

Analysis of generated ingredients during LIB safety test

Ensuring safety is a more important issue than even before, as lithium ion battery (LIB) are becoming larger in vehicles and in stationary applications. Toray research center, Inc. can conduct one-stop tests from various tests to analysis of components (gas, mist, dust) generated during the tests.

Flow of safety test & Analysis of generated ingredients

Safety test

- Nail penetration test, Crushing test
- Heating test
- Overcharging test

Analysis of generated ingredients



(example)
Nail penetration test

Generated ingredients

Gas *1

Mist *2

Dust *3

Sampling

The gas and the deposit in the test tank was collected.

Analyzing

Gas ... GC, GC/MS, IC

Mist ... FT-IR, NMR, GC/MS, GPC

Dust ... FT-IR, EDX, Raman, elemental analysis

*1 Gas ingredients in the test tank. *2 Chloroform soluble ingredient of the deposit in the test tank.
*3 Chloroform insoluble ingredients of the incrustation in the test tank.

Example (Nail penetration test)

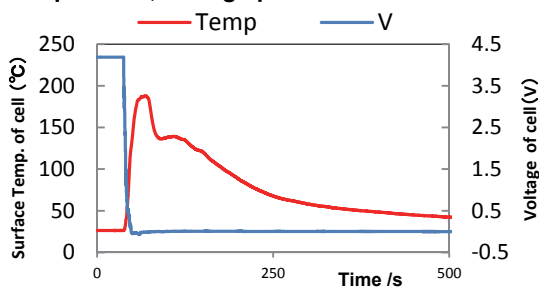
< Battery (laminate cell) component >

Cathode: LiCoO₂, Anode: Graphite, Separator: PE
Electrolyte: EC/DEC=1/1+LiPF₆(1 M), VC 2 mass%
Capacity: 2.6 Ah

< Summary of Nail penetration test >

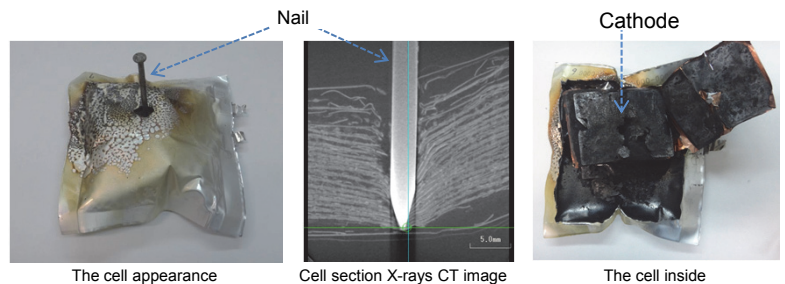
3 mm φ iron nail was inserted to the center of the battery of the charge state (CCCV charge, 4.2 V).

< Temperature, Voltage profile >



A temperature rose and the white smoke generated at the time of an internal short-circuit.

< State of the cell after the test >



The cell appearance

Cell section X-rays CT image

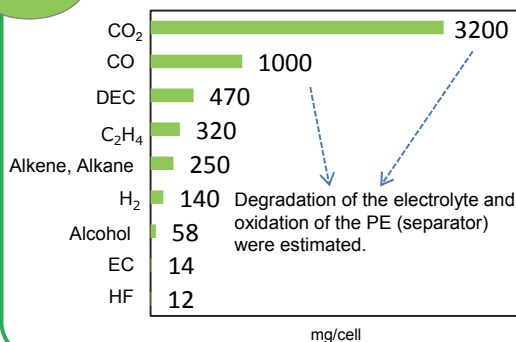
The cell inside

After the test, the separator completely disappeared. The cathode was greatly damaged.

< Analysis results of generated ingredients >

Gas

Total 5500 mg/cell



Degradation of the electrolyte and oxidation of the PE (separator) were estimated.

Mist

67 mass%

Alkene
(Weight average molecular weight (Mw) 1740)

Thermal decomposition of the PE (separator) was estimated

Dust

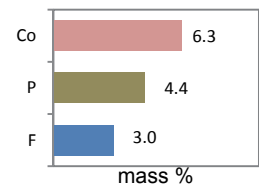
33 mass%

19%

•PE, Alkene, Graphite etc.

14%

•Co: Cobalt oxide (estimated)
•P: Lithium phosphate (estimated)
•F: Lithium fluoride (estimated)



The main ingredients generated by degradation of the electrolyte, oxidation, thermal decomposition of the PE (separator) was estimated.

Detailed analyses of the ingredients generated during the safety test allow consideration of the source materials.