

Designing and Manufacturing High Performance Li-ion Battery Cells in the UK

Topics

- 1. AMTE Power introduction and update**
- 2. PvE: electrochemical and mechanical considerations**
- 3. PvE: use cases for the UE and UHP cells**

AMTE Power Introduction

- A UK-based, lithium-ion (Li-ion) and sodium-ion (Na-ion) battery cell supplier
- We manufacture 2170 cylindrical and 300x100 pouch cells
- Our cells are used in energy (Stationary storage, BEV, PHEV) and power (HEV, Fuel Cell EV) applications
- Floated on LSE in 2021, achieved Green Economy mark
- Joint venture established in Australia – Bardan Cells
- UK-based Gigafactory planned for 2026-27

AMTE next-generation *Ultra* battery cells

- **Ultra Energy** cells deliver 20% further range
- **Ultra Safe** cells with zero Lithium
- **Ultra High Power** cells with 5x faster charge capability



APC Cell Development Projects



Project ULTRA

AMTE is Project Lead, will develop UE-2170 and UHP-300x100 cells into commercial EV and performance packs



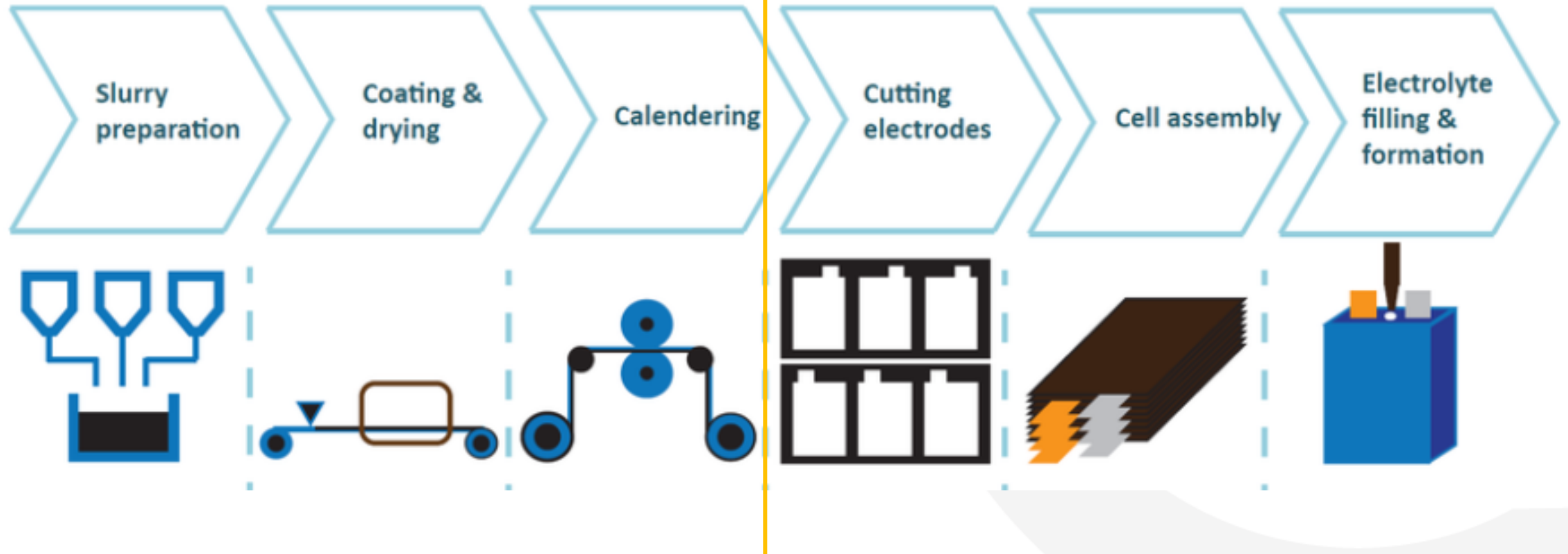
Project CELERITAS

AMTE is cell manufacturing partner, will develop UHP-2170 cell in an immersive-cooled battery pack



AMTE covers the whole cell production process

- Powder to product



Bringing products to market at Thurso

- Our highly flexible cell production facility has a strong track record in commercialising new products/IP and low volume batch supply.
- The facility can accommodate a range of chemistries and manufacture
 - Cylindrical & pouch cell formats
 - Rechargeable and primary chemistries





Executing gigascale manufacturing

Thurso HQ ~100 MWh (present)

- Capable of prototype development
- Small scale production
- Pouch and cylindrical

UKBIC scale-up facility ~500 MWh (present)

- Volume scale-up
- 300x100 (VDA standard) pouch
- 2170 cylindrical

AMTE modular Gigafactory ~2.5-10 GWh per plant

- Gigascale production
- ~2.5 GWh per line, per cell
- Li-ion and Na-ion chemistries

Micro Line – Assembly



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Power versus Energy

- Commercial Li-ion cells are optimised for either high energy density or high power density
- Hence there is a trade off in cell design between the power and energy requirements – different “power-energy” ratios



Power vs Energy

Designing cells for high power

- Cells designed for high power applications use smaller active material particles in both electrodes
- Cathodes used in power cells have lower loadings, higher porosities, are thinner with thicker current collectors
- To obtain the highest power possible all components are selected for low resistance



Ultra High Power (300 x 100 pouch)

Nominal Capacity	12 Ah
Nominal Voltage	3.7 V
Gravimetric Energy Density	>145 Wh/kg
Volumetric Energy Density	>300 Wh/l
Gravimetric Power Density	>3510 W/kg
Volumetric Power Density	>6630 W/l
Weight	<0.3 kg
Cycle Life	>3000



Designing cells for high energy

- Cells designed for high energy applications use medium-large particles of active material in both electrodes
- Cathodes used in energy cells have lower porosities are heavier, thicker and denser
- The separators and current collectors used in energy cells are generally selected to be as thin as possible



Ultra Energy (2170 format, Gen 1)



Nominal Capacity	5 Ah
Nominal Voltage	3.6 V
Gravimetric Energy Density	230 - 240 Wh/kg
Volumetric Energy Density	700 - 724 Wh/l
Continuous Power Density	0.4 kW/l
Peak Power Density (10s pulse)	2 kW/l
Weight	75 – 78 g
Cycle Life (1C charge / discharge, 100% DoD)	>1000
Dimensions cm (D x H)	2.12 x 7.040



Ultra Energy (2170 format, Gen 2 – silicon-based anode)

Nominal Capacity	5.5 - 5.7 Ah
Nominal Voltage	3.6 V
Gravimetric Energy Density	265 - 275 Wh/kg
Volumetric Energy Density	800 - 830 Wh/l
Continuous Power Density	0.8 kW/l
Peak Power Density	2.2 kW/l
Weight	0.076 - 0.078 kg
Cycle Life	>1200



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Ultra High Power cells – key uses

- AMTE's *Ultra* High Power 300x100 pouch cells are designed with a focus on mild-hybrid (MHEV) and fuel cell (FCEV) electric vehicles
- The unique mechanical construction of AMTE's UHP cells – encompassing very thin electrode layers, optimises for power density
- The pouch cell format maximises the surface area available for cooling, as do the opposing tabs

Ultra Energy (UE) cells – key uses

- AMTE's *Ultra Energy* 2170 cylindrical cells are designed with a focus battery (BEVs) and plug-in hybrid electric vehicles (PHEVs)
- The high Nickel Cobalt Aluminium (NCA) chemistry gives AMTE's Gen 2 UE cells market leading energy density (~280 Wh/kg) and high capacity (~5.7 Ah)



Summary

- Power cells deliver market beating performance
- Energy cells offer market leading levels of energy density
- Innovative cell design differentiates Ultra cells





Thank you

Please contact paul.tillett@amtepower.com to find out more