

# ANL: Prototype Cell Fabrication Facility

Andrew N. Jansen and Dennis W. Dees  
Chemical Sciences and Engineering Division

May 9-13, 2011

Vehicle Technologies Program Annual Merit Review and  
Peer Evaluation Meeting  
Washington, D.C.

Project ID:  
ARRAVT075

This presentation does not contain any proprietary, confidential, or otherwise restricted information.

# Overview

## *Timeline*

- Start: April 2010
- Finish: May 2011
- 100% Complete

## *Budget*

- Total project funding
  - 100% DOE
- FY2010: \$1,000K
- FY2011: \$0

## *Barriers*

- Development of a safe cost-effective PHEV battery with a 40 mile all electric range that meets or exceeds all performance goals
  - Reducing the time needed to move advanced materials from the laboratory into industrial PHEV batteries

## *Partners (Collaborators)*

- Ilias Belharouak, Argonne
- Wenquan Lu, Argonne
- Bryant Polzin, Argonne
- John Vaughey, Argonne



# Objectives, Milestones, and Approach

- The objective of this work is to identify and purchase several key pieces of equipment that will greatly enhance Argonne's ability to conduct vital preparation and diagnostic studies on advanced prototype lithium-ion cells, thereby supporting the DOE-EERE funded cell fabrication facility at Argonne
- Milestones for this year:
  - Equipment identified and orders placed (completed)
  - Equipment delivered and installed (completed)
- The approach for this project is to utilize the extensive in-house expertise at Argonne available to identify, purchase, and install the equipment critical to the support and operation of the Argonne prototype lithium-ion cell fabrication facility



# Major Accomplishments and Technical Progress

- All equipment have been identified and the orders placed
- All equipment have been received and installed
- List of equipment purchased and installed
  - Prototype cell testing and formation equipment
  - Environmental chambers and ovens
  - X-ray powder diffractometer
  - Accelerating rate calorimeter (ARC) system
  - Inert atmosphere glove box
  - Multi-channel electrochemical test station and impedance analyzer
  - Instron Materials Testing Instrument



# Description of Argonne Prototype Lithium-Ion Cell Fabrication Facility

- Semi-automated equipment housed in a state-of-the-art dry room
- Capability to coat and hot-roll press laminate electrodes
- Capacity to fabricate xx3450 pouch cells (i.e. prismatic stacked technology) and 18650 cells (i.e. cylindrical wound technology)
- Facility is fully operational
  - All equipment installed and personnel trained by vendor's engineers
  - Modifications were made to several pieces of equipment to enhance safety, with final approval to operate all equipment granted in February
- Prototype cell builds underway
  - Initial shakedown of cell fabrication equipment
  - Gain electrode and cell fabrication experience
- See Poster ES030 for detailed description



# Prototype Cell Testing and Formation Equipment



- MACCOR Series 4000 Automated Test System – 2 Units
  - 96 channels each
  - 0 to 10 V Multirange current channels (5 A, 150 mA, 5 mA, 0.15 mA)
  - Combine in parallel up to 40 A
  - Minimum step time of 10 mS
  - 32 Reference voltage inputs ( $\pm 10$  V)
  - 16 Thermistor inputs
  - Computer
- Auto-Calibrator
- These units are important for the formation process and testing of the prototype cells that are being produced by the Argonne cell fabrication facility (i.e. 18650 and xx3450 pouch cells)

# Environmental Chambers and Ovens



- Environmental Chamber – 4 Units
  - These units will allow Argonne to test prototype cells under a range of conditions
  - Temperature range: -20°C to 200°C
  - 2 Units with humidity control



- Ovens – 2 Units
  - These units will allow Argonne to test prototype batteries at elevated temperatures
  - Temperature range: 30°C to 250°C



# X-Ray Powder Diffractometer

- *Bruker D8 advanced* powder diffraction system
  - Rapid screening and identification of powder samples and is equipped with a 90-sample changer
  - Grazing angle attachment to determine the phase composition as function of depth from the surface.
  - Software to determine the ratio of amorphous to crystalline components
  - Higher detector sensitivity to help identify minor phases present in samples
  - Texture analysis capabilities to quantify preferred orientation in powder samples.
- X-ray powder diffraction is typically used to examine an active material's structure and purity, and as such it has become our first best gauge of the material's quality before the powder goes into the cell





# Accelerating Rate Calorimeter (ARC) System



- ARC-254 from NETZSCH
  - Cabinet equipped with an array of heaters and thermocouples, a pressure transducer, and a battery cycler interface
  - System is also equipped with VariPhi technology that allows the detection of exothermic and endothermic reactions
  - Fully automated computer control
- Calorimetry is the primary indicator of the potential of a cell technology to go into thermal runaway, which is a fundamental measure for assessing a lithium-ion technology's abuse tolerance
- An ARC is typically used for performing these studies on full cells

# Inert Atmosphere Glove Box

- Vacuum/Atmospheres Glove Box
  - Double sided (total of 4 workstations)
  - Dual purification bed
  - Dual vacuum pumps
  - Two antechambers (6" and 15" dia.)
  - Temperature chamber
  - Oxygen analyzer
  - Dual pressure relief bubblers
- Glove box will enable electrolyte formulation to be conducted in an inert atmosphere environment
- If necessary, electrolyte addition and sealing of lithium-ion prototype cells can also be accomplished under an inert atmosphere



# Multi-Channel Electrochemical Test Station and Impedance Analyzer

- Solartron cell test system (Ametek)
  - 8 channel potentiostat
  - 8 channel frequency response analyzer
  - MultiStat software
  - Computer
- Designed to conduct high speed pulse and impedance electrochemical characterization tests on prototype lithium-ion cells



# Instron Materials Testing Instrument

- Model 3343 Single Column Materials Testing System (1kN) for tension and compression test
  - Tension/Compression S-Beam Load Cell (50 N)
  - 250-N pneumatic grips
  - BLUEHILL software
  - computer
- Obtaining mechanically-strong high-quality laminates is critical to the performance of the prototype lithium-ion cells. This instrument is designed to measure the adherence of the electrode coatings to the foils.



# Summary

- The objective of this work is to identify and purchase several key pieces of equipment that will greatly enhance Argonne's ability to conduct vital preparation and diagnostic studies on advanced prototype lithium-ion cells, thereby supporting a DOE-EERE funded cell fabrication facility at Argonne
- The approach for this project is to utilize the extensive in-house expertise at Argonne available to identify, purchase, and install the equipment critical to the support and operation of the Argonne prototype lithium-ion cell fabrication facility
- List of equipment purchased and installed
  - Prototype cell testing and formation equipment
  - Environmental chambers and ovens
  - X-ray powder diffractometer
  - Accelerating rate calorimeter (ARC) system
  - Inert atmosphere glove box
  - Multi-channel electrochemical test station and impedance analyzer
  - Instron Materials Testing Instrument

# Acknowledgment

**Support for this work from DOE-EERE, Office of Vehicle Technologies is gratefully acknowledged**

- David Howell**
- Brian Cunningham**
- Peter Faguy**