Scale Up of Dry Process for Lithium Ion Electrode Manufacturing

Co-Authors
Michael D. Eskra, Paula K. Ralston
Scale Up of Dry Process for Lithium Ion Electrode Manufacturing

• Phase I

  – DLA Battery Network Short Term Project
  – Demonstrate a Laboratory Style Proof of Concept Process for the Manufacture of Electrodes
Scale Up of Dry Process for Lithium Ion Electrode Manufacturing

• Phase II (Midway Through 24 Month Project)
  – Expand Upon The Proof-of-Concept Line To A Fully Capable Electrode Fabrication Line And Expand The Cell Testing Effort.
  – Verify The Optimum Operating Parameters And Production Capability For Continuous Fabrication Of Electrode Materials.
  – Delivery Of A Design Package For The Commercial-Scale Manufacturing Line
Scale Up of Dry Process for Lithium Ion Electrode Manufacturing

• The Problems
  – Existing Lithium Ion Manufacturing is Normally Dedicated to One Cell Type with One Capacity
  – Changes are Expensive Due to Capitalization Requirements and Time to Implement
  – Majority of Commodity Cells Being Purchased for Government and Military Applications are Manufactured in Japan and China
  – Majority of Existing Manufacturing is Product Specific; One Machine = One Product
  – US has Little Control of Product Consistency from Foreign Manufacturers
  – Counterfeit Batteries
Scale Up of Dry Process for Lithium Ion Electrode Manufacturing

• Goals of the Program
  – Ability to Produce Multiple Electrode Chemistries and Designs from the same Equipment
  – Allow Small Lots of Different Types of Batteries from the Same Line
  – Reduce Level of Work in Process and Scrap
  – Rapid and Inexpensive Change-Over
  – Minimization of Capital Requirements, Enabling Sustainable Business Decisions for the Manufacturer
  – Eliminate the Use of Solvents (NMP and MEK, Known Carcinogens)
  – 100% Dry Process
  – Process Should be Independent of Active Materials
  – Uniform Porosity, Density and Thickness Control
Scale Up of Dry Process for Lithium Ion Electrode Manufacturing

• What We’ve Achieved
  – Developed Prototype Manufacturing Line
  – 100% Dry Process
  – Eliminated All Solvents
  – Drastically Reduced Footprint Needed for Manufacturing, Reducing Capitalization Costs
  – Demonstrated Quick Change-Over Between Chemistries Allowing Short-Run or Specialized Production
Scale Up of Dry Process for Lithium Ion Electrode Manufacturing

• What We’ve Achieved
  – Estimated 40% Manufacturing Cost/Ah Savings
  – Cells Built and Tested, With Comparable Characteristics to Solvent Cast Electrode
  – Patent Filed
Scale Up of Dry Process for Lithium Ion Electrode Manufacturing

Electrodes Exhibit Comparable Characteristics to Solvent Cast Electrodes

Discharge, Anode ltd, LTO Cell #34 0.485mAh/cm²
Scale Up of Dry Process for Lithium Ion Electrode Manufacturing
Scale Up of Dry Process for Lithium Ion Electrode Manufacturing

- 40% Cost Savings/Ah (Estimated)
  - 50-75% Reduction in Capital Equipment
    - 75% Reduction in Mixing Capital
    - 50% Reduction in Drying Capital
    - 50% Reduction in Coating Capital
    - 100% Reduction in Solvent Recovery Capital
  - 30% Reduction in Labor Costs
    - Simplification of Processes
  - 40% Reduction in Utility Costs
    - Space Needed, Energy Cost
    - Work In Process Reduction

2015 Joint Services Power Expo
Cincinnati Ohio   25-27 August
Approved for Public Release
Scale Up of Dry Process for Lithium Ion Electrode Manufacturing

• The Process
  – Charged Fluidized Bed Depositing on Grounded Current Collector with a Series of Heated Stations
  – Applies to All Common Active Materials and Particle Sizes
  – Utilizes the Same Binder and Active Materials as Conventional Manufacturing
  – Introduces no Solvents, Eliminates Drying Steps
  – Electrode is Immediately Ready for Cell Construction
Scale Up of Dry Process for Lithium Ion Electrode Manufacturing
Scale Up of Dry Process for Lithium Ion Electrode Manufacturing
Scale Up of Dry Process for Lithium Ion Electrode Manufacturing

ETP Dry Processed Electrodes Before Manufacturing Into.....

Cylindrical Cells and

Pouch Cells for testing
Scale Up of Dry Process for Lithium Ion Electrode Manufacturing
Scale Up of Dry Process for Lithium Ion Electrode Manufacturing

– Process Allows for Quick Change Over
– Electrode Performance Is As Good or Better Than Solvent Cast
– Process Allows for Varying Particle Size With Defined Layers
– Process Uses the Same Binder and Active Materials and Ratios, as Conventional Solvent or Wet Cast Manufacturing
– Works With Varieties of PVDF
Scale Up of Dry Process for Lithium Ion Electrode Manufacturing

- Electrodes From 12 um to 500 um Thickness
- Cell Testing
  - Exceptional High Rate Performance >100 to 330 C Rate Demonstrated
  - Fade Rates Appear to be Similar or Improved Compared to Solvent Cast (150 to 400 Cycles C/3)
  - Life Testing Still needs to be Validated.
Scale Up of Dry Process for Lithium Ion Electrode Manufacturing

Acknowledgements

ETP would like to acknowledge MEGTEC Systems for their participation and COR Matt Hutchens of DLA BattNet for his support.