Innovative Manufacturing and Materials for Low-Cost Lithium-Ion Batteries

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Project ID# ES136
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Overview

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Timeline

- Start – October 2011
- End – September 2014
- 5% complete

Barriers

- Cost reduced to $300/kWh by 2014
- Energy density to 300 Wh/kg by 2015

Budget

- Total Project Funding
  - DOE $2,249K
  - Contractor $ 750K
- Funding for FY12 $ 698K

Partners

- Madico, Inc. – Electrode Stack Mfg.
- Dow Kokam, LLC – Battery Mfg. and Testing
- University of Rhode Island - Electrolyte
- Ashland – Coating Solvent & Polymers

Objectives

Three year Project

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Project Long-term Objective

- Reduce the cost, weight, and/or volume of the cell's inactive components by at least 20%, and preferably by at least 40%, while maintaining cell performance

Project Immediate Objectives (Oct-11 to Mar-12)

- Complete initial ceramic separator design, essential as the physical support layer of the future coated stack design & for electrolyte development
- Complete initial anode-current collector-anode-separator-coated stack design

Milestones

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Project Milestones for FY12 – Part 1 of 2

Month/Year	Milestone	Status – % Completion
Jan-12	Initial Ceramic Separator Design for Thickness and Porosity for use in rest of project work complete	100%
Jan-12	Initial Anode-Anode Current Collector-Anode-Separator Coated Stack Design complete	100%
April-12	Initial Cathode-Cathode Current Collector-Cathode-Separator Coated Stack Design complete	20%

Milestones

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Project Milestones for FY12 – Part 2 of 2

Month/Year	Milestone	Status – % Completion
April-12	Initial Low Cost Electrolyte Design for Lithium Salt complete	10%
June-12	Initial Current Collection & Termination Design complete	10%
June-12	Initial Low Cost Electrolyte Design for Solvents complete	10%

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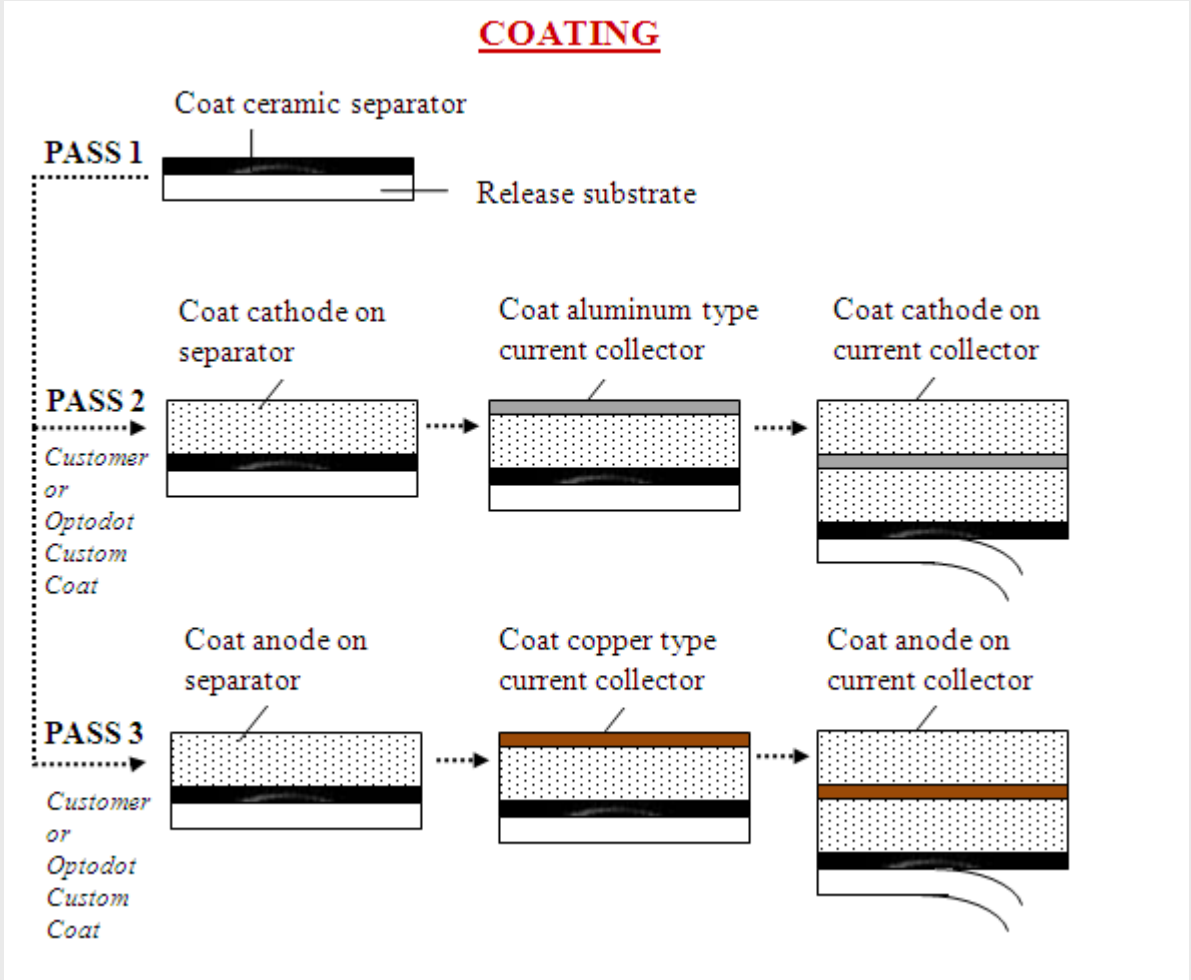
Battery Stack Manufacturing Process



- Utilizes a roll-to-roll process
  - Lower cost
  - Higher efficiencies
  - Wider Widths
- Release substrate is removable, enabling interleaving of anode and cathode coated stacks

Approach

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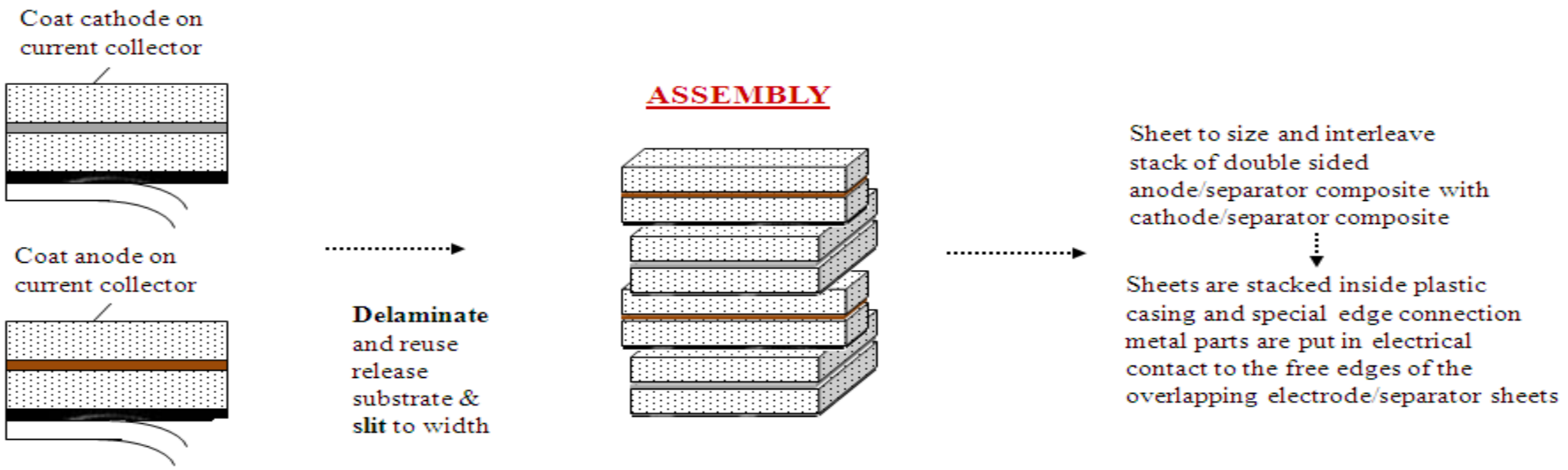
Battery Stack Manufacturing Process



- Lower cost and lighter inactive components
  - Nanopore nature of ceramic separator enables overcoating with electrodes
  - Thinner separator enables new low cost electrolytes
  - Thinner & lighter current collector layers
  - Lower cost cell termination and casing

Accomplishments

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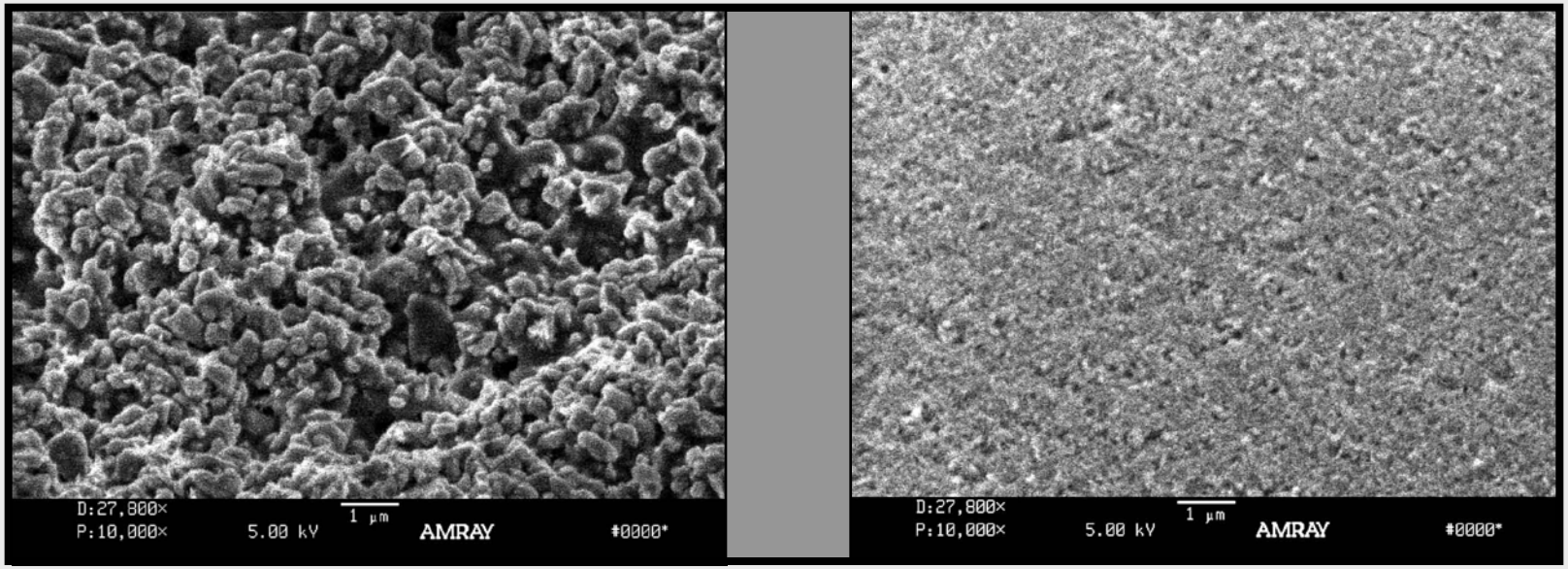
FY12 Accomplishments (Oct-11 – Mar-12)

- Cells with electrode/current collector/electrode/ separator stacks
  - Completed initial anode stack design
  - Further efforts in FY12 will include initial cathode stack, current collector layer & termination designs

- New lower cost electrolytes
  - Selected & manufactured 8 and 12 micron thick ceramic separator for use in coated stack & electrolyte development and with pore size diameters well below 100 nm
  - Further FY12 work will include electrolyte design

Accomplishments

FY12 Accomplishments (Oct-11 – Mar-12)



- Conventional Ceramic Separator Layer with 0.5 micron pore diameter

- Optodot Ceramic Separator Layer with about 10 times smaller pores suitable for use in making electrode/ separator coated stacks

Accomplishments

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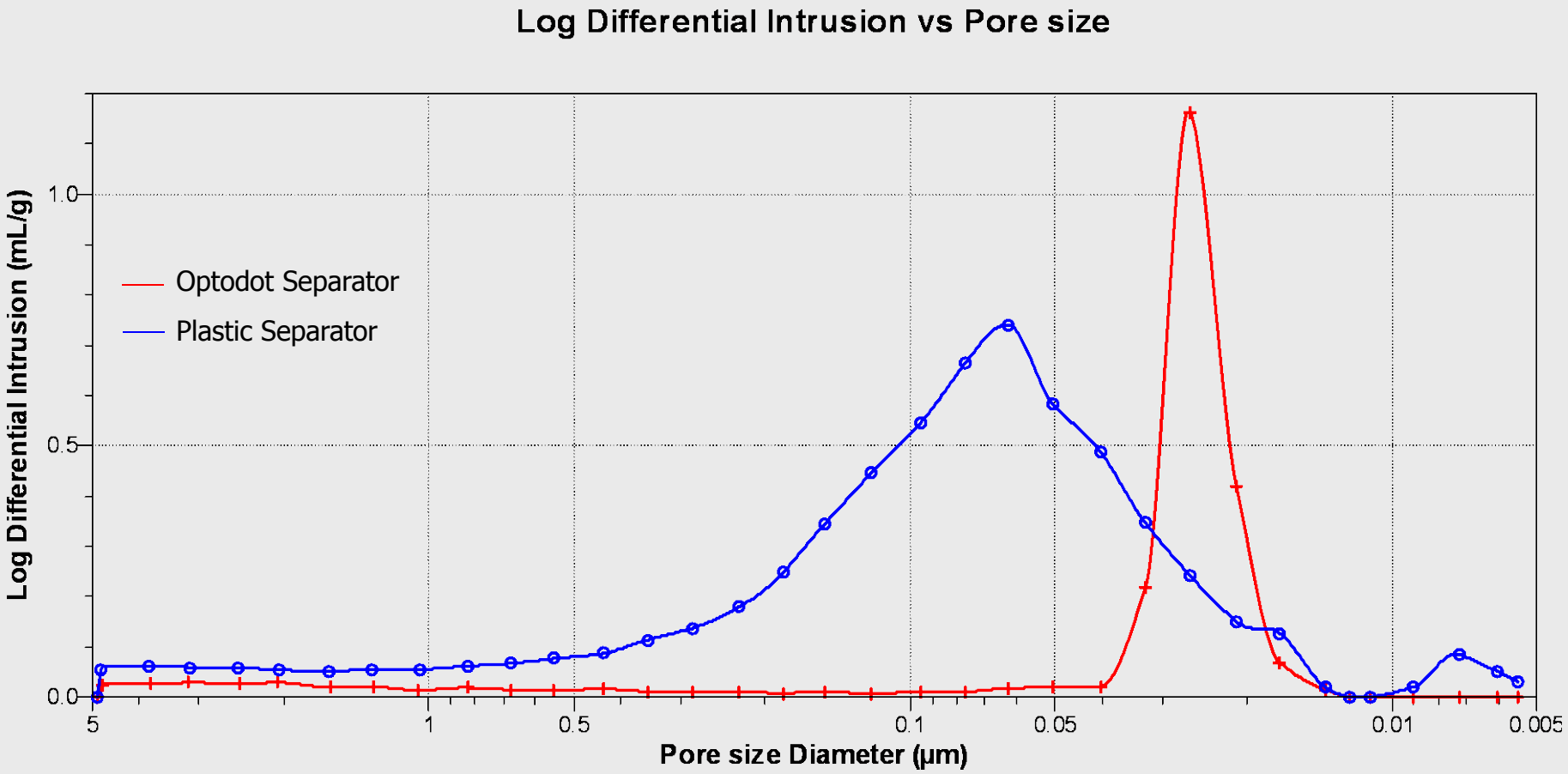
FY12 Accomplishments (Oct-11 – Mar-12)



- Pore Size Distribution

Collaborations

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Subcontractors

- **Madico** (industry) on mfg processes of mixing & coating of the ceramic separator
- **Dow Kokam** (industry) on electrode coatings
- **URI** (academic) on cell cycling testing on various ceramic separator designs & on electrolytes
- **Ashland** (industry) on NMP recycling & polymer selection for battery coatings

Future Work *Activities for FY2013*

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- Continue development and evaluations of new inactive components made with coated stack mfg process
  - GO/NO GO decision by Dec-12. Criteria is cost/performance of initial coated stack design.
- Deliver eight 2 Ah coated stack & control cells by Oct-12 for DOE testing
  - Provide cost analysis of these cells by Dec-12
- Evaluate design options for new current collector layers and cell termination
- Manufacturing scaleup & optimization on the coated stack design & process completed by Sep-13

Summary

- Meeting the at least 20% improved cost, volume and/or weight, as well as the performance requirements, for the key inactive components of Li-ion cells and developing a low cost next generation manufacturing process will help meet the DOE goals of cost reduction to $270/kWh by 2017 for PHEVs and to $150/kWh by 2020 for EVs.
- This will help to reduce U.S. dependence on foreign oil, reduce greenhouse gas emissions, and enable U.S. manufacturers to be competitive in the global market.
- Our 4 partners and subcontractors, Madico, Dow Kokam, URI, and Ashland, are providing coating and converting expertise and equipment, battery assembly and testing capability, electrolyte expertise, and polymer and NMP solvent expertise.
- Optodot and its manufacturing and business partner, Madico, are working closely together on the commercialization of this technology.