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COMPUTATIONAL EVALUATION OF BENDING FATIGUE TEST ON ELECTRODE OF LITHIUM-ION BATTERY

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The application of the Lithium-ion battery (LIB) is expanded to electric automobiles. The reliability of the battery should be established to prevent serious incidents because of the high energy density. Especially, the cyclic load by the vibration and the thermal stress causes the fatigue damage of the electrode apart from the microscopic fatigue by the charge and discharge [1]. The electrode is the active material coated on the metallic foil. The strength and the stiffness of the active material are much lower than those of the metallic foil. Some studies take the approach that the mechanical properties of the active material are ignored in the computational homogenization, even though the active material has relatively low strength [2].

In order to investigate the mechanical property of the active material subjected to the cyclic load, this study has proposed a fatigue testing method for the active material by applying bending deformation repeatedly. The bending fatigue test was performed by using the anode sheet of the LIB that is graphite coated on copper foil. The finite element (FE) simulation was also performed to evaluate the proposed testing method.

In the actual test, the crack initiation was observed at the graphite or the copper foil. The location of the crack initiation depended on the thicknesses of the graphite and the copper foil. At the first bending, the plastic deformation occurred in the copper foil. After that, the repeated variable strain occurred in the copper foil during the testing process. Then the maximum strain was equal to the strain under the bending, and the minimum strain was equal to the permanent strain. The mechanical behaviour computed by the FE simulation agreed with that in the actual test. The strain of the graphite in the FE simulation was substituted for the actual value that is difficult to be measured directly. The strain amplitude of the graphite monotonically decreased against the number of cycles until the crack initiation.

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REFERENCES

[1] C. Yang et al., Stable interstitial layer to alleviate fatigue fracture of high nickel cathode for lithium-ion batteries, *Journal of Power Sources*, Vol. **376**, pp. 200-206, 2018.

[2] W. Lai, M. Y. Ali and J. Pan, Mechanical behavior of representative volume elements of lithium-ion battery modules under various loading conditions, *Journal of Power Sources*, Vol. **248**, pp. 789-808, 2014.