A 12V Start-Stop Li Polymer Battery Pack

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LG Chem Power / LG Chem

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Project ID: ES249

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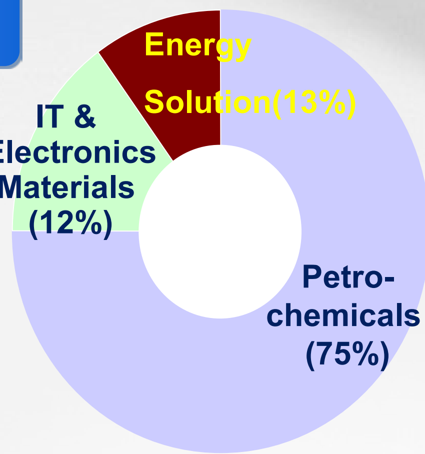
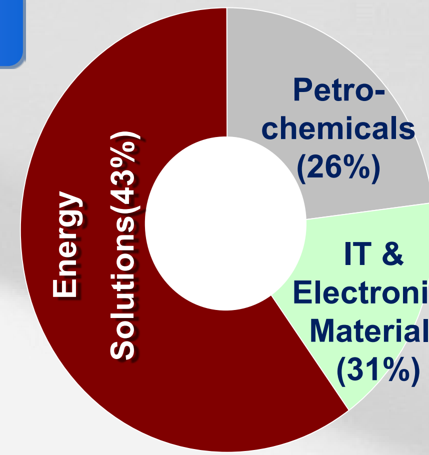
LG Chem at a glance

Revenue



R&D Expense



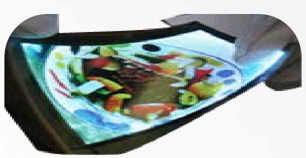
Energy Solution

- Lithium-Ion Batteries for
  - Mobile Phone, Laptop, Power Tool
  - Hybrid & Electric Vehicles
  - ESS

Petrochemicals

- ABS/EP
- NCC/Polyolefin
- PVC/Rubber
- Acrylate

IT & Electronics Materials



- LCD Polarizer
- LCD Glass
- OLED Materials
- Color Filter

LGCPI

- Battery Pack Concepts, Design and Prototype Builds
- Battery Management Systems
- Sales and Customer Support

Troy, MI

Sales & Pack R&D

LGCMI

- $300M+ investment with ARRA funding
- Groundbreaking: Summer 2010
- In Production now

Holland, MI

Cell Manufacturing

Overview

Timeline

- Project Start: Dec 1, 2014
- Project End: Nov 30, 2016
- Percent complete: 25 %

Budget

- Total project funding: $1.82M
- DOE share: $0.91M
- Contractor share: $0.91M
- Funding for FY14: $75k

Barriers

- Cold-Cranking Power
- Cost

Partners

- LG Chem, INL, SNL, NREL
- Project lead: LGCPI

Objectives

- Develop a cell suitable for use in the 12V Start-Stop Battery.
- A key goal of the program is to lower the pack cost to close to the $ 220 target.
- Optimize the cell chemistry to meet the cold-cranking power requirement.
- Design a low-cost, simplified BMS.
- Deliver cells and battery packs to USABC for testing.

12V Start-Stop Battery Pack Goals

	Units	USABC Not under hood target
Discharge Pulse, 1s	kW	6
Max current, 0.5s	A	900
Cold cranking power at -30 °C (three 4.5-s pulses, 10s rests between pulses at lower SOC)	kW	6 kW for 0.5s followed by 4 kW for 4s
Min voltage under cold crank	Vdc	8
Available energy (750W)	Wh	360
Peak Recharge Rate, 10s	kW	2.2
Sustained Recharge Rate	W	750
Cycle life, every 10% life RPT with cold crank at min SOC	Engine starts/miles	450k/150k
Calendar Life at 30°C, 45°C if under hood		15 at 30°C
Minimum round trip energy efficiency	%	95
Maximum allowable self-discharge rate	Wh/day	2
Peak Operating Voltage, 10s	Vdc	15
Sustained Max. Operating Voltage	Vdc	14.6
Minimum Operating Voltage under load	Vdc	10.5
Operating Temperature Range (available energy to allow 6 kW (1s) pulse)		-30 to +52°C
30 °C to 52 °C	Wh	360
0 °C	Wh	180
-10 °C	Wh	108
-20 °C	Wh	54
-30 °C	Wh	36
Survival Temperature Range (24 hours)		-46 to +66
Maximum System Weight	kg	10
Maximum System Volume	L	7
Maximum System Selling Price (@100k units/year)	$	$180

Approach/Strategy

- Study cathode/anode materials properties to improve power.
- Characterize and improve their performance especially cold-cranking power by optimizing electrode structures, electrolyte compositions, and separator features.
- Develop low-cost battery pack designs (mechanical, thermal and electrical) to meet the USABC targets.

Technical Accomplishments/Results

- Initial work is focused on studying the impact of material attributes such as morphologies on power, high and low temperature behavior.
- Composition and processing of electrodes are being optimized that will lead to high low temperature power.
- Studying low-cost, efficient packaging and thermal solutions.
- Focusing on the development of low-cost BMS.

Technical Accomplishments/Results

- **Higher surface area cathode material results in lower cell resistance. However, they might lead to higher side-reactions especially at elevated temperatures, and hence we are optimizing these parameters.**

- **Electrodes of lower porosities lead to lower cell resistance.**

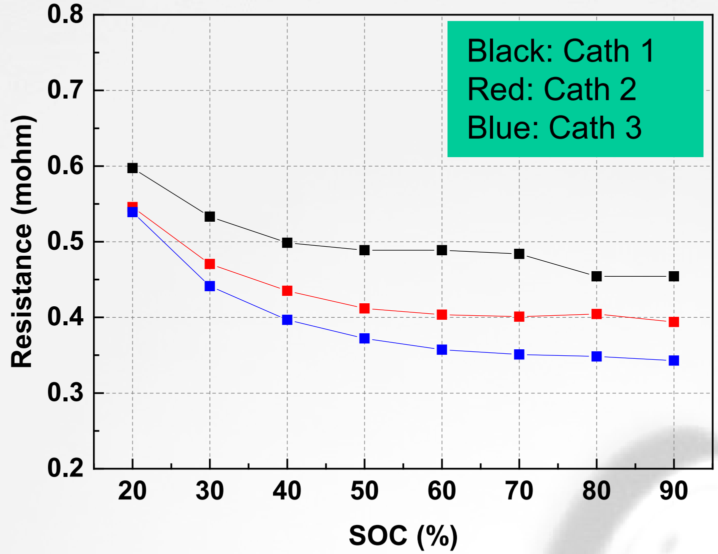
- **Initial studies on thermal management are being carried out now.**

- **Low-cost BMS is being designed.**

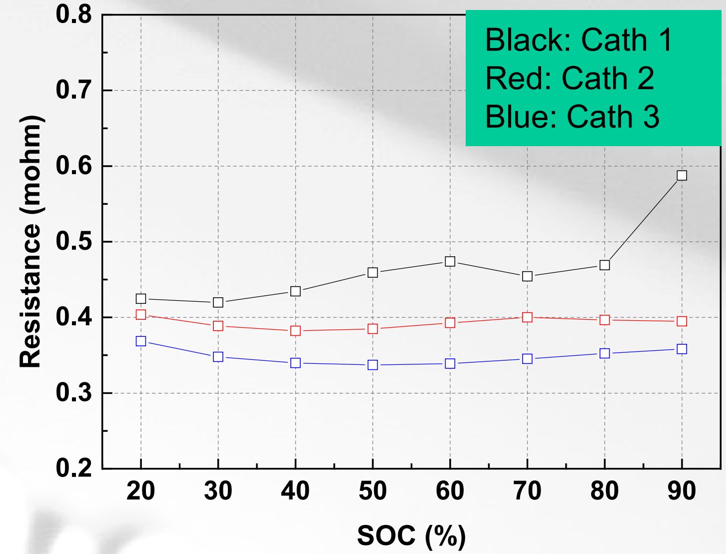
Results- *continued……*

Effect of cathode material surface area

10s Discharge



10s Charge

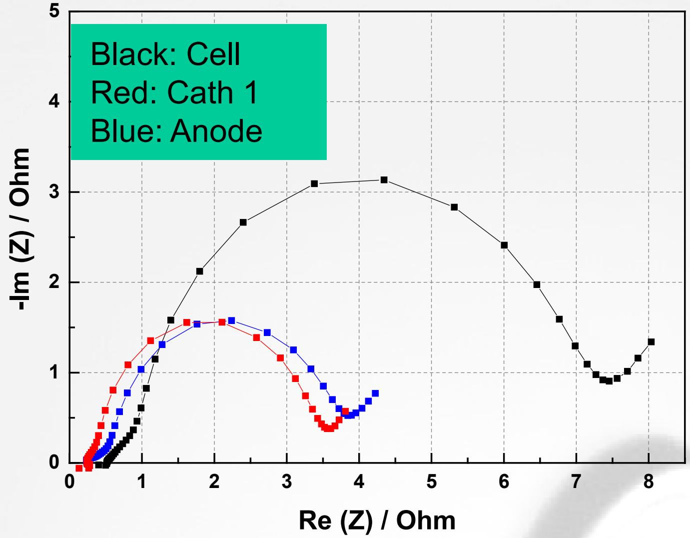


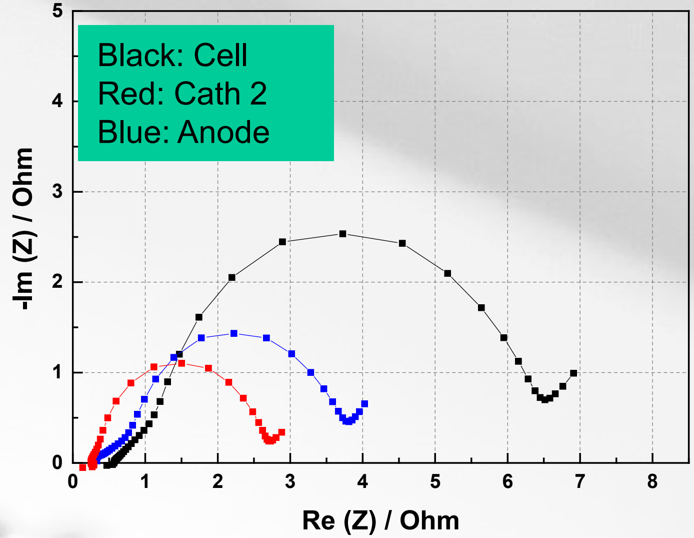
- **Higher surface area cathode material leads to lower cell resistance.**

Results- *continued……*

Effect of cathode material surface area

-10°C



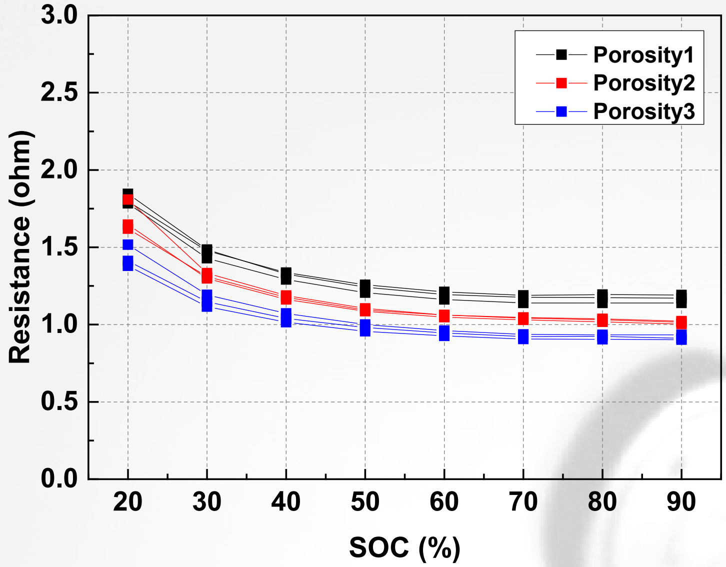


- There is a reduction in cathode resistance as evidenced by EIS at low temperatures

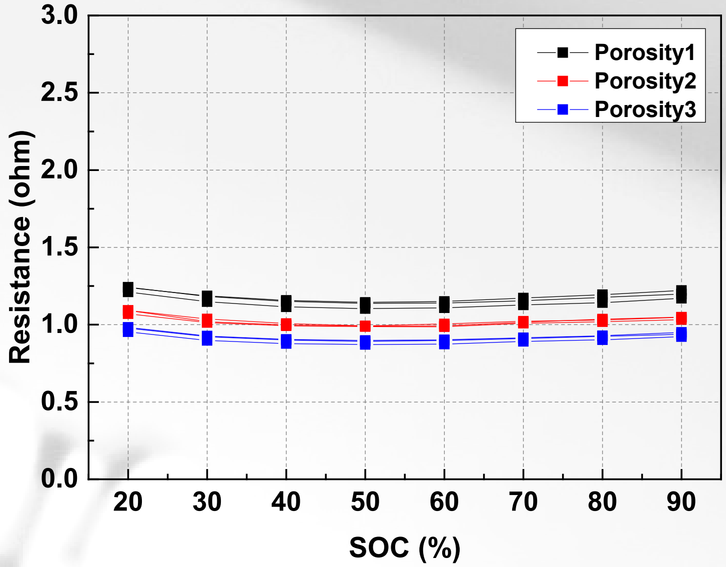
Results- *continued……*

Effect of cathode porosity on cell resistance

10s Discharge



10s Charge



- **The lower the porosity, the lower is the cell resistance**

Results- *continued……*

Pack Studies:

- **Designing efficient and low-cost packaging and thermal system.**
  - **Cell frame and Inter-Connect Board design**
  - **Vehicle-mounting**
  - **Thermal strategy**
  - **High and low-current connections**
- **Designing simplified, low-cost BMS.**

Future Work

- Further optimization of cell characteristics to improve cold-cranking power, including:
  - Cathode and anode material properties.
  - Optimization of electrode structures in order to reduce cell resistance.
  - Extensive studies of electrolyte compositions to improve cold-cranking power.
  - Evaluation/optimization of separator properties.
- Optimize pack and BMS designs to lower pack cost.
- 1st Delivery of cells/packs to National Labs.

Development of a High Energy Density Cell and Module for EV Applications

PI: Mohamed Alamgir and Hoejin Hah

LG Chem Power / LG Chem

June 10, 2015

Project ID: ES249

Overview

Timeline

- Project Start: Feb 11, 2015
- Project End: Feb 28, 2018
- Percent complete: %

Budget

- Total project funding: $3.28 M
- DOE share: $1.64 M
- Contractor share: $1.64 M
- Funding for FY14: 0k

Barriers

- Energy density
- Life
- Cost

Partners

- LG Chem, INL, SNL, NREL
- Project lead: LGCPI

Objectives

- Develop a cell and module suitable for use in the 200-Mile USABC BEV program.
- Two key goals of the program are to meet the USABC cell level targets of 750 Wh/l and $100/kWh.
- The objective will be to employ next-generation high energy density cathodes such as layered-layered compounds and Si anodes.
- Deliver cells and modules to USABC for testing.