In-Operand Measurement of Temperature and Stress Distribution in Lithium-Ion Batteries

Tatsumi Hirano [a], Takehiro Maeda [a], Tetsuyuki Murata [a], Takahiro Yamaki [a], Eiichiro Matsubara [a], Takahisa Shobu [b], Ayumi Shiro [c], Ryo Yasuda [c] and Daiko Takamatsu [d]

[a] *Kyoto University, Uji-shi, Kyoto, Japan*

[b] *Japan Atomic Energy Agency, Koto, Sayo, Hyogo, Japan*

[c] *National Institutes for Quantum and Radiological Science and Technology, Koto, Sayo, Hyogo, Japan*

[d] *Hitachi Ltd., Hitachi-shi, Ibaraki, Japan*

E-mail: t-hirano@ rising.saci.kyoto-u.ac.jp

It was pointed out that temperature rise due to a high current/power operation and stress due to an expansion or contraction of electrodes in the lithium (de)-intercalation are degradation factors in lithium-ion batteries (LIBs) for electric vehicles during charge-discharge cycles. Therefore, a new method to measure the temperature and stress simultaneously in the inside of LIBs during the battery operation was investigated. The keys realizing the operand measurement were 1) constant gage volume by rotating spiral slits 2) photography of X-ray diffraction images by high-sensitive two-dimensional detector and 3) analysis method based on $\sin^2\psi$. The results show that the inner temperature rise was 30 °C, the axial tensile stress was 67 MPa and the radial compressive stress was 46 MPa in the 18650-type LIB during the high current cycle operation. That is, the operand measurement of the temperature and stress in the inside of LIBs during the battery operation has been realized.

This work was supported by the New Energy and Industrial Technology Development Organization (NEDO) under RISING2 project and the Shared Use Program of JAEA Facilities (2016B-E13, 2017A-E11, 2017B-E10).

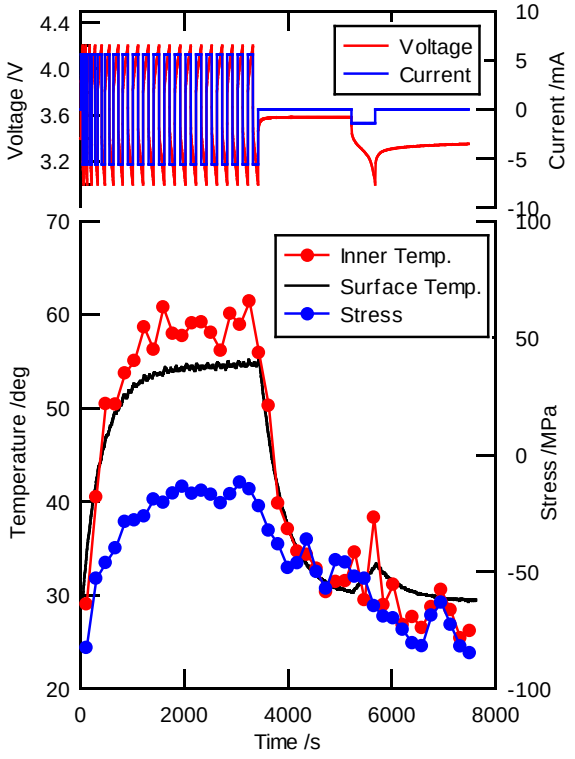

Fig. 1 Time dependence of inner and surface temperature, inner stress in 18650-LIB, voltage and current during charge-discharge cycles. X-ray irradiation points was 2.1 mm from the 18650-LIB surface.