

# Battery Ultracapacitor Energy Storage TECHNOLOGIES



Southwest Research Institute®  
San Antonio, Texas

**E**nergy storage technologies – advanced batteries and ultracapacitors – are key components to the adoption of alternatives in today’s hybrid, plug-in and electric vehicles.

Southwest Research Institute® (SwRI®) has more than 25 years experience in hybrid electric vehicle design, integration, analysis, computer testing, control system development, modeling simulation and construction. Research in energy storage technologies encompasses conventional and unconventional technologies, including flywheels, hydraulic accumulators, ultracapacitors and a number of electrochemical battery chemistries including lead acid, nickel cadmium, lithium-ion, nickel metal hydride, and other experimental chemistries.

The Institute also has experience with batteries and ultracapacitors and can model, design and test the cycle life of these systems to assist clients in developing robust systems. SwRI can assist clients with integrating battery cells into packs, and packs into vehicular applications. The Institute can develop fully integrated battery management and hybrid powertrain controls.

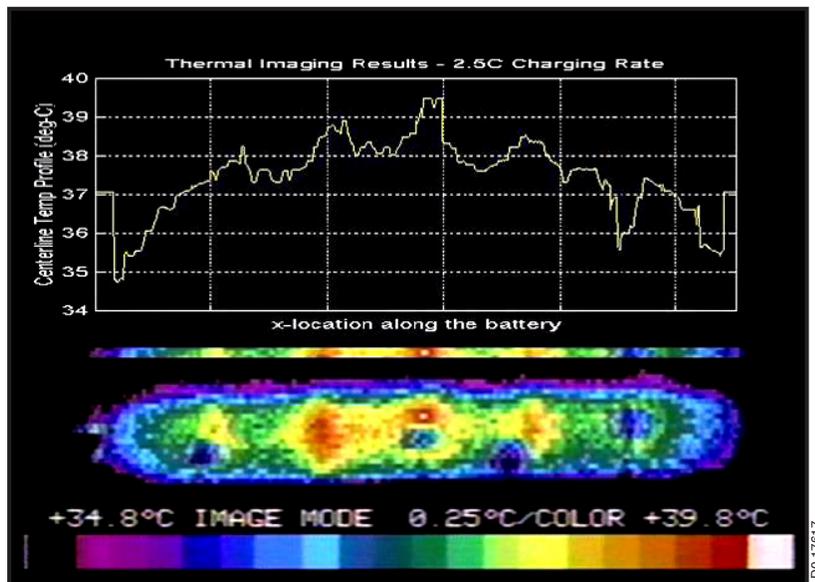
## Battery evaluations

- Battery performance characterization
- Life cycle testing
- Electrochemical impedance spectroscopy
- Environmental impact on battery performance
- Battery abuse testing (environmental, mechanical, electrical, and hazardous substance monitoring)
- Testing for battery management system development
- Testing for modeling and simulation

Battery characterization using infrared thermal imaging is also performed to identify harmful temperature gradients resulting from fast charging and discharging, providing essential data for proper thermal management design.



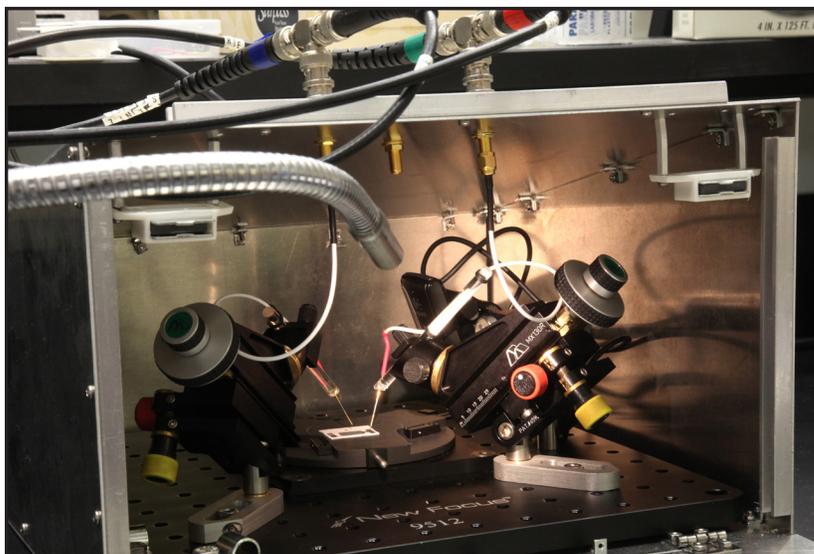
SwRI conducts battery abuse testing, including crush tests with outgas constituency characterization, to help clients design batteries to meet SAE and UN standards.



Infrared thermal imaging of hybrid vehicle components identifies harmful temperature gradients resulting from fast charging and discharging, and provides essential data for proper thermal management design.



The Institute conducts battery cell and module level tests to assist with in-depth performance characterization.



SwRI scientists use in-house instrumentation to evaluate thin-film batteries at one of the Institute's many test facilities.

## ESSES Consortium

Southwest Research Institute is forming an Energy Storage System Evaluation and Safety (ESSES) Consortium to begin in January 2011. The Consortium will provide transparency in the automotive battery market as a means to advance the development of energy storage systems by developing precompetitive detailed cell-level test data on currently available electrochemical storage systems across a diverse number of manufacturers and products, and performing research to advance the testing methodologies used to benchmark batteries, making tests faster, cheaper and more significant. For additional information, visit [www.batteryconsortium.swri.org](http://www.batteryconsortium.swri.org).

## State-of-the-art equipment

- AV 900V battery testing system, with power rating up to 250 kW, voltage rating up to 900 Vdc, and a current rating up to 1000 Adc
- ABC 150 battery testing system, with power rating up to 125 kW, voltage rating up to 420 VDC, and a current rating up to 530 Adc
- Hydraulic crush stand capable of 230,000 pounds force
- Specialty salt fog chamber
- Short circuit test rig for high-energy batteries
- Electrochemical work stations
- Constant-current and constant-voltage load control systems
- Bitrode MCV8-100-12 multi-channel cell level battery test system, with voltage rating up to 16VDC, and a current rating up to 100A per channel, with the ability to parallel up to 8 channels for a maximum single channel test current of 800A
- Electrochemical impedance spectroscopy
- High temp furnaces; pool and bonfire capabilities
- Oxygen consumption calorimeters for heat release measurements
- Nicolet™ Magna-IR 560 and Nicolet 6700 FT-IR for gas analysis

SwRI uses thermal chambers to test batteries independent of the vehicle or in conjunction with the engine, transmission or entire hybrid powertrain. Thermal chamber testing is also available to test complete powertrains or vehicles. Customized battery testing can be designed to meet specific client needs.

## ESS performance characterization

- |                              |                                    |
|------------------------------|------------------------------------|
| ■ Thermal stability          | ■ Overcharge                       |
| ■ Over-discharge             | ■ Soft short circuit               |
| ■ Hard short circuit         | ■ Separator shutdown integrity     |
| ■ Crush                      | ■ Penetration                      |
| ■ Electrolyte vapor analysis | ■ Forced vent with thermal runaway |
| ■ Radiant heat               | ■ Cold cranking                    |
| ■ Static capacity            | ■ Energy efficiency                |
| ■ Hybrid pulse power         |                                    |
| ■ Life cycling               |                                    |

## Testing levels

- Cell-level lab
- Battery-pack lab
- Battery with electric motor lab
- In-vehicle battery
- In-vehicle pack
- In-vehicle battery and powertrain

# Southwest Research Institute®



*The Institute occupies more than 1,200 acres in San Antonio, Texas, and provides more than 2 million square feet of laboratories, test facilities, workshops and offices for more than 3,200 employees who perform contract work for industry and government clients.*

**F**ounded in 1947 as an independent, nonprofit research and development organization, Southwest Research Institute provides a significant research, engineering and testing resource for industry, business and government. SwRI's 12 technical divisions, ranging from automobile research and space science to bioengineering and intelligent systems ([swri.org](http://swri.org)) use a multidisciplinary, integrated approach to solve complex problems in science and applied technology. As part of a long-held tradition, patent rights arising from sponsored research at the Institute are often assigned to the client. SwRI generally retains the rights to Institute-funded advancements.

***Benefiting government, industry & the public  
through innovative science & technology***



**We welcome your inquiries. For more information, please contact:**

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## ***ISO Certification – Engine, Emissions and Vehicle Research Division***

The Office of Automotive Engineering (OAE) is certified to ISO 9001:2008 "Quality Management Systems – Requirements," accredited to ISO/IEC 17025:2005 "General Requirements for the Competence of Testing and Calibration Laboratories" and certified to ISO 14001:2004 "Environmental Management Systems." The OAE has also achieved Ford Tier 1 status for providing engineering services and the Engine, Emissions and Vehicle Research Division has received the Ford Q1 Quality Award. In conjunction with these divisional quality system accomplishments, the Petroleum Products Research Department is a Nuclear Procurement Issues Committee (NUPIC)-approved laboratory and the Fuels and Lubricants Research Division has maintained its status as an American Chemistry Council (ACC)-approved laboratory.