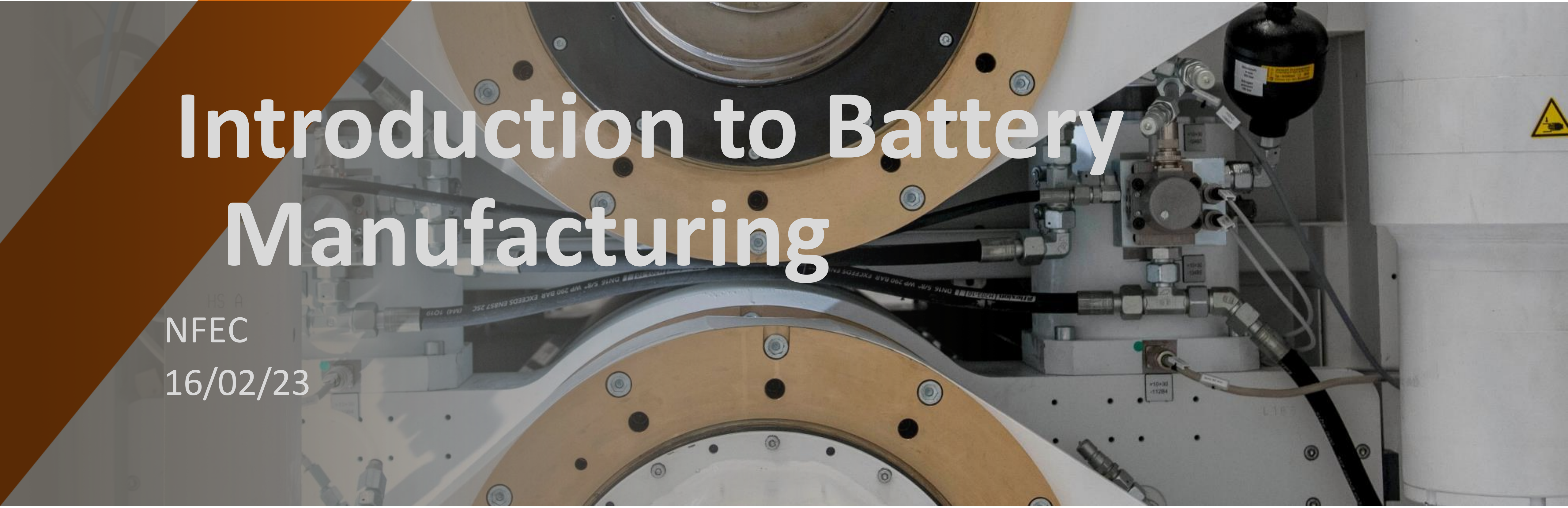
UK BATTERY INDUSTRIALISATION CENTRE



Introduction to Battery Manufacturing

NFEC

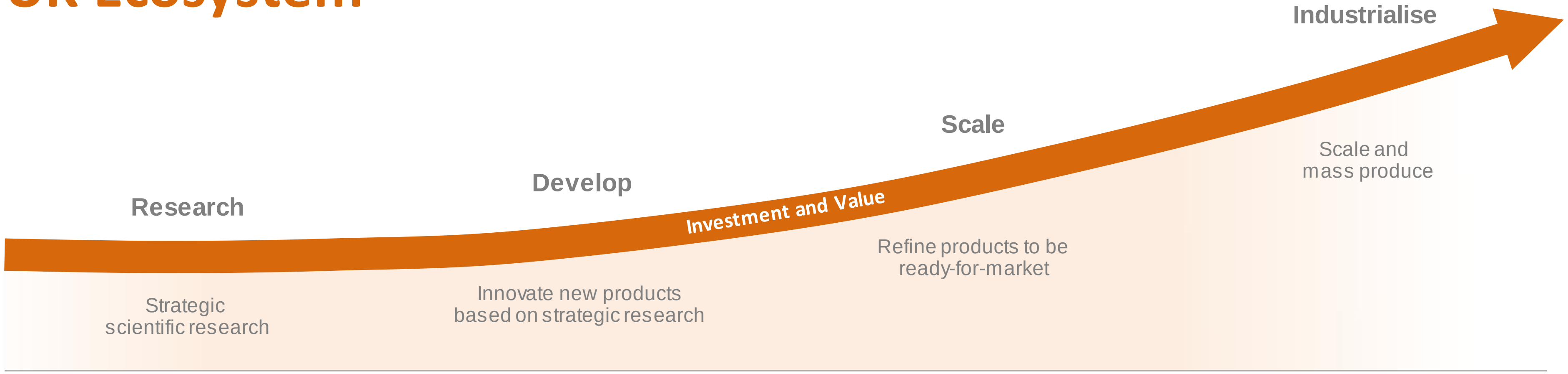
16/02/23

Welcome to the UK Battery Industrialisation Centre

Feb 2023

UK BATTERY INDUSTRIALISATION CENTRE

The UK Ecosystem



UK Research and Innovation

Faraday Battery Challenge

THE FARADAY INSTITUTION

Building a Science Superpower

Collaborative R&D

Scaling high-tech businesses

UK BATTERY INDUSTRIALISATION CENTRE

Open access scale up with Gigafactory capability

ADVANCED PROPULSION CENTRE UK

ADVANCED PROPULSION CENTRE UK

Automotive Transformation Fund

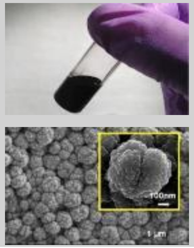
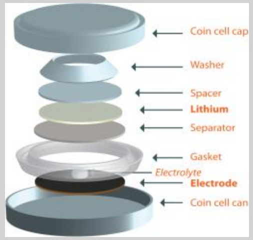
Source: Advanced Propulsion Centre

UK BATTERY INDUSTRIALISATION CENTRE

Bridging the Gap from R&D to Mass Production

UKBIC scope

Volume, TRL, MRL

	Gramme Scale	Kilogramme Scale	Tonne Scale	Giga Scale
	 			
Characteristic	▪ University scale research labs using small quantities of hand-made materials. ▪ Fundamental materials research ▪ Initial half-cell experiments at coin cell scale.	▪ Corporate R&D pilot line or university / Catapult centre. ▪ Used to demonstrate early scalability of materials to full size cell ▪ Develop and demonstrate electrode mixtures, deposition processes and cell formats.	▪ Full-scale GWh/yr manufacturing facilities used at low output rate. ▪ Used to develop and validate materials, cell design, manufacturing processes and parameters at industry rates prior to full plant investment.	▪ Full-scale, high volume manufacturing plant. Typically 6-50GWh/year. ▪ Used to deliver very large volumes of cells with no variation or flexibility to chemistry, format or quality. ▪ Cost/kWh and process consistency are critical.

Technology Readiness

TRL 1	TRL 2	TRL 3	TRL 4	TRL 5	TRL 6	TRL 7	TRL 8	TRL 9
Principles & Research	Explore Applications	Analytical Experiments	Validation & Requirements	Design & Performance	Model & Prototype	Performance & Testing	Test & Demonstrate	Real World & Launch

Research & Development — Industrial Engineering — Commercialisation

Manufacturing Readiness

MRL 1	MRL 2	MRL 3	MRL 4	MRL 5	MRL 6	MRL 7	MRL 8	MRL 9	MRL 10
Implication & Materials	Identify Processes	Proof of Concept	Identify Technology & Test	Prototype Materials, Tools & Skills	Processes & Detailed Costs	Pilot Line & Materials	Process Maturity Demonstration	Manufacturing Processes Proven	Production Ready
Material Solution Analysis				Technology Development		Engineering & Manufacturing Development		Production & Deployment	Operation & Support

UKBIC Scope

UK BATTERY INDUSTRIALISATION CENTRE

Key Facts

1. $20{,}000m^2$ manufacturing research facility located on the outskirts of Coventry
2. Battery Electrode, Cell, Module and Pack manufacturing capability at industrial rates
3. Modular "Learning Factory". Used for trialling and short volume manufacture of:
   - New manufacturing processes
   - New materials
   - New cell formats
   - New module structures
   - New pack structures
4. Reducing commercial risk for high volume manufacturing investments
5. Open access and promotes UK industrial collaboration for organisations of all sizes
6. Does not exist to own IP or product but to enable industry user outcomes
7. Delivers skills and training to support the growth of the UK battery industry

UK BATTERY INDUSTRIALISATION CENTRE

Learning and Development at UKBIC

UK BATTERY INDUSTRIALISATION CENTRE

Delivery

Theoretical/process awareness

- Managers
- New starters
- Execs
- Directors

Lineside training

- New starters
- Upskilling
- Reskilling

Maintenance training

AR/VR delivery

- Digital twins
- Operational activity
- Troubleshooting

UK BATTERY INDUSTRIALISATION CENTRE

Resources

- UKBIC current course offering
  - Introduction to Battery Manufacturing Processes
  - Hazardous voltage (Lv. 1 – 4)
- ESP Units
- Consultancy
  - Educational
  - Operational
- UK Wide current offering
  - Mostly Academic based
  - Only 1 current large scale manufacturer of Batteries in the UK.

Battery Technology through the Ages

UK BATTERY INDUSTRIALISATION CENTRE

Primary vs secondary

Primary

- A single use cell when discharged, cannot be recharged by an electric current

Lithium metal. Non-rechargeable batteries.

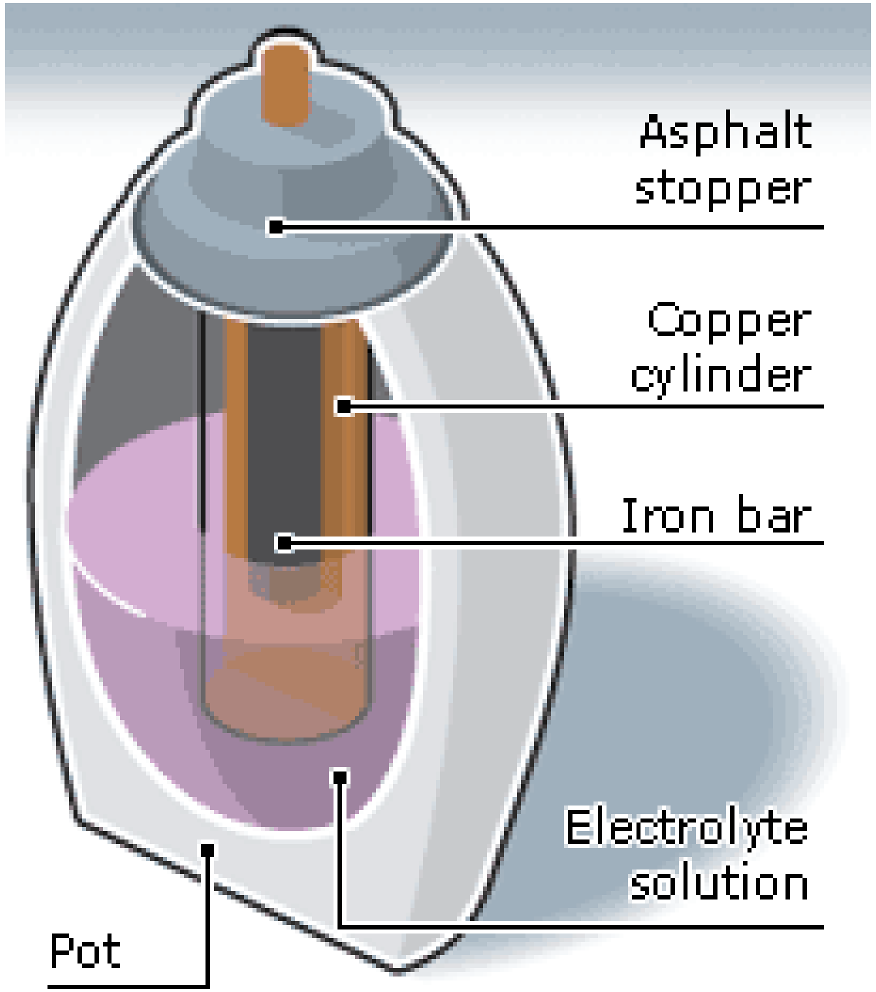
Secondary

- A rechargeable cell where, after being discharged, may be recharged and reused

Lithium-ion / lead acid / NiMh

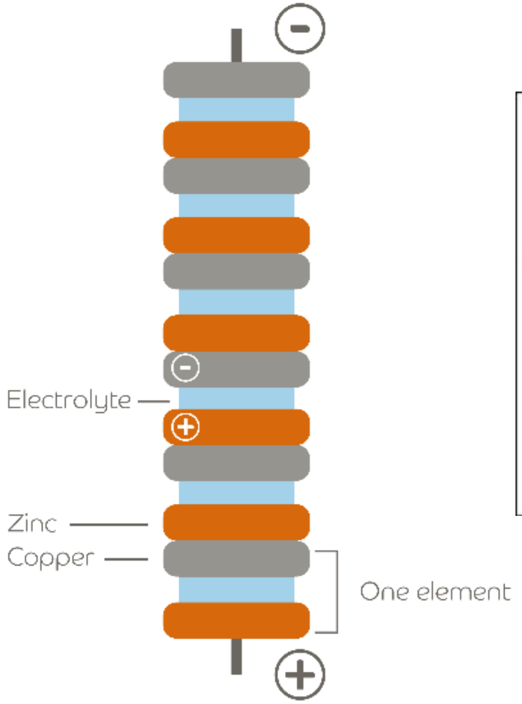
What is a battery? – brief history

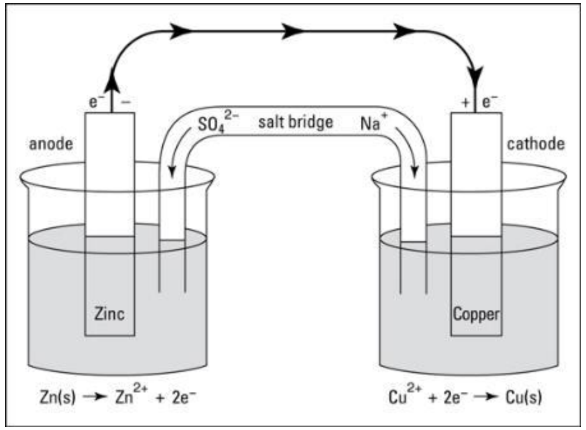
- First probable recorded battery usage was ~ 1000 - 2000 Years ago.
- “Baghdad Batteries”
- Terracotta jar containing a copper cylinder, insulated from an iron rod and filled with a conductive electrolyte.

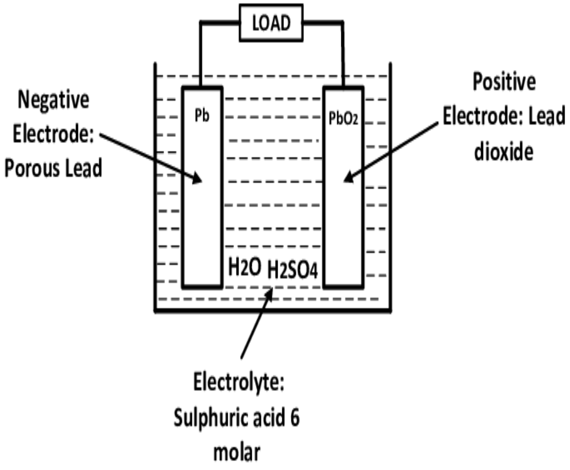


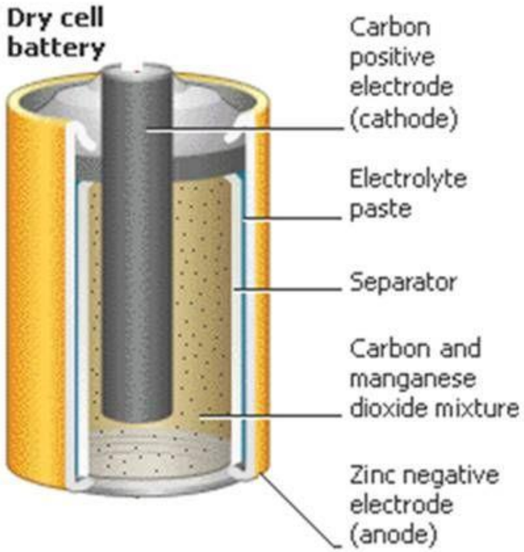
UK BATTERY INDUSTRIALISATION CENTRE

Early batteries









Voltaic Pile
(c1800)

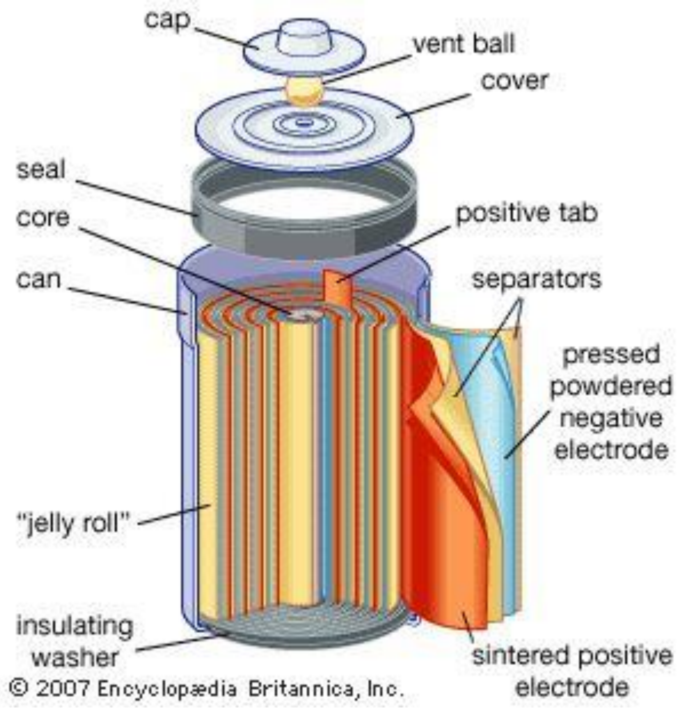
Daniell cell
(c1836)

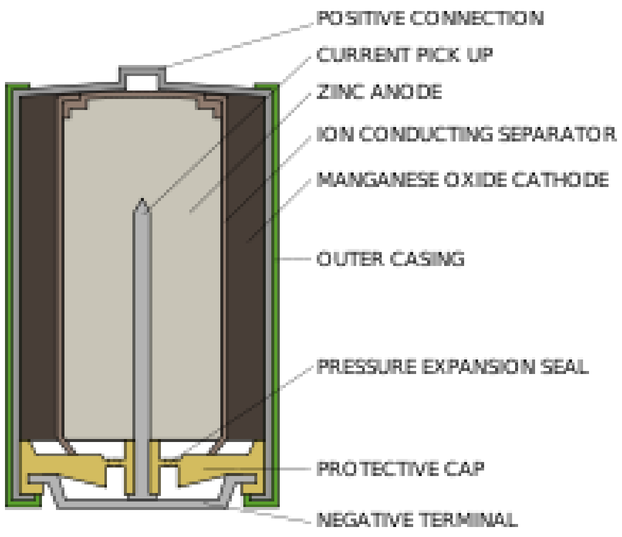
Lead-acid
(c1860)

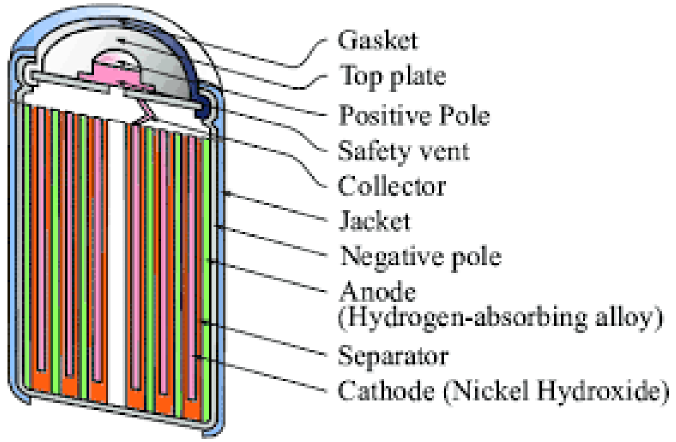
Zinc-carbon
(c1866)

UK BATTERY INDUSTRIALISATION CENTRE

Modern Batteries







Nickel-Cadmium
Secondary (c1899)

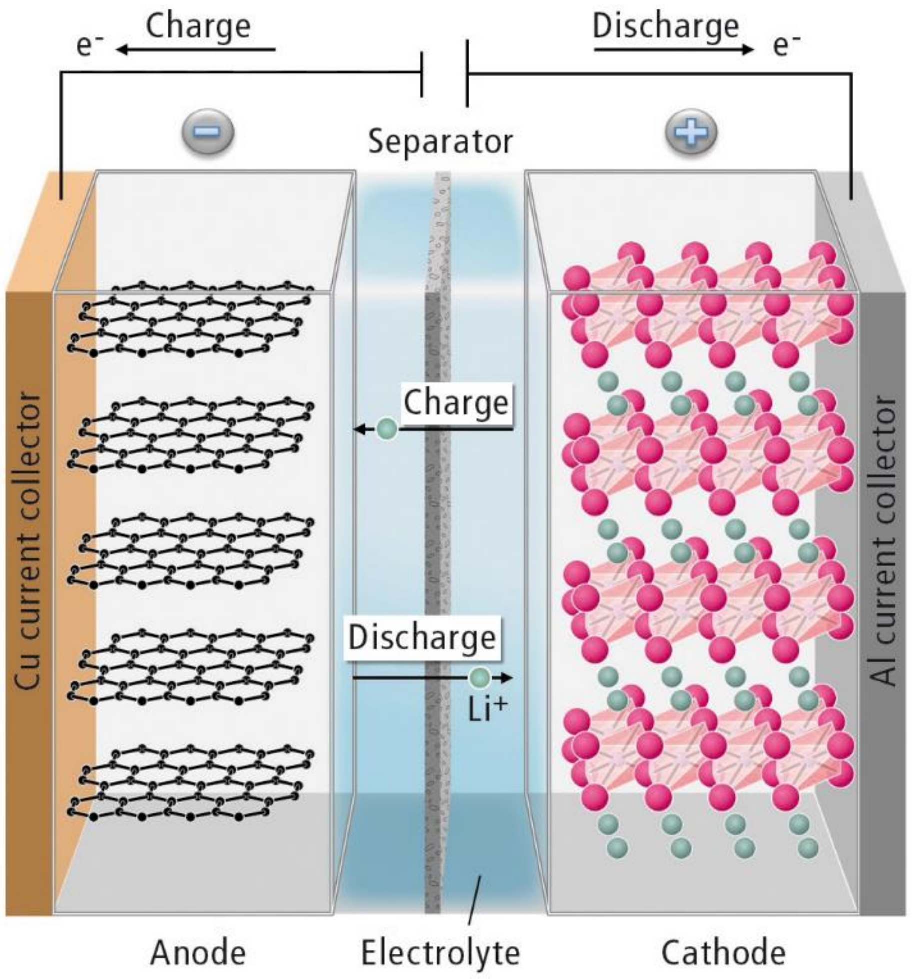
Alkaline
Primary (c1959)

Nickel Metal-hydride
Secondary (c1986)

UK BATTERY INDUSTRIALISATION CENTRE

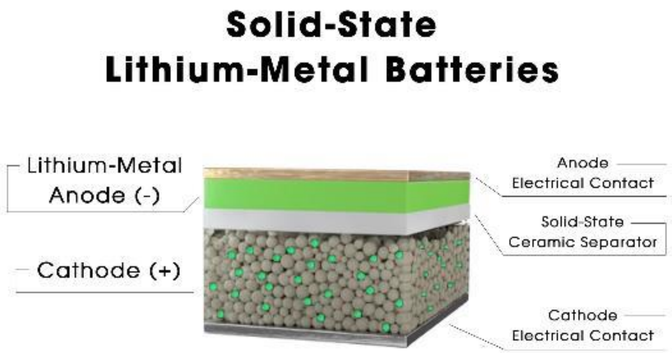
Lithium-Ion batteries

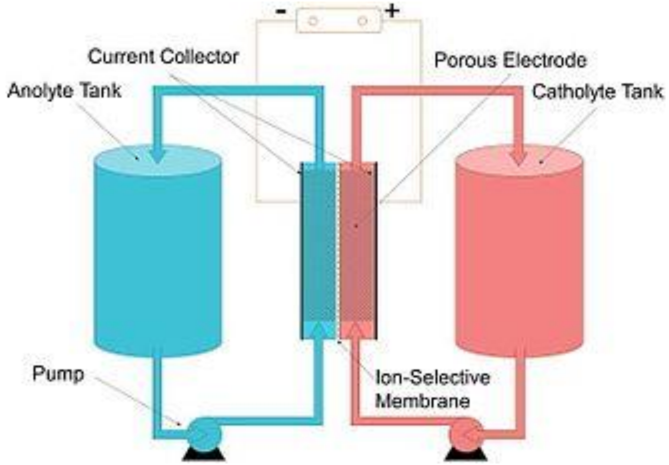
- A negative copper current collector
- Graphite anode layer
- Electrolyte
- Separator
- Carbon cathode layer
- A positive aluminium current collector



UK BATTERY INDUSTRIALISATION CENTRE

Potential Future Tech





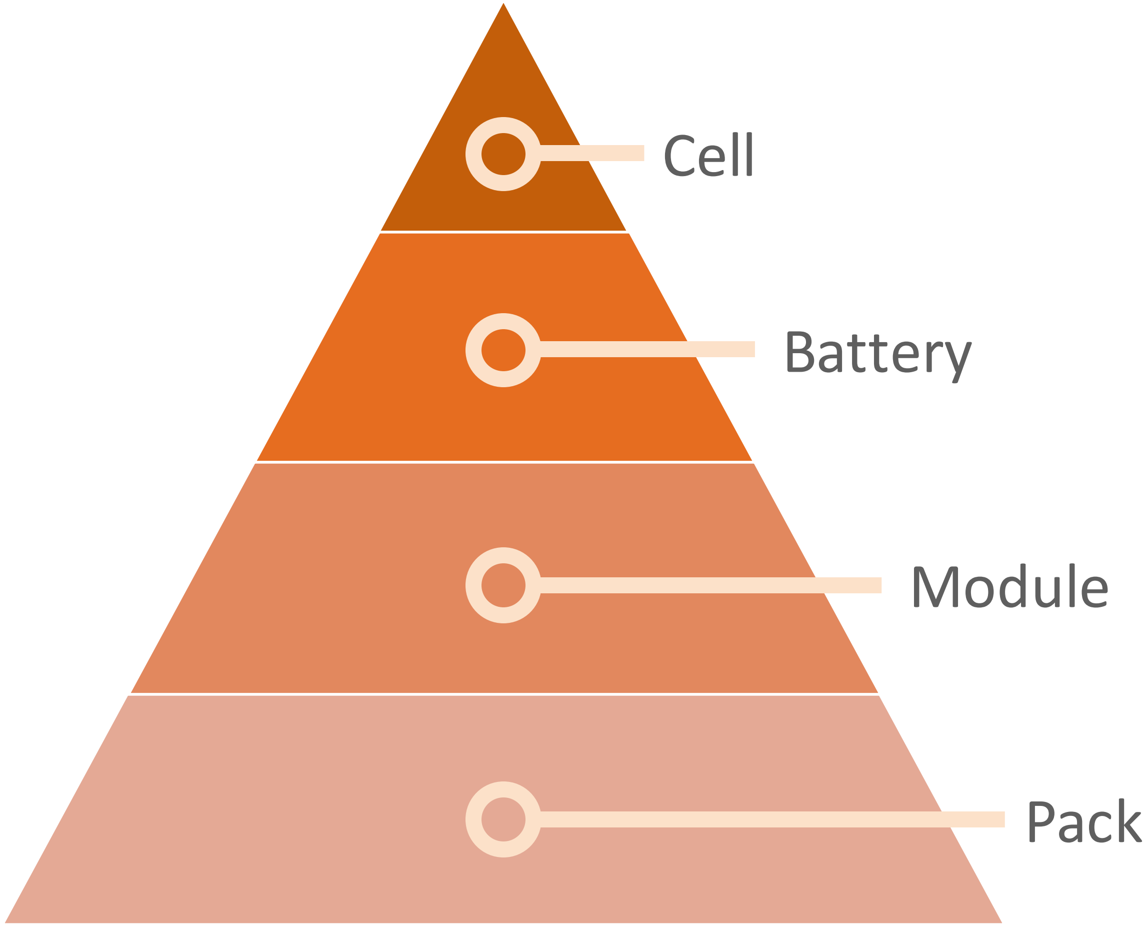
Solid State
Secondary (c2011)

Sodium Ion
Secondary (c2010-2020)

REDOX Flow
Primary/Secondary (c1970s)

UK BATTERY INDUSTRIALISATION CENTRE

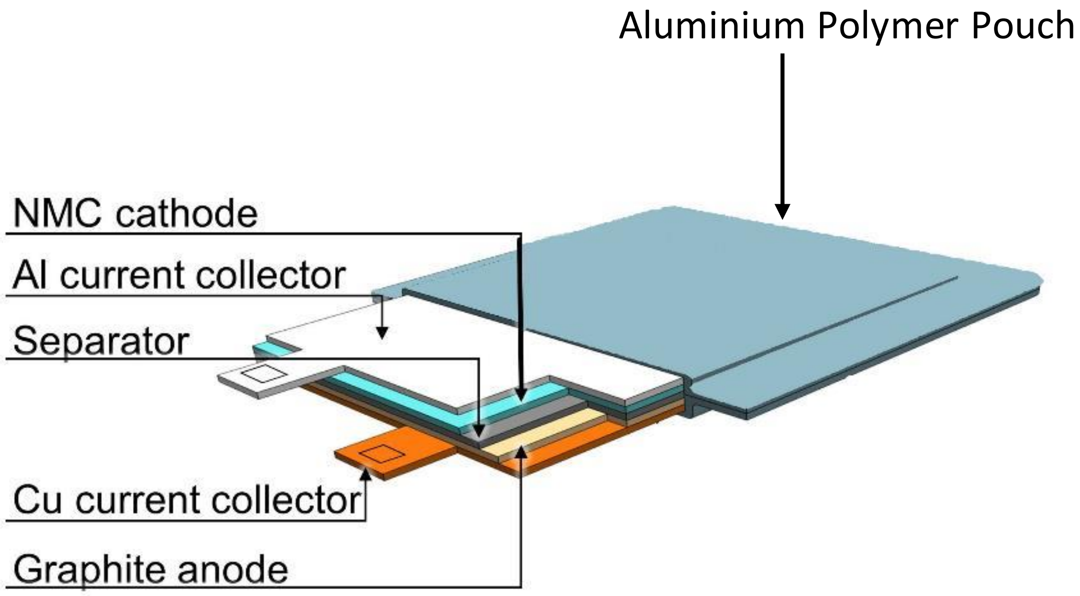
What's the difference?



- A cell is an individual energy source
- A battery consists of 1 or more cells
- A module is a collection of 1 or more batteries assembled in a frame
- A pack is the complete enclosure that delivers power

UK BATTERY INDUSTRIALISATION CENTRE

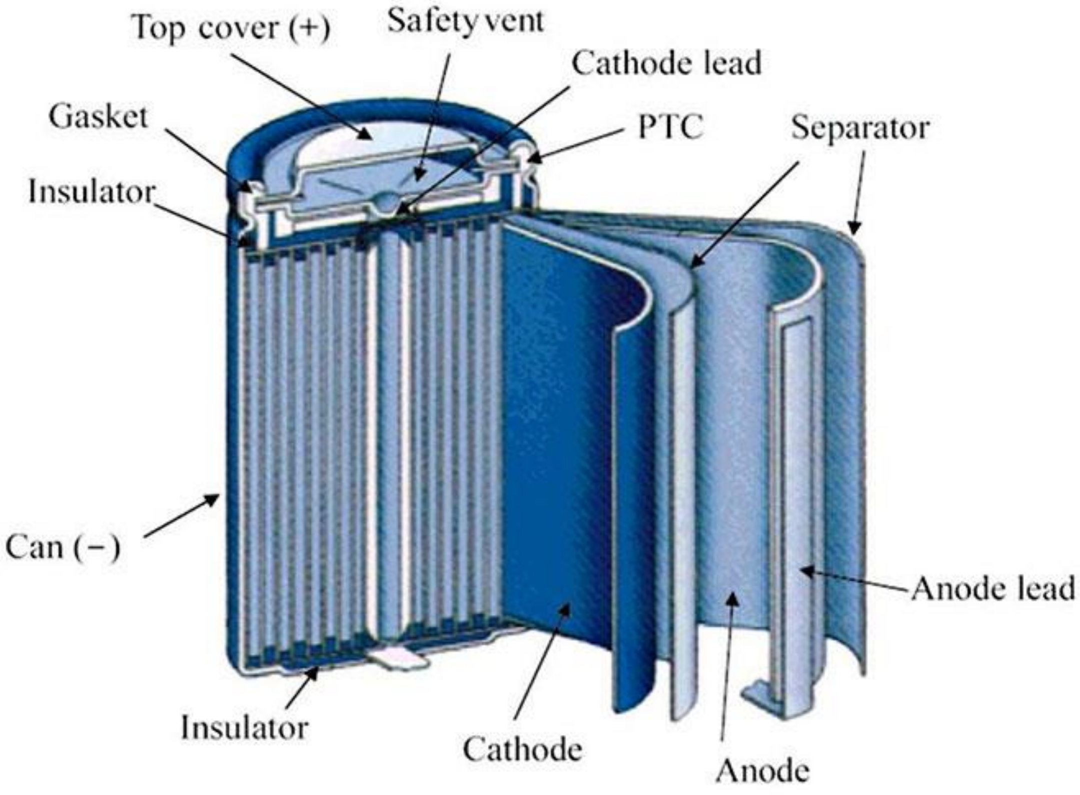
Components of a pouch cell

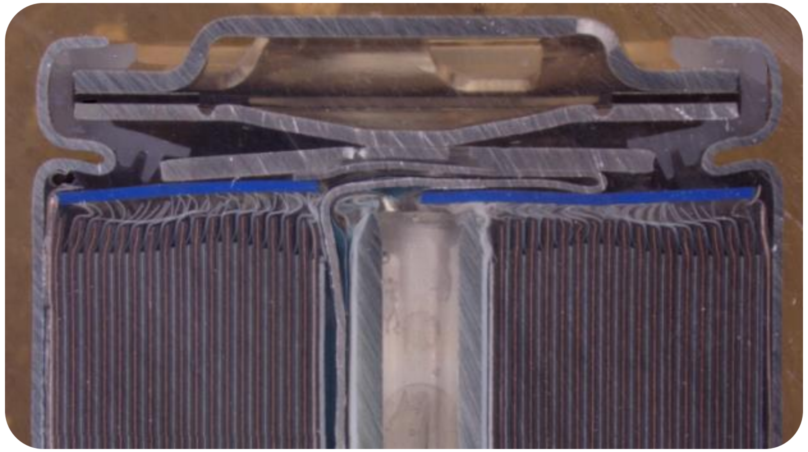


- Aluminium Polymer pouch
- NMC Cathode Coating
- Aluminium Foil Substrate
- Separator
- Copper Foil Substrate
- Graphite Anode Coating

UK BATTERY INDUSTRIALISATION CENTRE

Cylindrical cell components





UKBIC products

Cylindrical cell	Pouch cell	Module	Pack

Battery Manufacturing Process

UK BATTERY INDUSTRIALISATION CENTRE

Process flow overview

Electrode				Cell		Module	Pack
Mixing →	Coating and Drying →	Calendering →	Slitting →	Cylindrical / Pouch Assembly →	Formation, Age & Test →	Module Assembly →	Pack Assembly

UK BATTERY INDUSTRIALISATION CENTRE

Electrode

Mixing Area

Electrode				Cell		Module	Pack
Mixing	Coating and Drying	Calendering	Slitting	Cylindrical / Pouch Assembly	Formation, Age & Test	Module Assembly	Pack Assembly

Mixing formulation

- Both Anode and Cathode slurry requires a combination of ingredients to produce a coat-able slurry, to the specifications required

- Active Materials
- Conductive Materials
- Binder
- Solvent

CMC: Carbo-methyl Cellulose

NMP:N-Methyl-2Pyrrolidone

NMC: Nickel Manganese Cobalt

SBR: Styrene Butadiene Rubber

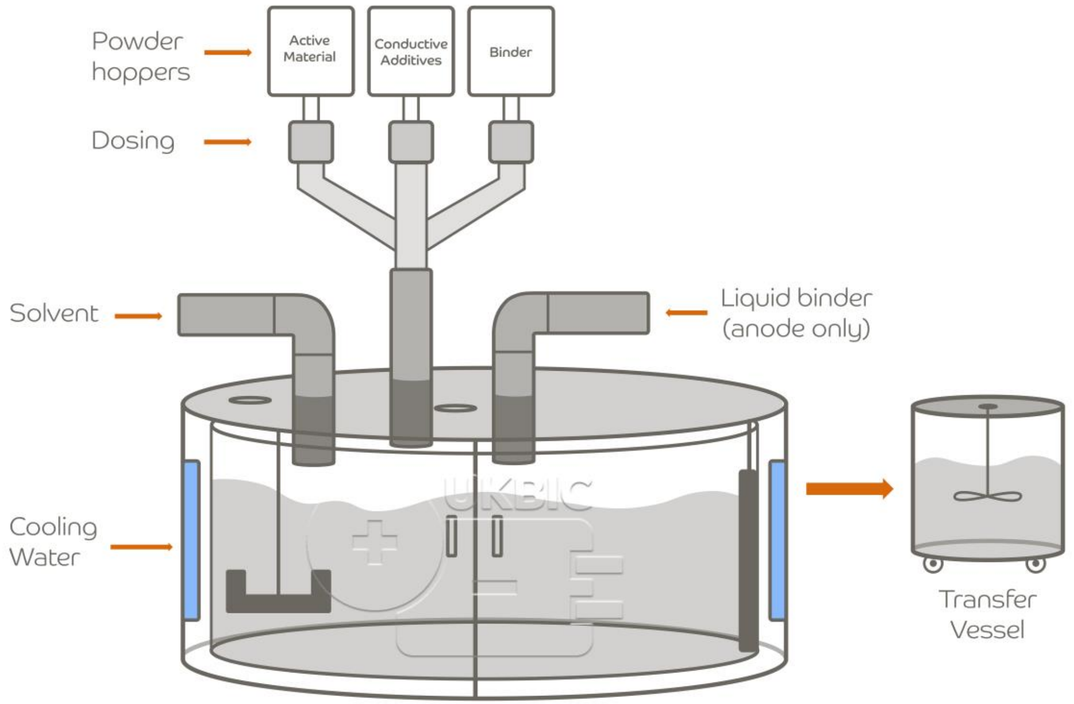
PVDF: Polyvinylidene Fluoride

- Anode Materials:
- Graphite
- CMC
- Di-ionised water
- SBR

- Cathode Materials:
- NMC
- Carbon
- PVDF
- NMP

UK BATTERY INDUSTRIALISATION CENTRE

Mixing process



Dry powders in → Solvents added → Slurry agitated → Slurry moved to transfer vessel → Air is removed from slurry → Slurry is transferred to coating

UK BATTERY INDUSTRIALISATION CENTRE

Mixing process

- We use an Eirich RL12W Intensive Mix Solver 150L/hour 250L capacity
- Can be used as Standard planetary mixer. Speed of pan rotation and agitation define this (customer dependent)
  - Dry mix: Powders mixed to fully combine them
  - Liquids added: Approximately 50% of total to form a dough like substance
  - Kneading: Mixed at lower speeds to fold the material
  - Dilution: Adding the remaining liquids to produce the final slurry
- Samples can be taken at various points throughout the mix, normally after kneading
- Many factors including length of each operation, ingredients, order of added ingredients and sampling, are customer dependent

UK BATTERY INDUSTRIALISATION CENTRE

Mixing technologies

Main technologies:

- Planetary dispersion
- Screw extruder
- Eirich intensive mixer

Key quality parameters:

- Viscosity
- Solid content
- Uniformity
- Free from gas

Challenges:

- Yield
- Raw material variation
- Scale-up

Summary:

Disperse materials effectively to make a slurry and keep making slurry to feed the coater.

Electrode				Cell		Module	Pack
Mixing	Coating and Drying	Calendering	Slitting	Cylindrical / Pouch Assembly	Formation, Age & Test	Module Assembly	Pack Assembly

UK BATTERY INDUSTRIALISATION CENTRE

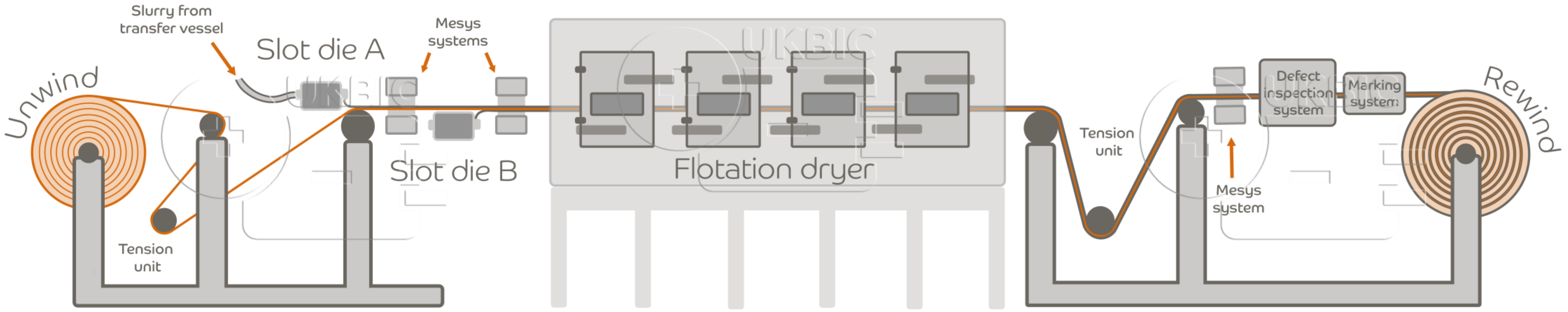
Electrode

Coating & drying area

Electrode				Cell		Module	Pack
Mixing	Coating and Drying	Calendering	Slitting	Cylindrical / Pouch Assembly	Formation, Age & Test	Module Assembly	Pack Assembly

UK BATTERY INDUSTRIALISATION CENTRE

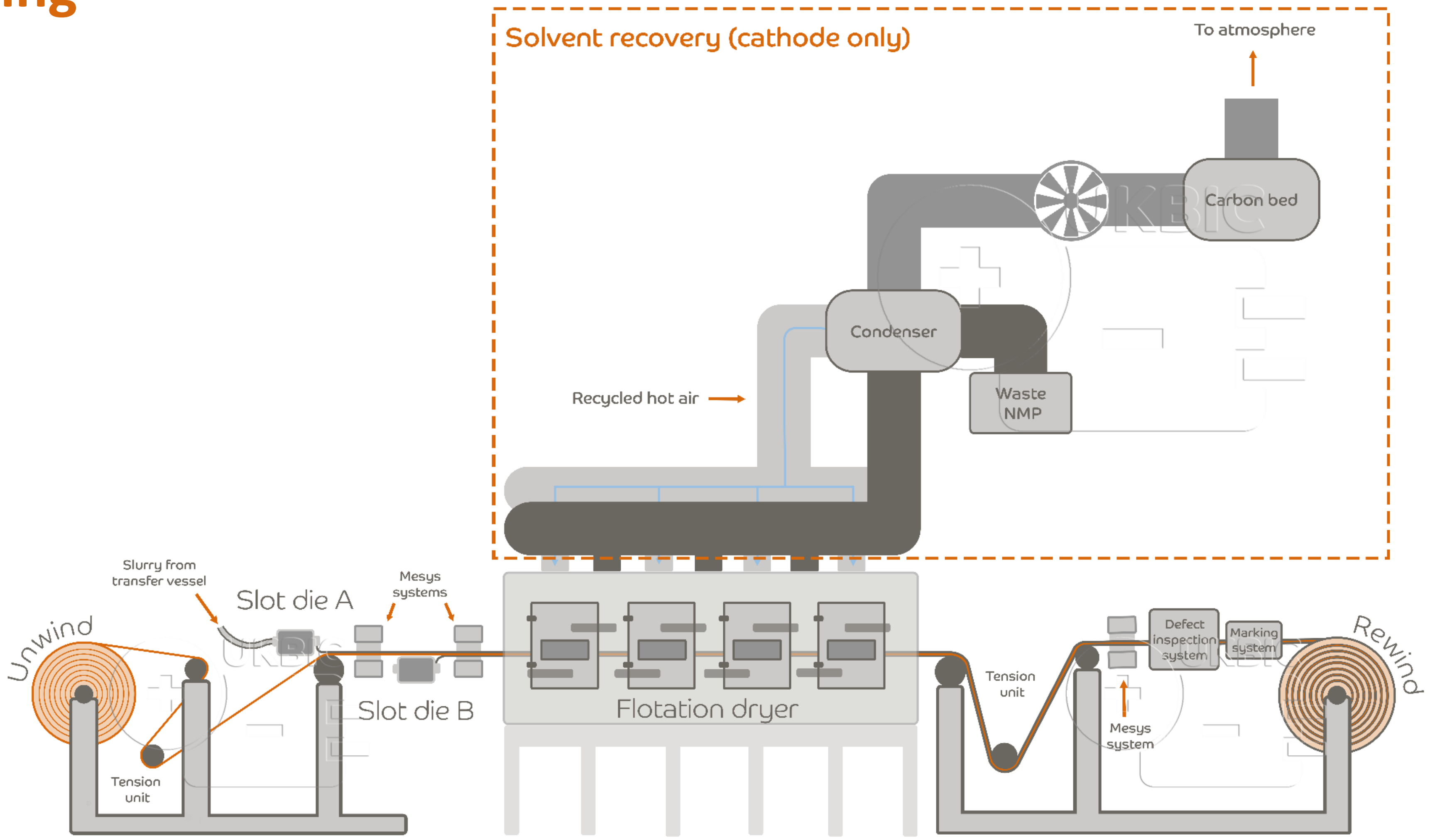
Coating & drying process



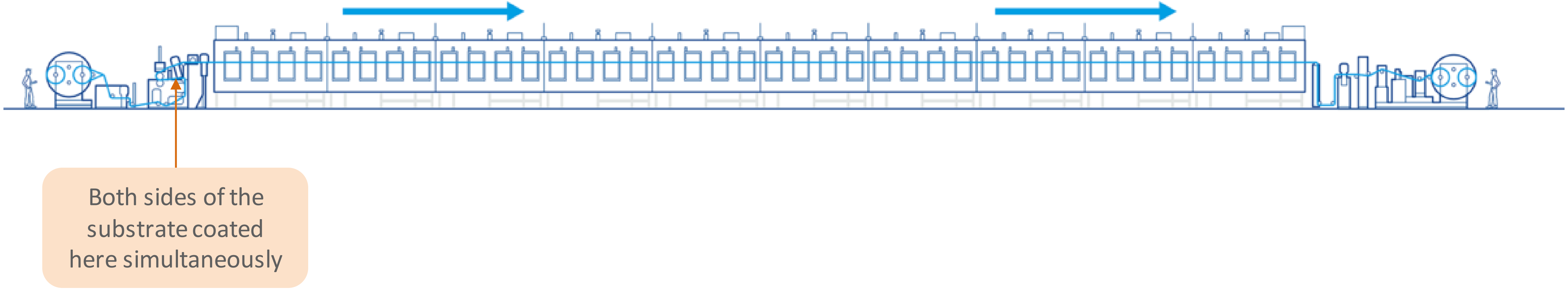
- Slurry pumped from transfer vessel to coating heads
- Slurry coated onto both sides of the foil
- Test equipment checks geometry and defects
- The coated foil is dried
- The dried foil is checked again for defects and geometry
- Coated foil is dried and rewound

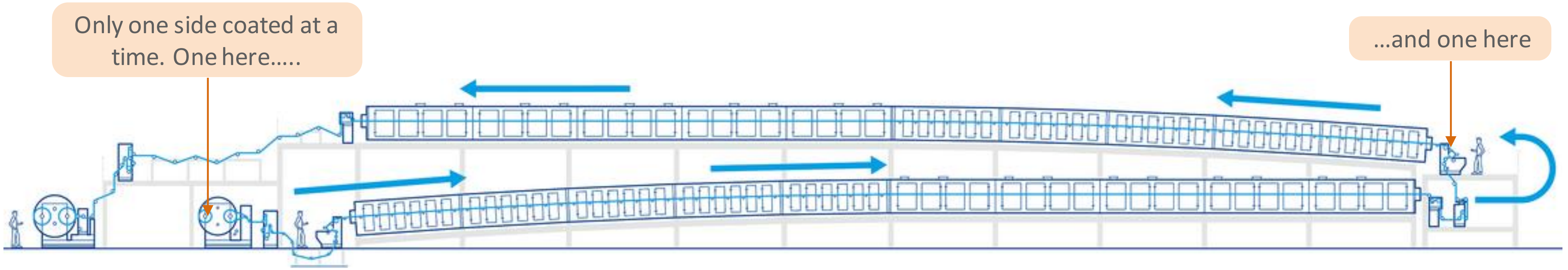
UK BATTERY INDUSTRIALISATION CENTRE

Drying



Simultaneous vs tandem coating





UK BATTERY INDUSTRIALISATION CENTRE

Drying technologies

Main technologies:

- Flotation for simultaneous coating
- Roll supported for tandem coating

Key quality parameters:

- Residual solvent content
- Adhesion
- Correct drying profile

Challenges:

- Throughput
- Emissions

Summary:

Remove solvent from slurry quickly without causing defects and to dry the coating

Electrode				Cell		Module	Pack
Mixing	Coating and Drying	Calendering	Slitting	Cylindrical / Pouch Assembly	Formation, Age & Test	Module Assembly	Pack Assembly

UK BATTERY INDUSTRIALISATION CENTRE

Coating summary

Main technologies:

- Simultaneous/Tandem Coating
- Slot die
- Comma bar

Key quality parameters:

- Coat-weight / thickness
- Geometry
- Defect free
- Adhesion

Challenges:

- Uniformity and consistency
- Throughput
- Skip coating

Summary:

Uniformly apply the slurry to the surface of the foil

Electrode				Cell		Module	Pack
Mixing	Coating and Drying	Calendering	Slitting	Cylindrical / Pouch Assembly	Formation, Age & Test	Module Assembly	Pack Assembly

Electrode

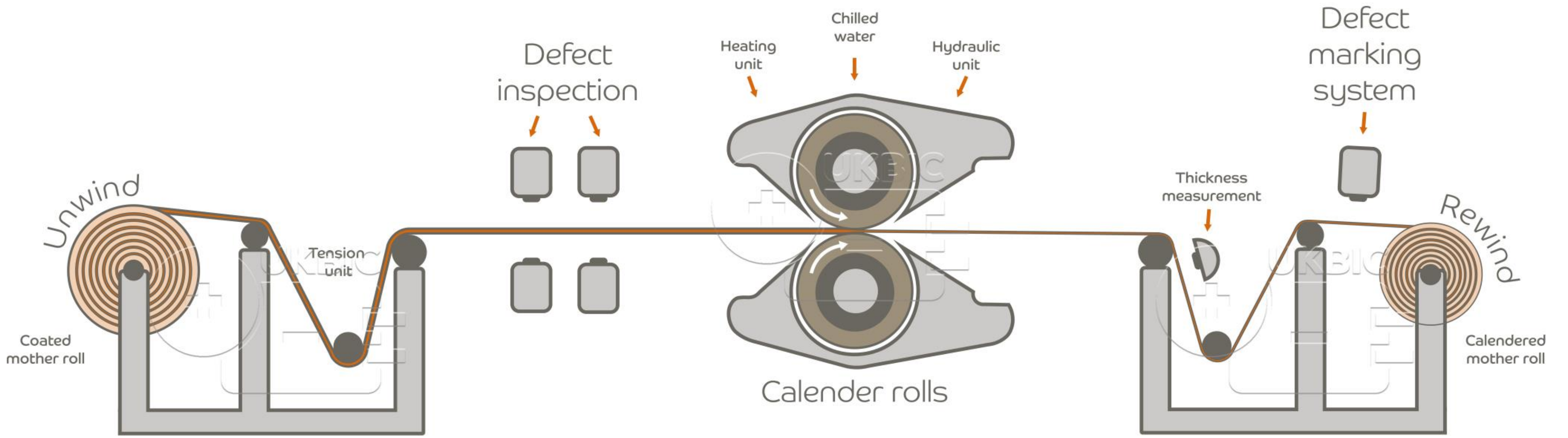
Calendering area

Electrode | **Cell** | **Module** | **Pack**

Mixing → Coating and Drying → **Calendering** → Slitting → Cylindrical / Pouch Assembly → Formation, Age & Test → Module Assembly → Pack Assembly

UK BATTERY INDUSTRIALISATION CENTRE

Calendering process



Dry coated foil loaded onto unwind → Foil threaded through machine → Vision system looks for defects → Coated material compressed → The new thickness is measured for accuracy → Compressed material rewound to make mother roll

UK BATTERY INDUSTRIALISATION CENTRE

Calendering technologies

Main technologies:

- Compression & heat

Key quality parameters:

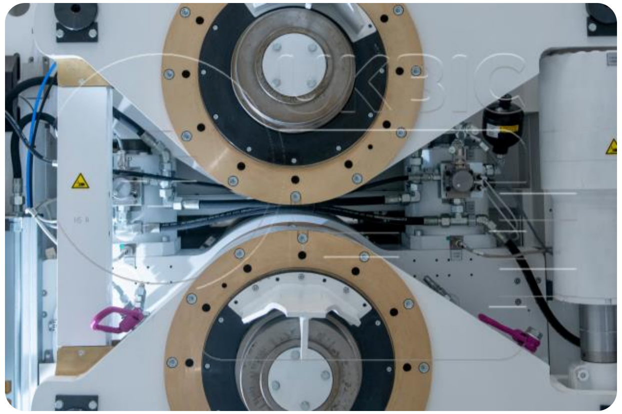
- Even thickness
- Mechanical properties
- Adhesion

Challenges:

- Uniformity
- Throughput
- Calender roll bending
- Electrode deformation

Summary:

Compress coating to improve energy density of final electrode



Electrode | Cell | Module | Pack

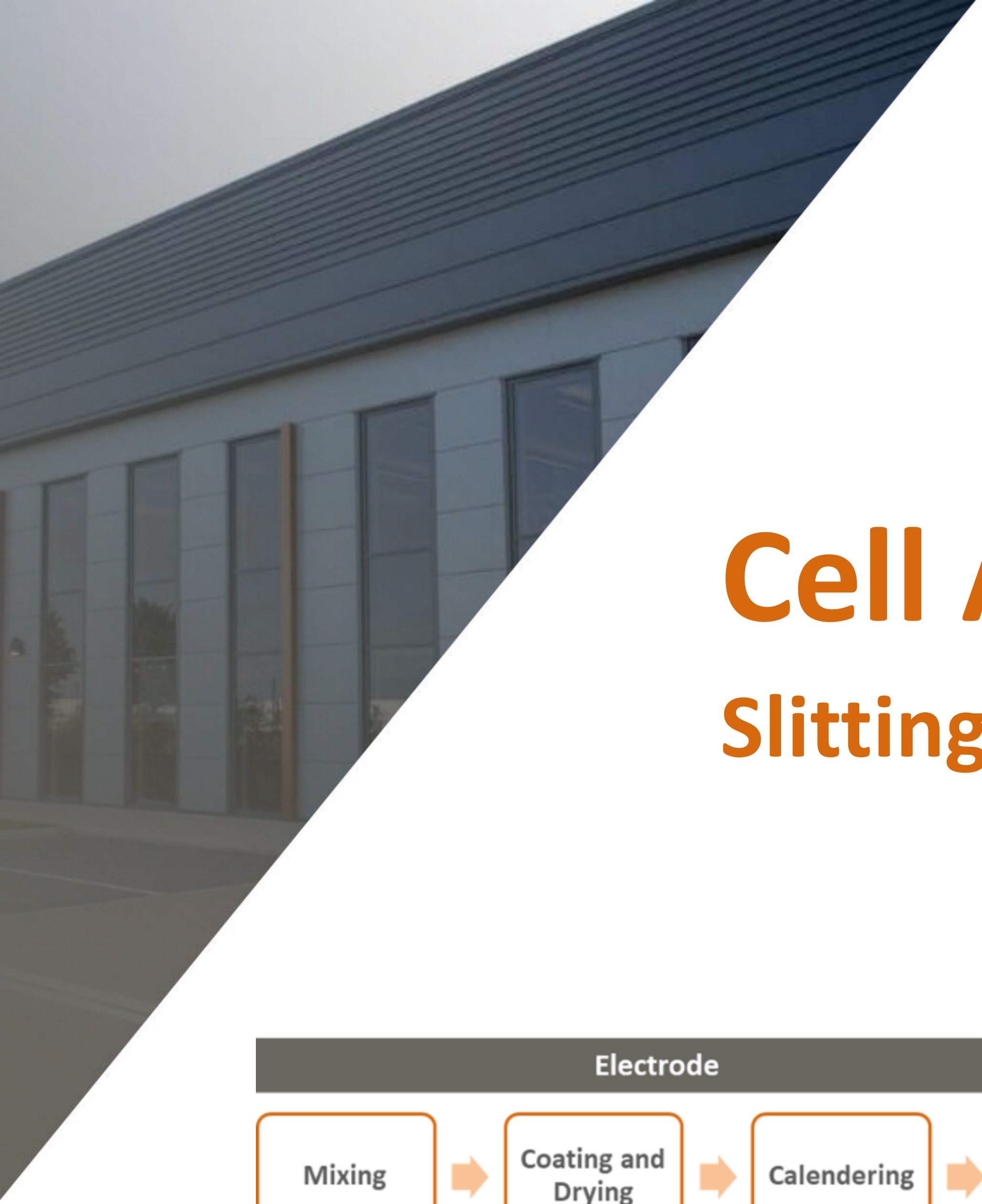
Mixing → Coating and Drying → **Calendering** → Slitting → Cylindrical / Pouch Assembly → Formation, Age & Test → Module Assembly → Pack Assembly

UK BATTERY INDUSTRIALISATION CENTRE

Example electrode details

Parameter	Units	21700		300x100 Pouch cell	
		Anode	Cathode	Anode	Cathode
Number of units	#	1	1	30	29
Width	mm	64	63	264	261
Length	mm	920	850	77	75
Thickness	um	142	139	142	139
Areal capacity	mAh/cm 2	2.64	2.4	2.64	2.4
Coatweight	g/m2	107	197	107	197

Fixed by cell assembly equipment   Variable parameters



UK BATTERY INDUSTRIALISATION CENTRE

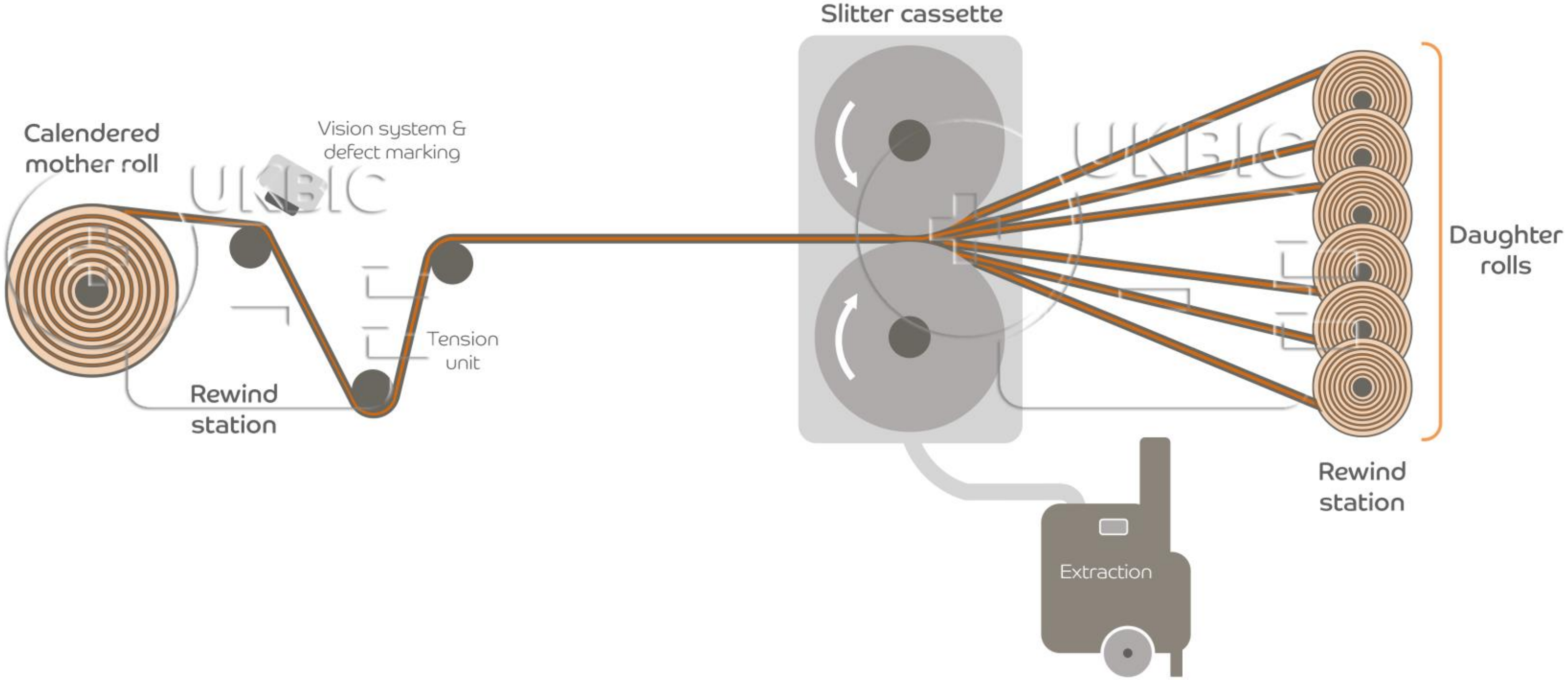
Cell Assembly

Slitting area

Electrode				Cell		Module	Pack
Mixing	Coating and Drying	Calendering	Slitting	Cylindrical / Pouch Assembly	Formation, Age & Test	Module Assembly	Pack Assembly

UK BATTERY INDUSTRIALISATION CENTRE

Slitting



Load calendered mother roll onto machine

Feed material up to the slitter cassette

Material is slit into strips

Material is rewound into daughter rolls

UK BATTERY INDUSTRIALISATION CENTRE

Slitting technologies

Main technologies:

- Rotating knives
- Laser Cutting

Key quality parameters:

- Slit width
- Burr size

Challenges:

- Uniformity
- Throughput
- Electrode deformation

Summary:

Cut electrode into final width ready for cell assembly

Electrode				Cell		Module	Pack
Mixing	Coating and Drying	Calendering	Slitting	Cylindrical / Pouch Assembly	Formation, Age & Test	Module Assembly	Pack Assembly

Cell Assembly

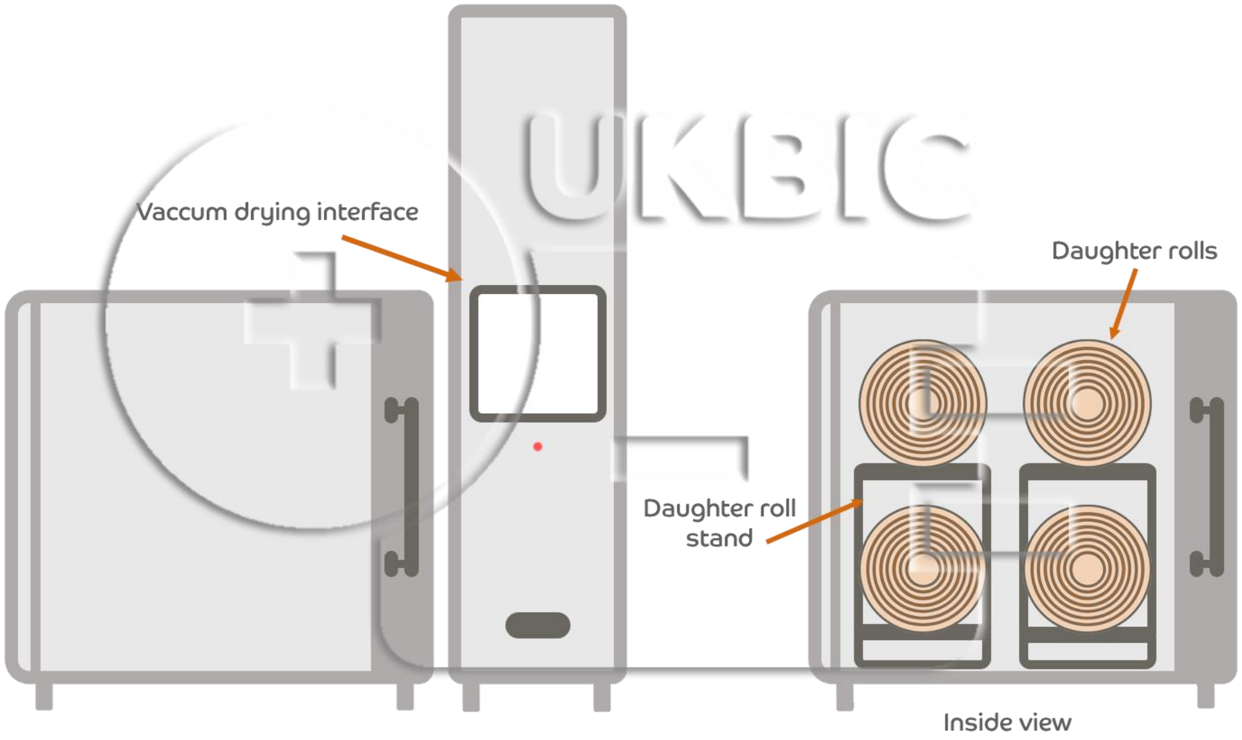
Cell assembly area

Electrode				Cell		Module	Pack
Mixing	Coating and Drying	Calendering	Slitting	Cylindrical / Pouch Assembly	Formation, Age & Test	Module Assembly	Pack Assembly

UK BATTERY INDUSTRIALISATION CENTRE

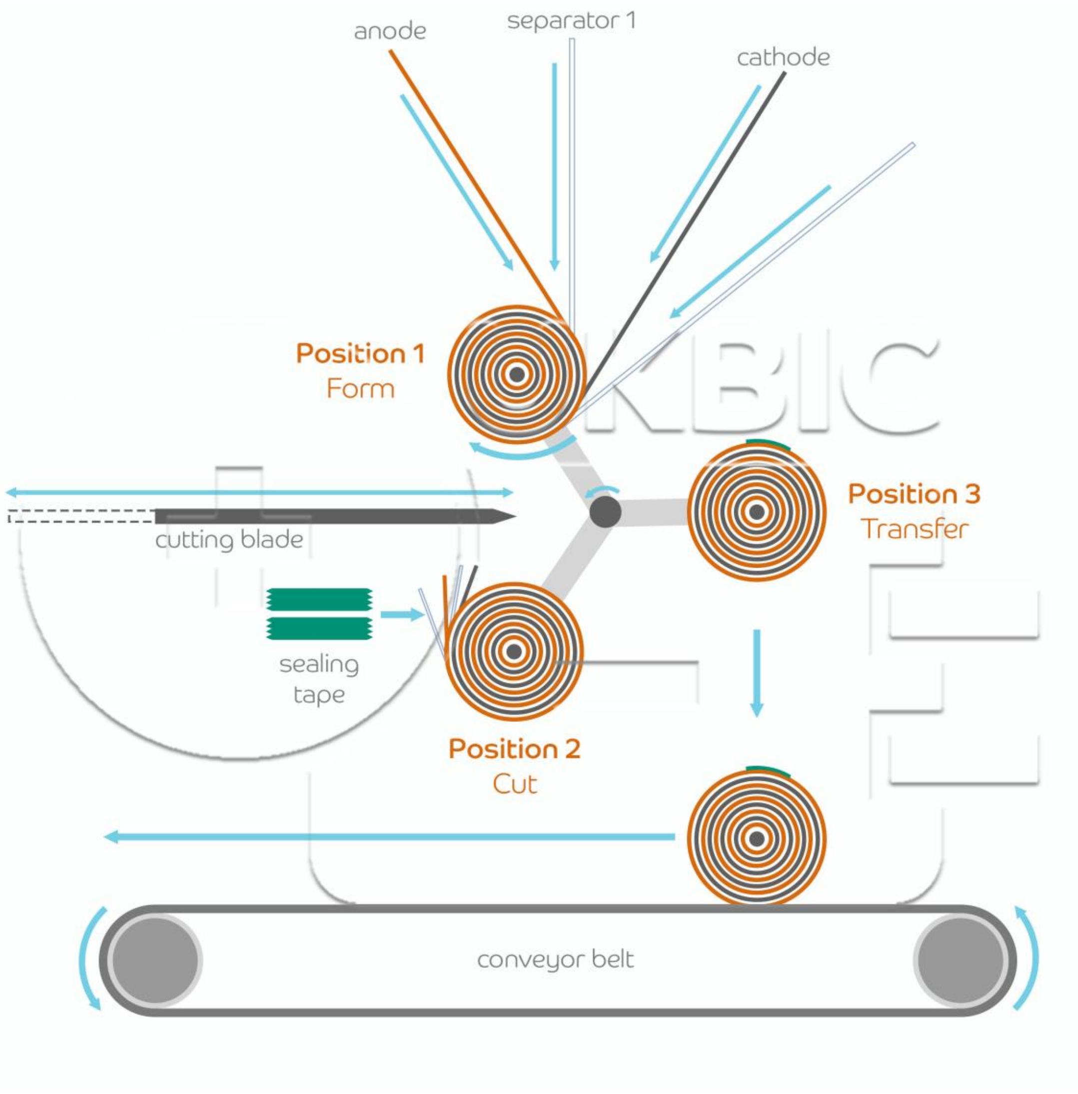
Vacuum drying

- Daughter rolls are loaded into the vacuum dryer to remove any remaining moisture
- Evaporation is achieved at high temperature and under vacuum



UK BATTERY INDUSTRIALISATION CENTRE

Cylindrical cell winding

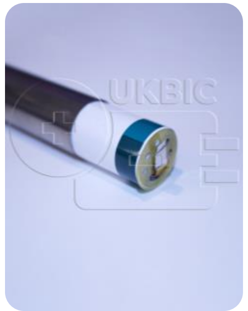


- Anode, cathode and 2 separators are wound together at position 1
- With all 4 elements still attached the coil of materials moves into position 2, during that movement a blade cuts through the material
- At position 2 green sealing tape secures the material in a tight coil
- This coil pack moves to position 3, where it is lowered on to a conveyor belt and loaded into trays ready for assembly

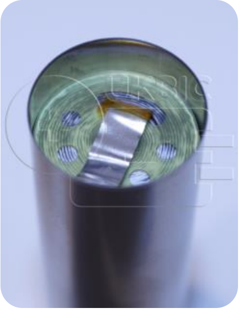
UK BATTERY INDUSTRIALISATION CENTRE

Cylindrical cell – packaging & filling

An insulator is added at the bottom

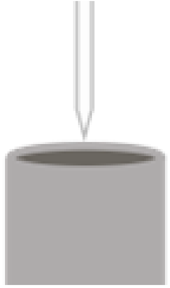


Coil pack is inserted into metal can and printed for ID

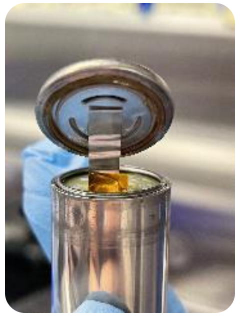


Anode tab is welded to base of can and a top insulator is added

A groove is formed at the top for rigidity and location of the cap



The can is filled with electrolyte



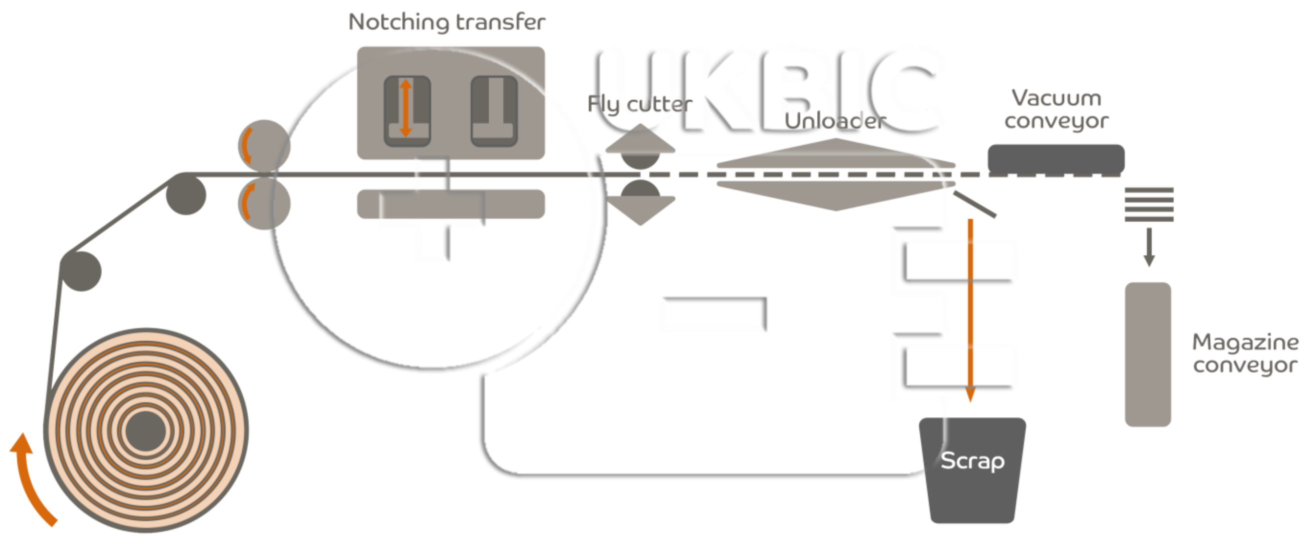
The cap is welded onto the cathode tab

The cap is crimped in place and the cell is sealed

The can is washed, sleeved, and printed with identification

UK BATTERY INDUSTRIALISATION CENTRE

Pouch notching



Daughter rolls are unwound and fed through the notcher

The electrode tabs are stamped out

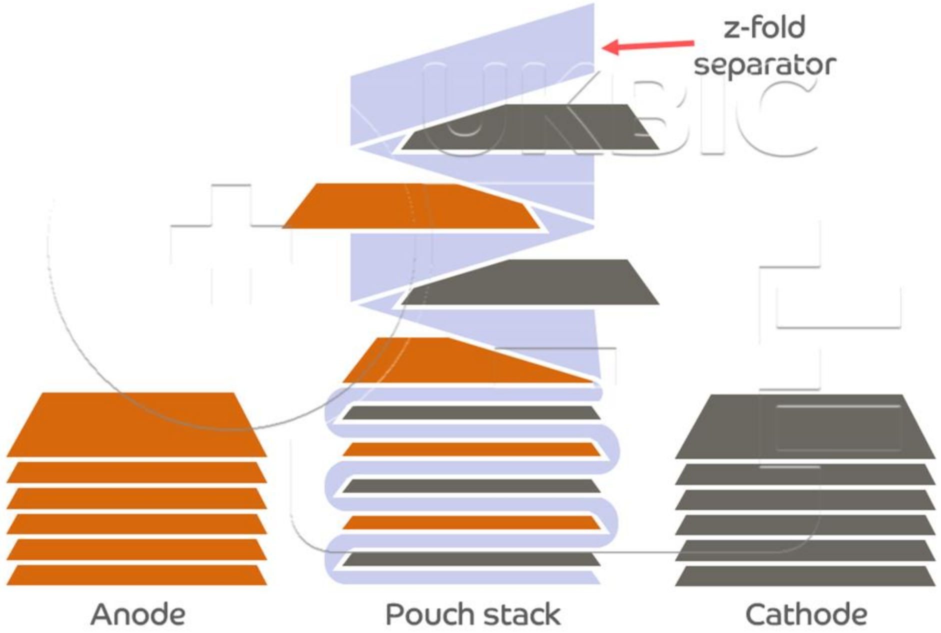
Each electrode is cut into individual pieces

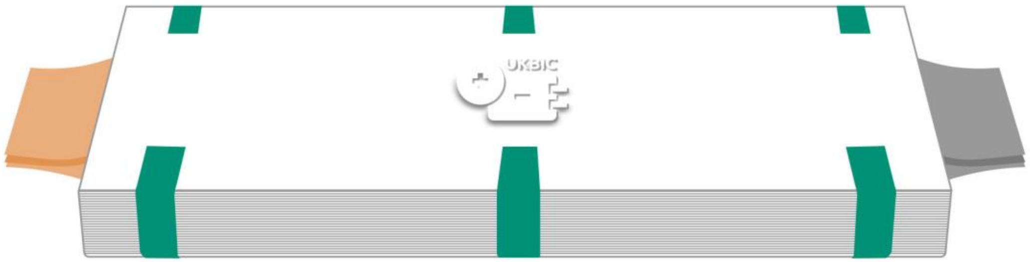
Good material is stacked in the magazine

The magazine is transferred to the stacker

UK BATTERY INDUSTRIALISATION CENTRE

Pouch stacking





Cut electrodes are separated and stacked

A single piece of electrode is placed in a…

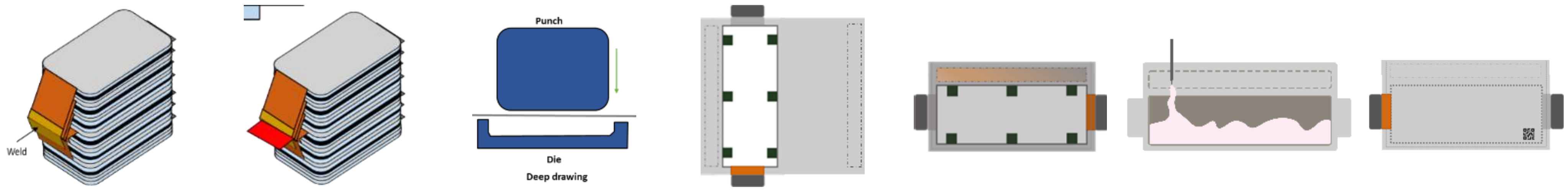
..continuous stack of separator material

The completed stack is wrapped in separator and taped to hold in place

This produces a pouch stack

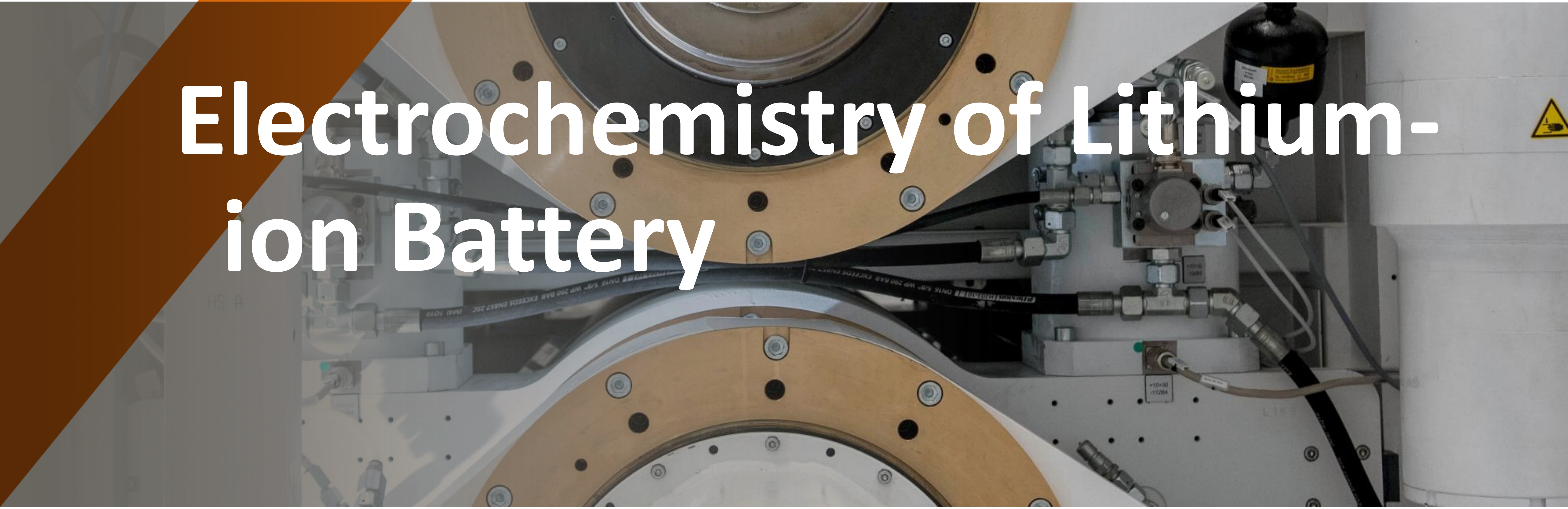
UK BATTERY INDUSTRIALISATION CENTRE

Pouch Stacking



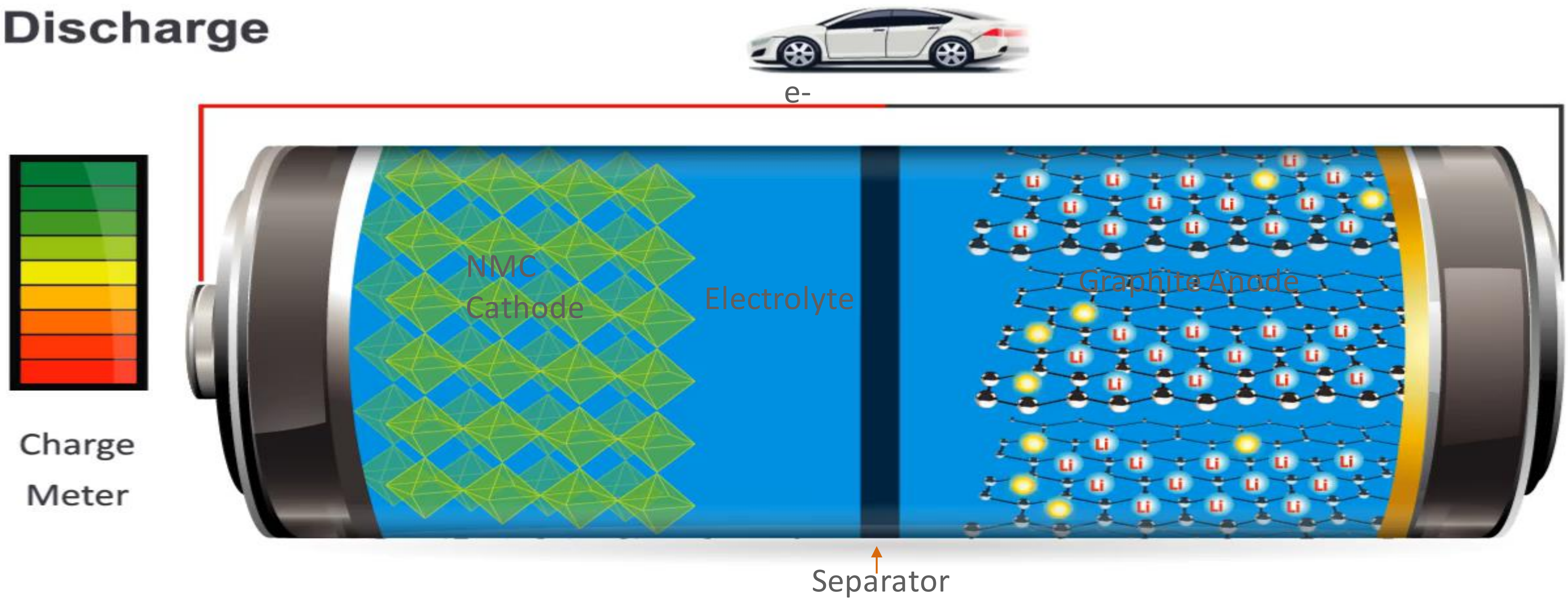
- Electrode ends are welded together, excess is trimmed off
- An additional tab is welded to the ends
- An Aluminium-polymer pouch is formed in a deep draw press
- Pouch stack is inserted into the pouch
- The Pouch is folded and sealed on 3 sides
- Pouch is filled with electrolyte by a needle and sealed
- The pouch is printed with a data matrix

Electrochemistry of Lithium-ion Battery



UK BATTERY INDUSTRIALISATION CENTRE

Principle Operation of LIBs



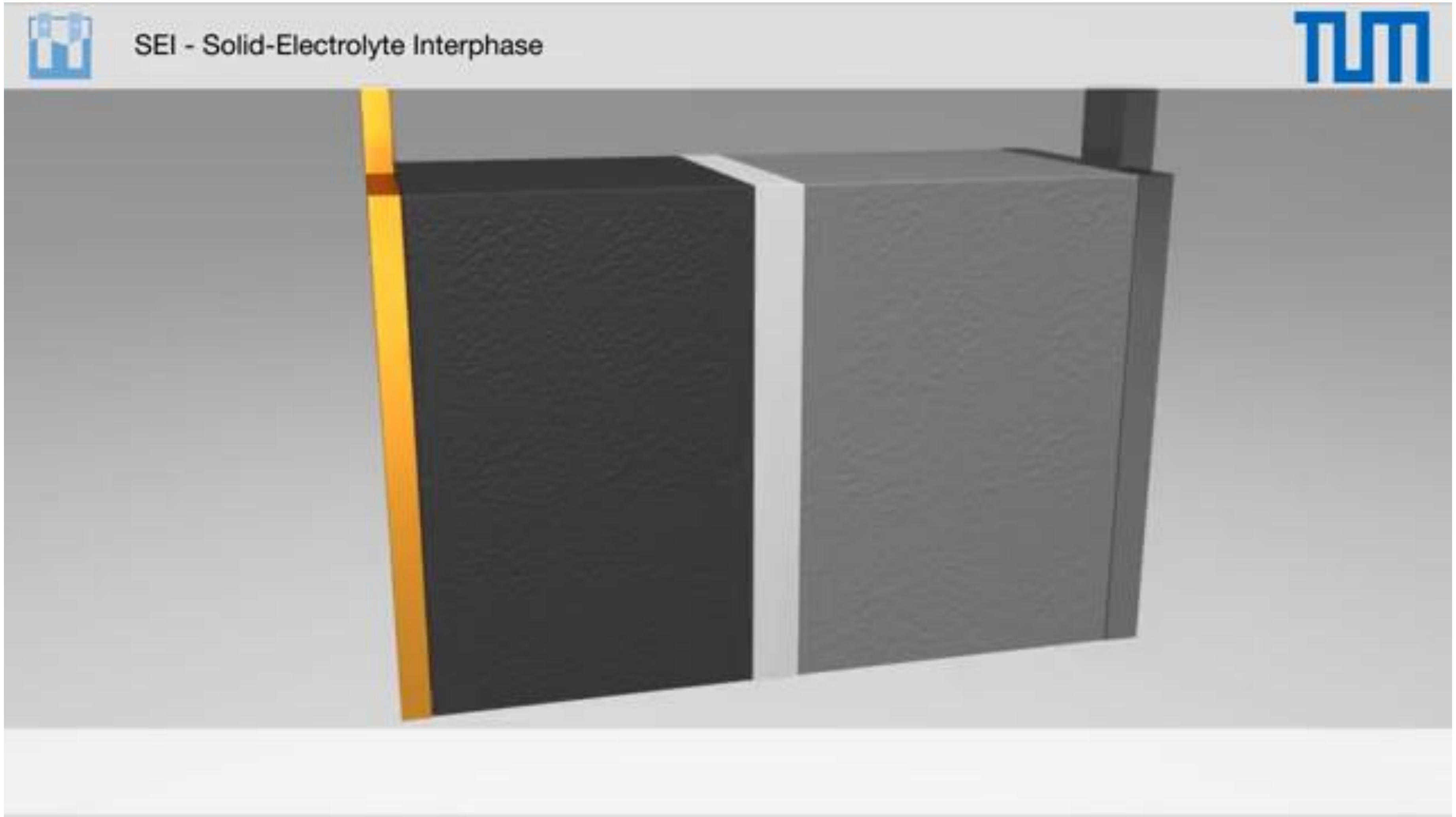
Lithium-ion "Rocking Chair"

Li^{+} cycles between anode and cathode, storing and releasing energy

Source: S. Harman, Renewable Energy Lab, USA

UK BATTERY INDUSTRIALISATION CENTRE

Solid Electrolyte Interphase (SEI)



F. Kindermann, Ing. Wolfgang, et al. Institute of Electrical Energy Storage Technology, TUM, Germany.

UK BATTERY INDUSTRIALISATION CENTRE

Example of Various Lithium-ion Battery Chemistry Comparison and Application

LI-ION BATTERY CHEMISTRY	NOMINAL VOLTAGE (V)	CYCLE (LIFE)	CHARGE CURRENT RATE (C)	DISCHARGE CURRENT RATE (C)	THERMAL RUNAWAY (°C)	PACKAGING (TYPICAL)	SPECIFIC ENERGY (Wh/Kg)	APPLICATIONS	REMARKS
Nickel Manganese Cobalt Oxide (NMC)	3.6 (3.0-4.2) range	1000+	0.7-1C	1-2C	210°C (410°F)	18650, 21700	150-220	E-Bikes, Medical Devices, EVs, Industrial	High-specific energy, Low self-heating rate
Lithium Iron Phosphate (LFP)	3.2 (2.5-3.65) range	2000+	1C	1C	270 °C (518°F)	18650, 32650, prismatic	90-120	Stationary Applications with high capacity, EV	Flat discharge voltage, high power, low capacity, safe
Lithium Nickel Cobalt Aluminium Oxide (NCA)	3.6 (3.0-4.2) range	500-1000	0.7C	1C	150 °C (302°F)	18650	200-260	Medical, Industrial, Electric Powertrain	Long life, fast charge, wide temperature range, safe & expensive
Lithium Titanate Oxide (LTO)	2.4 (1.8-2.85) range	3000-7000	1C	10C	Highest	Prismatic	50-80	Electric Vehicle and Energy Storage Systems	Highest capacity with moderate power
Lithium Cobalt Oxide (LCO)	3.6 (3.0-4.2) range	500-1000	0.7- 1C	1C	150 °C (302°F)	18650 Prismatic & pouch cell	150-200	Laptops, Mobile Phones, Tablets, Cameras	High energy, limited power
Lithium Manganese Oxide (LMO)	3.7 (3.0-4.2) range	300-700	0.7-1C	1C	250 °C (482 °F)	Prismatic	100-150	Medical Devices, Electric Powertrains, Power Tools	High power, less capacity; safer than LCO

Source: Ion-Energy.

UK BATTERY INDUSTRIALISATION CENTRE

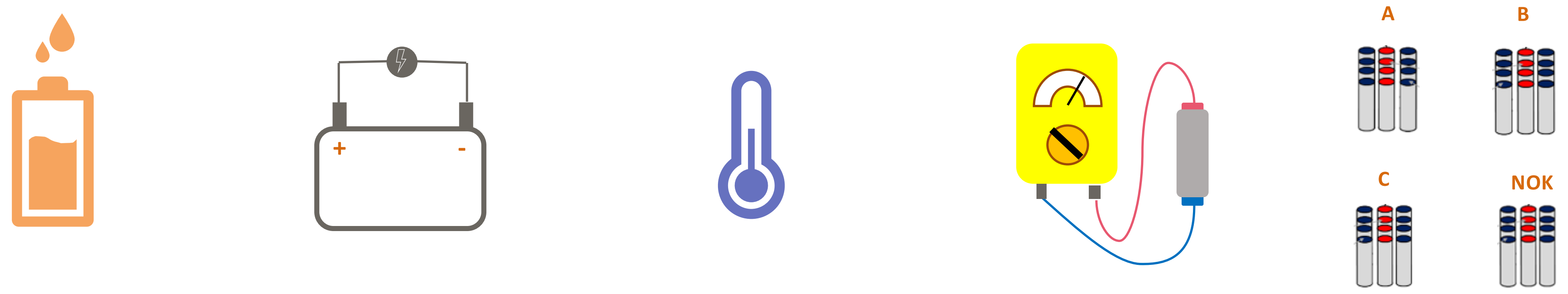
Formation, Ageing and Testing (FA&T)

Electrode | Cell | Module | Pack

Mixing → Coating and Drying → Calendering → Slitting → Cylindrical / Pouch Assembly → Formation, Age & Test → Module Assembly → Pack Assembly

UK BATTERY INDUSTRIALISATION CENTRE

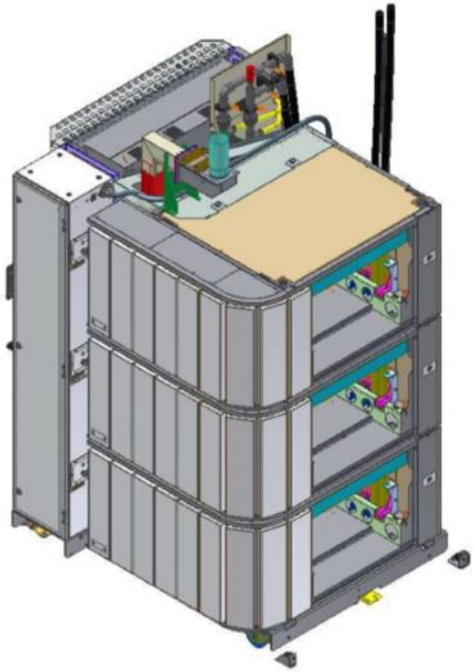
FA&T Process



Soaking	Formation	Ageing	Testing	Grading
Cells are left to soak to ensure the electrode leaves are fully soaked in electrolyte	Cells are charged and discharged. Charging forms the SEI	The partly charged cells are heated to crystallise and dissolve any contaminants	Cells are tested for OCV and DCIR	After testing, cells are grouped into similar characteristics

UK BATTERY INDUSTRIALISATION CENTRE

Formation



- Formation towers are autonomous units, where the cells are charged and discharged to alter the chemistry of the cells to allow them to be rechargeable.
- During formation, lithium ions are embedded into the crystal structure of the graphite on the anode. Here the SEI forms, an interface layer between the electrolyte and the electrode
- The towers also act as a fire box and can be closed off to contain a thermal event for about 14hrs
- There are separate towers for cylindrical cells and pouch cells. 2048 cylindrical cells can be processed at one time in trays. 360 pouch cells can be processed in pressurised racks.
- After formation, Pouch cells are degassed and the gas strip is removed

Ageing

- Ageing is the process of heating up cells to form crystals and dissolve them.
- Crystals form from unwanted inclusions within the cell.
- We can heat to NT (normal temperature upto 30C) or HT (high temperature upto 45C)
- Any combination of the above or no Ageing may be used, customer dependant

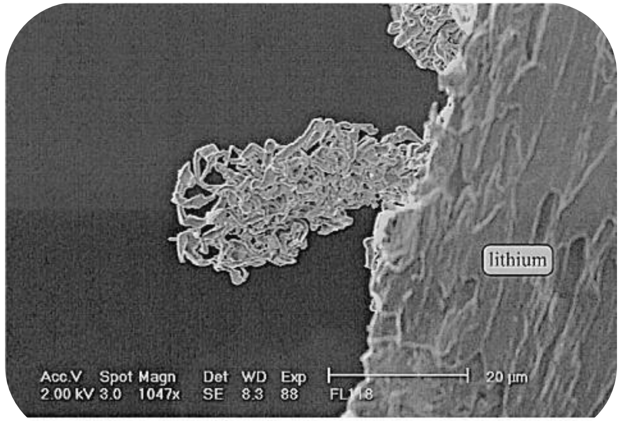


Fig. 8. Dendrite formed in a lithium battery after one charge at 2.2 mA/cm^2

UK BATTERY INDUSTRIALISATION CENTRE

Testing and Grading

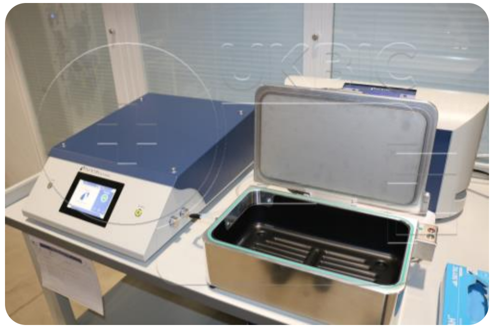
- Cells are tested for numerous characteristics:
  - DCIR
  - OCV
  - Self discharge rate
  - Charging efficiency
  - Charge/Discharge capacity
- Doing these tests helps to determine: energy density, lithium reduction and electrolyte deficiency
- From these results, the cells are graded to the customers requirements.
- Grades A, B, C, D and NOK (not ok)

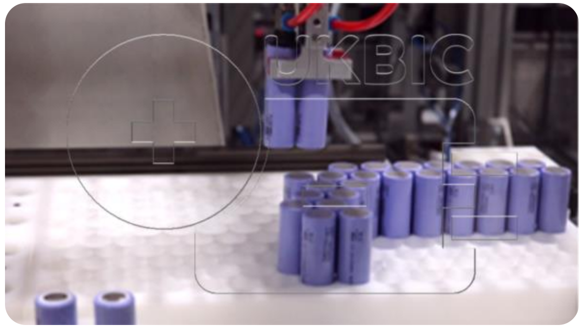
Module and Pack

Electrode				Cell		Module	Pack
Mixing	Coating and Drying	Calendering	Slitting	Cylindrical / Pouch Assembly	Formation, Age & Test	Module Assembly	Pack Assembly

UK BATTERY INDUSTRIALISATION CENTRE

Module line (cylindrical)





M1X-20-1 Cell decant

Cylindrical cells are removed from packaging and visually inspected for defects

M1P-80-1 Leak test

Cylindrical cells are loaded into a magazine which is then inserted into the leak tester. Cells are now analysed for any potential electrolyte leaks.

M1Y-40-1 Cell sorting & test

The magazine full of cells is now loaded into the robot. As the cells are drawn into the machine an OCV and resistance measurement is taken to asses the cells health. A vision system is also used to detect defects which could have been missed in previous processes. If passed the robot will automatically orientate the cell and place it into the correct position within the module casing. During this process the bar codes of each cell will be recorded into the HMI system for traceability.

Module assembly

M1X-150-1 Laser welding

Bus bars are now cleaned and added onto the cells into the specified locations. Module is then feed into the welder where bus bars are welded onto the individual cells connecting them together.

M1X-150-2 Wire bonding

Bus bars are now cleaned and added onto the cells into the specified locations. The module is then placed into the wire bonding machine where bus bars are connected to individual cells using aluminium wire.

M1X-200-1 MMU & sensor assembly

Welded modules will now have any additional sensors / cooling or LV harnesses added along with MMU (Module monitoring unit).

M1X-220-1 Final assembly

Final parts will now be added onto module and casing fitted

M1X-500-1 EOL tester

Fully assembled modules will be placed into the test chamber and connected to the test rig. Various tests can be preformed to asses the module is fit for purpose depending on customer requirements

UK BATTERY INDUSTRIALISATION CENTRE

Module line (pouch)

M1X-20-1
Cell decant

Pouch cells are removed from packaging and visually inspected for defects

M1P-80-1
Leak test

Pouch cells are loaded into the leak tester. Cells are now analysed for any potential electrolyte leaks.

M1P-60-1
Cell testing

Pouch cells are loaded into a testing jig where an OCV and resistance test is taken to asses the cells health.

M1P-60-2
Tab trimming

Pouch cells are loaded into a jig where tabs are trimmed to a predetermined length specified by the customer.

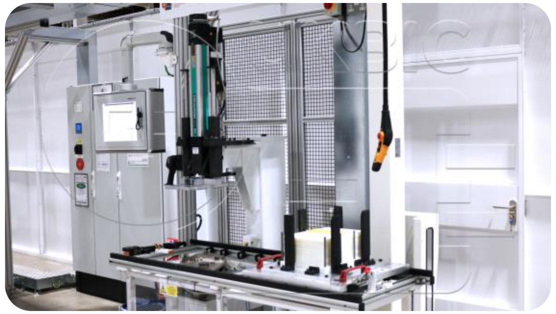
UK BATTERY INDUSTRIALISATION CENTRE

M1P-60-3
Tab bending

Pouch cells are loaded into a jig where tabs are bent to the correct angle predetermined by the customer.

M1P-60-1
Cell stacking

Pouch cells have a thermal adhesive pad applied and are stacked up inside of the module casing.



M1P-100-1
Tox press

Module is now loaded into Tox press with pouch cells stacked inside. Press will apply a predetermined pressure onto the pouch cells compressing them to a set thickness and height. Cage will be secured to keep level set before being moved to next process.

M1X-150-1
Laser welding

Bus bars are now cleaned and added onto the cells into the specified locations. Module is then feed into the robot where buss bars are welded onto the individual cells connecting them together.

M1X-150-1
Wire bonding

Bus bars are now cleaned and added onto the cells into the specified locations. The module is then placed into the wire bonding machine where bus bars are connected to individual cells using aluminium wire.

UK BATTERY INDUSTRIALISATION CENTRE

M1X-200-1
MMU & sensor assembly

Welded modules will now have any additional sensors / cooling or LV harnesses added along with MMU (Module monitoring unit). Once assembled a final OCV and resistance test is taken.

M1X-220-1
Final assembly

Final parts will now be added onto module and casing fitted.

M1X-500-1
EOL tester

Fully assembled modules will be placed into the test chamber and connected to the test rig. Various tests can be preformed to asses the module is fit for purpose depending on customer requirements.

UK BATTERY INDUSTRIALISATION CENTRE

Pack line

P1X-20-1
Pack sub assembly

Sub assemblies for the pack build are built up. Various sub assemblies could be made depending on pack design and specification.

P1X-40-1
Module and Cooling System Fit

Modules are now placed into the pack casing along with any cooling system components. Bus bars are added ready for connecting.

P1X-60-1
BMS and Cover Install

BMS is now installed into pack and all HV and LV connections are made before outer cover is installed to pack. Once cover is fully installed a Resistance and voltage test will be conducted to ensure pack is safe.

UK BATTERY INDUSTRIALISATION CENTRE

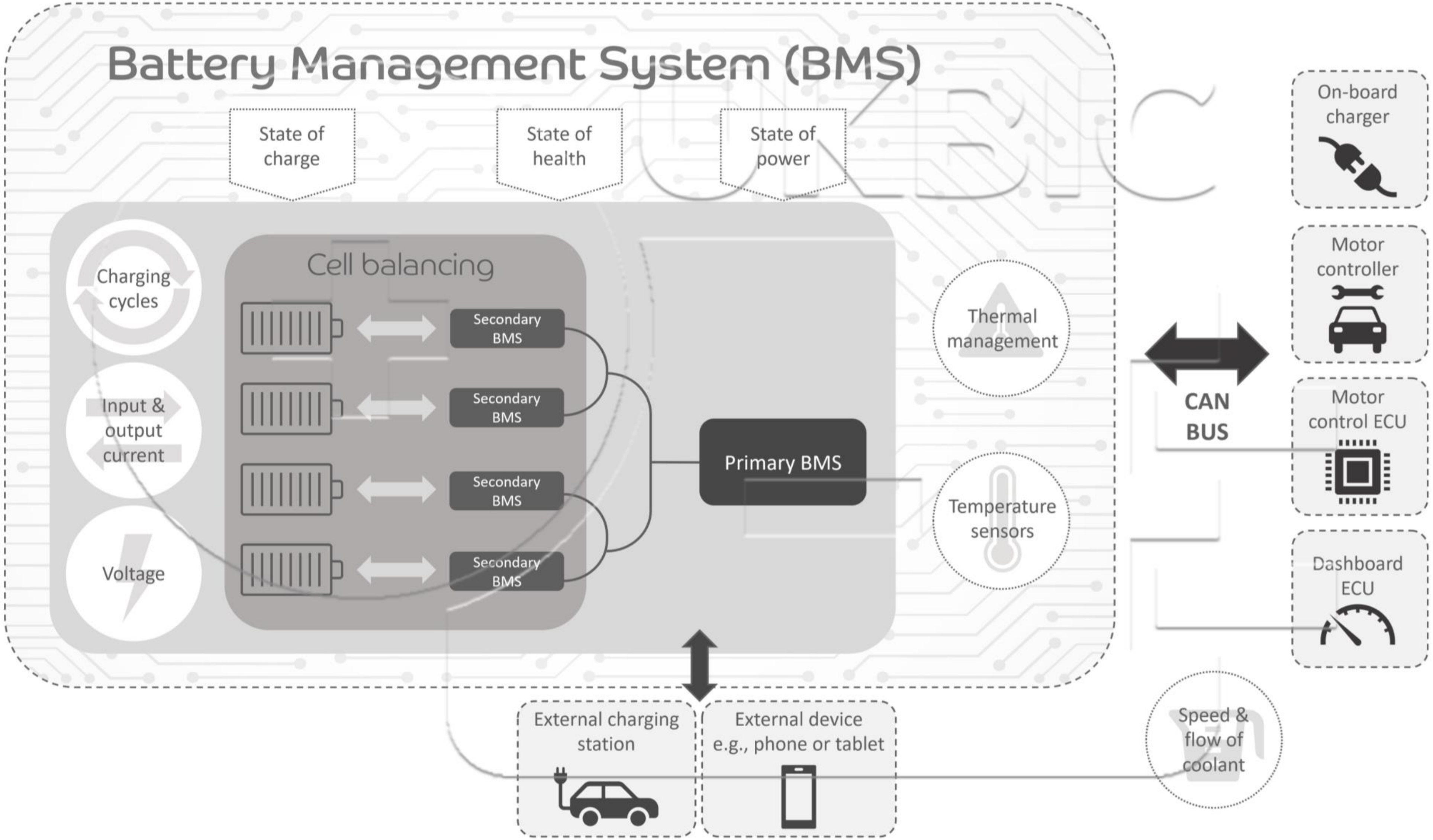
P1X-80-1
Leak test

Sub assemblies for the pack build are built up. Various sub assemblies could be made depending on pack design and specification.

P1X-500-1
Pack EOL Tester

Fully assembled Battery Packs will be placed into the test chamber and connected to the test rig. Various tests can be preformed to asses the module is fit for purpose depending on customer requirements.

UK BATTERY INDUSTRIALISATION CENTRE



UK BATTERY INDUSTRIALISATION CENTRE

Questions?

Electrode				Cell		Module	Pack
Mixing	Coating and Drying	Calendering	Slitting	Cylindrical / Pouch Assembly	Formation, Age & Test	Module Assembly	Pack Assembly