Advances in Batteries with Smart Cells and Sensing

Ian Whiting
Business Development Director AGM Batteries Ltd
Co-Founder of AMTE Power Ltd
ian.whiting@agmbatteries.co.uk
AGM Background / Business Model

AGM provides a portal between labs and volume producers.

**History:** AGM plant commissioned in 2000. JV between AEA Technology, GS Japan Storage (GS Yuasa) & Mitsubishi Materials. Successfully developed and scaled new Li-ion tech for GS and Mitsubishi Materials. AEA Technology bought out the JV in 2005 and utilised plant to manufacture Li-ion cells for defence & specialist applications.

**Present:** Acquired by AMTE Power in 2013, with new business strategy based on new investment & utilising the facility as a scale up plant for new electrical energy storage technologies (taking TRL 3 /4 tech through to manufacture
Powder to Power Manufacturing Facility

Mixing ➔ Coating ➔ Calendaring ➔ Slitting

Cutting ➔ Stacking / Winding ➔ Formation ➔ Testing
AGM operates from powder to power.

Mid-scale. Capability to produce several million ‘18650’ cells (or equivalent) pa.

To bridge the development gap and transfer cell research to manufacture.

AGM works with emerging electrochemistries, advanced sensing and communications to prove next generation battery technology and smart cells.

Images: AGM ‘D’ cells previously manufactured in several million quantities at AGM; ‘21700’, the new defacto cylindrical cell; AGM ‘PHEV2’ pouch cell, currently in development.
Battery pack design and performance are heavily driven by cell type availability.

Mechanical interfaces, BMS compatibility, chemistry limitations, commercial terms etc. What can we address?

» Reliability / Lifetime / Performance
  » Thermal management
  » Cell interface
  » Depth of discharge

» Weight / size

» Cost
Emerging Solutions

» Advanced & solid state electrolytes
» High thermal conductivity cell materials
» Nano-materials & graphene
» Metallic electrodes
» New chemistries

But what about the nearer term.....
Nearer term Developments

**Sodium Ion**
- Scale-up of Exciting Na-ion Chemistry
- Lower Cost, Safety, Transportation
- Co-funded by Innovate UK IDP12 for automotive application

**Smart Cells**
- Smart Cells for Smarter Batteries
- Lighter, Smaller, Reliable, Safer, Big Data, 2nd Life Use
- Automotive & Energy Storage
- Co-funded by UK Automotive Battery Supply Chain (APC4)

**On-cell Sensing**
- Direct Cell SoC Measurement
- Increased SoC window, Improved SoH monitoring
- Target Automotive & Energy Storage
On-cell monitoring - Smart cells

> Multiple wires, multiple connections add weight, cost and reduce reliability
  > Embedded ASIC. ‘Wireless’ communication. Less wire, less connections, simpler pack build
  > Reduced pack weight (> 10%), improved reliability, higher effective capacity
  > Developed using high power LFP / Carbon.
  > NCA and MNC / Silicon variants being trialed.
Traditional BMS

BoM

- Cells
- Busbars
- Harness
- Slave
- BMU
Smart Cell Approach

BoM

- Cells
- Busbars
- Harness
- ASIC
- BMU
Development System
Sensors in the cell – why?

- Increase useable capacity
- Increase power density
- Increase charging rate

- Reduced CO2 emission
- Increased available energy
  - Increased charge rate
  - Better temperature control
- Extended drive range
  - Faster charging
  - Reduced fire risk
- 2nd Life valuation
- Cost efficient storage
  - Increased grid flexibility
  - State of Health and warranty
- Recycling
  - Optimized usage before recycling

- www.agmbatteries.com
Sensors in the cell - disruptive

» Voltametric measurements are imprecise
  » Cell DoD limits are conservative hence reduced range or larger battery

» Direct cell monitoring offers true, realtime condition monitoring
  » Enables much more efficient battery use / deeper DoD / higher effective cell capacity
  » Detects failure warning signs
  » Can integrate with smart cell

Example – Insplorian. Nanoparticles are used as sensing elements. The sensor is sensitive to changes in the refractive index in the volume within a few tens of nanometers from the nanoparticles.
Sensors in the cell

- Nanosensor – readily miniaturised
- Sensitive yet robust
- Scaleable, cost-effective production
- Fibre optic based with transmission and signal processing advantages
- Proven using AGM standard cells and NCA / carbon
- Chemistry agnostic
- Proof of concept developed with US Tier 1 Automotive supplier
Sensors in conventional cells

» Implementation of the sensor in conventional pouch cells
» Developing for series production
» Cell capacity unaffected
Our Faraday Challenge Activity

Faraday Challenge

Faraday Institute
- Supporting Fast start projects
- Influencing training & skills programme

IUK Strand
- Co-funding for two new cell technology projects
- Exploitation partner on a range of successful applications

Scale Up Strand
- Already active in through AGMs scale up facility
- As the only UK mass cell producer (powder to power), supporting the UKBIC

www.agmbatteries.com
Thankyou

Ian Whiting
ian.whiting@agmbatteries.co.uk