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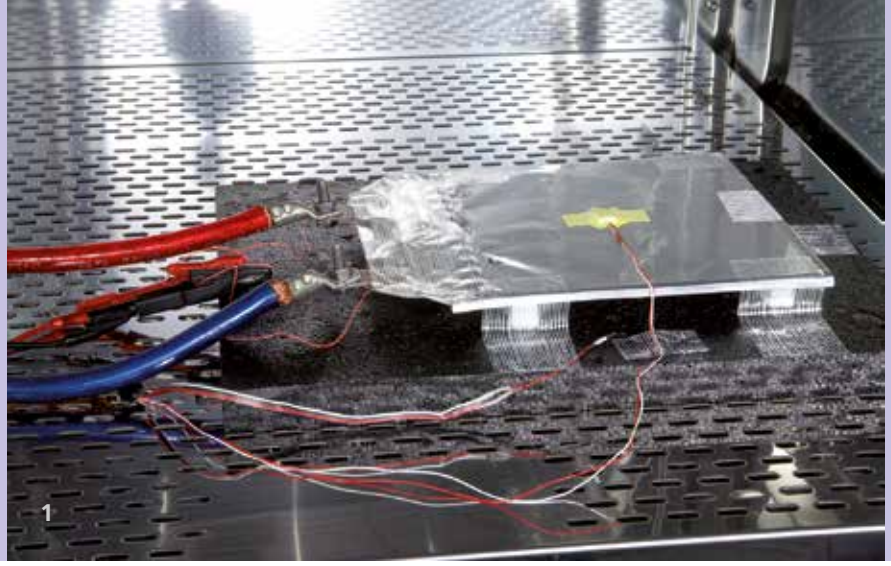
FRAUNHOFER INSTITUTE FOR CHEMICAL TECHNOLOGY ICT

ELECTROCHEMICAL ENERGY STORAGE – SAFETY TESTS



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Electrical energy is important, as it can easily be converted into other energy forms such as heat, electromagnetic radiation or mechanical energy. It therefore plays a dominant role in almost every area of industry. However, the storage of electrical energy is a particular challenge with regard to efficiency, energy density and cost. The Fraunhofer ICT has been working for over three decades with a wide variety of electrochemical energy storage systems in a broad capacity range. Our know-how extends from primary (non-rechargeable) and secondary (rechargeable) battery systems to the construction and evaluation or testing of complex systems consisting of several cells. We also have competence in monitoring and energy management within these systems, and in causal research in post mortem analysis.

Safety tests with gas analysis

Electrochemical energy storage devices, in particular lithium ion systems, can pose a significant risk when operated outside their specifications, due to the high energy density and the materials used.

The Fraunhofer ICT carries out all the conventional tests in which electrochemical storage devices are evaluated on an individual basis with regard to their behaviour under mechanical, thermal and electrical stress. Safety tests on modules and complete battery systems can also be performed, including customer-specific tests beyond conventional testing specifications. In order to evaluate the safety of the storage system, these tests analyse all the substances emitted in case of failure. Particularly comprehensive methods have been developed for the analysis and qualitative detection of the gaseous reaction products. In a closed pressure vessel, quantitative analysis of gaseous reaction products can also be carried out. A further service is the design of test environments, based on the results of safety tests. We also carry out mechanical safety tests beyond manufacturers' specifications.

Test procedures: safety tests are carried out for energy storage devices of up to 6 kWh according to the following specifications:

- FreedomCAR – Electrical energy storage systems abuse test manual for electric and hybrid vehicles
- VDA test specifications for lithium ion batteries for hybrid electric vehicles
- Tests according to the UN Regulations on Transport of Dangerous Goods
- Further tests according to selected specifications and guidelines (e.g. UL 1642)

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COVER PHOTO-GRAPH:

Nail penetration test equipment.

1 *Thermal stability test on a lithium ion cell.*

2 *Nail penetration test on a lithium ion cell.*

Conventional tests defined in the testing specifications include:

Mechanical abuse tests
- Controlled crash
- Penetration
- Fall tests
- Immersion
- Roll-over simulation
- Mechanical shock

Thermal abuse tests
- Thermal stability
- Simulated fuel fire
- Storage at high temperature
- Rapid charging/discharging
- Rapid temperature cycling

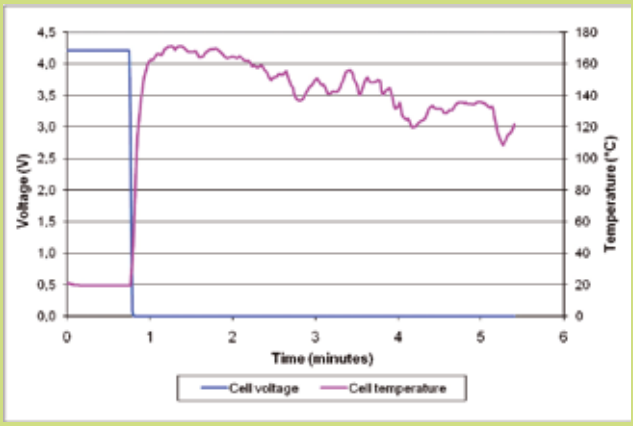
Electrical abuse tests
- Overcharging
- Short-circuiting/partial short-circuiting
- Forced discharge/voltage reversal

Based on our research and development work on electro-chemical sensors, the Fraunhofer ICT has substantial know-how relating to the manufacture of calibration gases for explosives. Following continuous expansion and optimisation of measurement set-ups, a unique, sophisticated system is available to analyse the gases emitted, including in battery tests.

Post-mortem analysis

Our long-standing experience in the set-up of different electrochemical storage systems and the reaction processes occurring in them gives us extensive knowledge concerning the ageing and failure mechanisms of these systems. On this basis we can offer post-mortem analysis of new, aged, dysfunctional or damaged cells and batteries. We can determine the cause of failure or indicate constructional changes. Smaller systems with a volume of approximately 50 ml can also be investigated non-destructively by computer tomography. The Fraunhofer ICT also offers a comprehensive selection of analytical methods for the investigation of cell and battery components.

U/T diagram, nail penetration test.



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