1 shows PES of O 1s core-level. Peaks at 529.1, 531.6 and 533.0 eV are assigned to $LiNi_{0.8}Co_{0.2}O_2$, lithium carbonate and lithium alkyl carbonate, respectively. Both spectra are normalized by height of the peak of $LiNi_{0.8}Co_{0.2}O_2$. After cycle-test, amount of the carbonates on the surface of the electrodes is significantly increased compared with that of the initial cell. This result suggests that electrolytes of the test cells reacted to the positive electrode during cycle-test at 80 °C, and the amounts of carbonates are increased. HX-PES is one of the powerful tools to estimate the degradation of the cells.

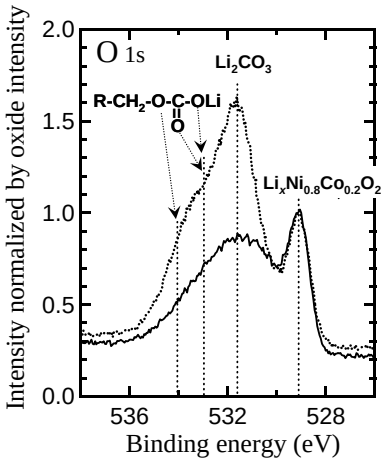

Fig. 1. PES of O 1s core-level for the positive electrode. Solid and broken line shows spectra before and after cycle-tests at 80 °C, respectively.

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References: [1] 'PNGV battery manual': DOE/ID-10597 Rev.3 (2001).