LEADING IN
PRODUCTION
EFFICIENCY

DÜRR

Solutions for the manufacture of electric vehicles and batteries

October 2019
Bietigheim-Bissingen

Andreas Schaal - Director

Agenda

1. Motivation
2. Battery Value Chain
3. Dürr Product Portfolio
4. Outlook

1

Motivation

Motivation

Key-drivers for E-Mobility: Leading to a reallocation of OEM investments

Infrastructure/Urbanization/Connectivity

- Necessity of a better, cleaner, smarter and connected mobility as well as infrastructure (esp. in cities)
- Changing perception (from ownership to access)
- Trend towards connected energy & mobility systems

Technology

- E-Mobility as basis for future mobility (autonomous driving)
- E-Mobility as precondition for future competitiveness and innovativeness

Economic factors

- Cost advantage of combustion engines shrinking rapidly (TCO advantage becomes a dominant factor from 2030 onwards)
- New business potential along the whole value chain

Ecological goals

- Climate change (2 degrees goal)
- Limited resources (oil)

Regulations & Subsidies

- VOC/CO_2 emissions regulations (CN & EU)
- Subsidies and buying incentives (CN & EU)
- National R&D funding for EVs
- Vehicle Fleet regulations (95g/km)
- New WLTP Standard

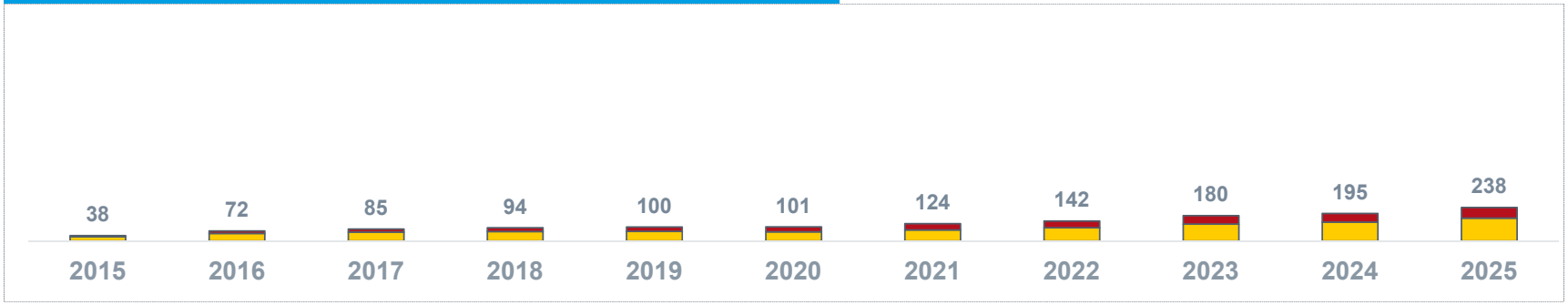
China as benchmark

- China expected to extend global leading position in E-Mobility
- New EV start-ups as a threat for traditional OEMs
- Clear and top-down political goals for E-Mobility growth

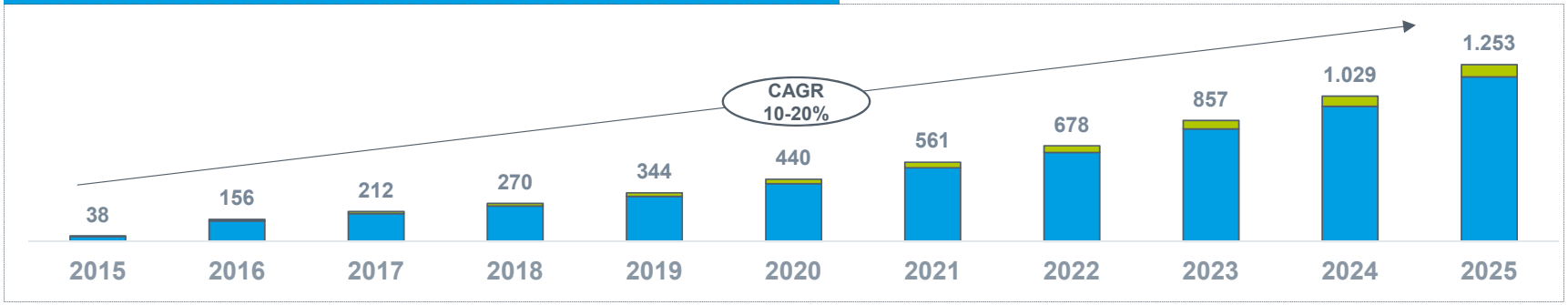
Market Potential Battery Assembly 2025

Predicted growth in GWh/a until 2025

Small-scale applications: Available production capacity [in GWh/a]



Large-scale applications: Available production capacity [in GWh/a]

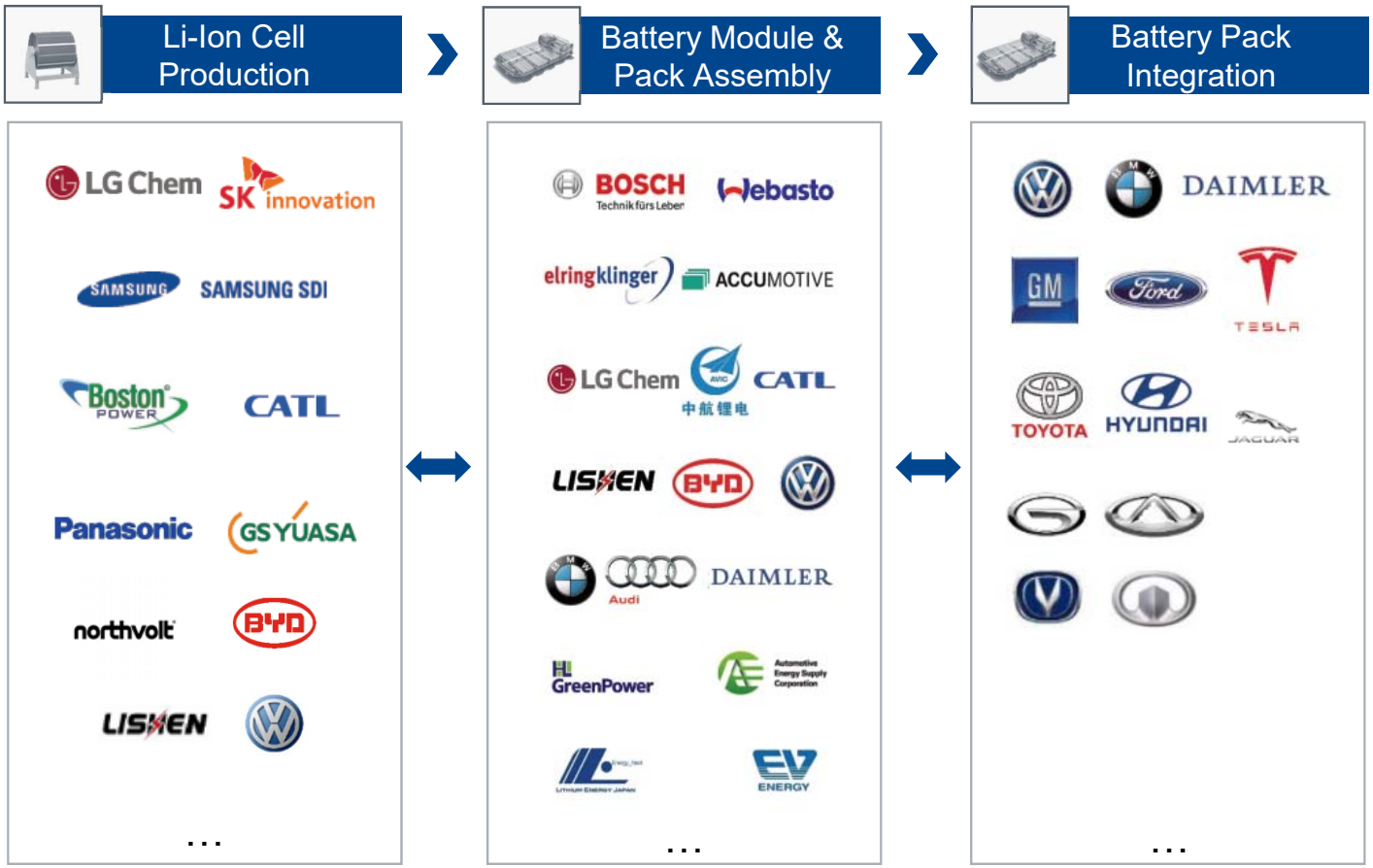


2

Battery Value Chain

Battery Value Chain

Varying customers depending on scope (extract)



3

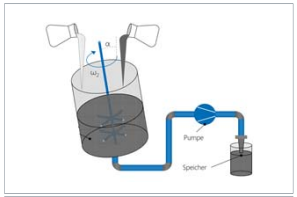
Dürr Product Portfolio

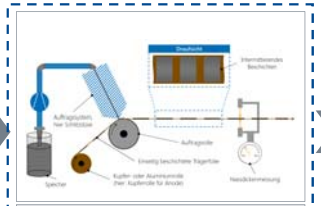
Dürr Product Portfolio: Li-Ion Cell Production

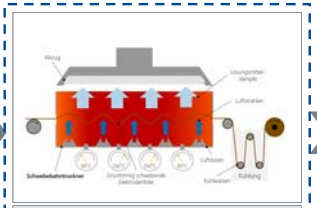
Focusing on coating, drying and solvent recovery

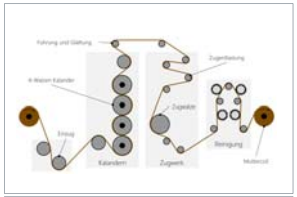
DÜRR Equipment

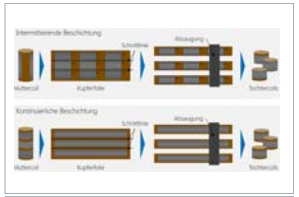
ELECTRODE MANUFACTURING

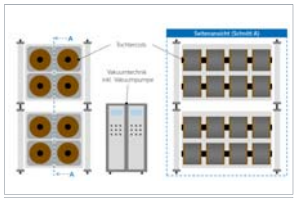

Mixing


Coating

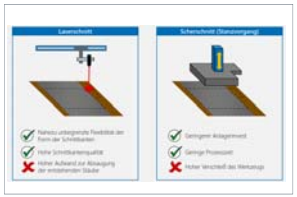

Drying & Solvent Recovery

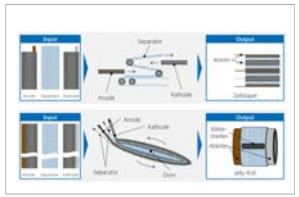

Calendering

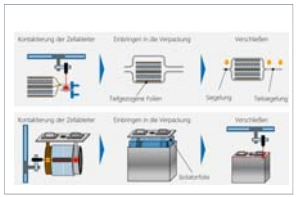

Slitting

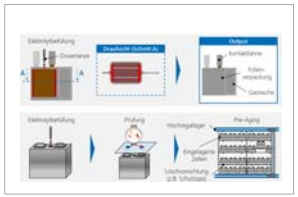

2nd Drying

CELL ASSEMBLY

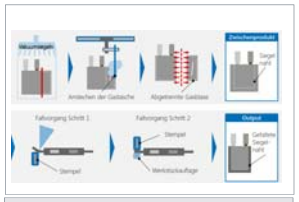

Notching

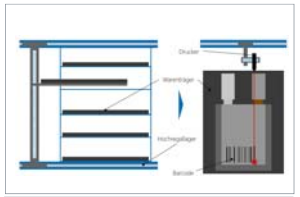

Stacking or Winding


Packaging


Electrolyte Filling

FORMATION & AGING


Formation


Aging and Grading

Dürr Product Portfolio: Li-Ion Cell Production

Li-Ion coating lines: Coater configurations

Single-Side Coater – 2 runs

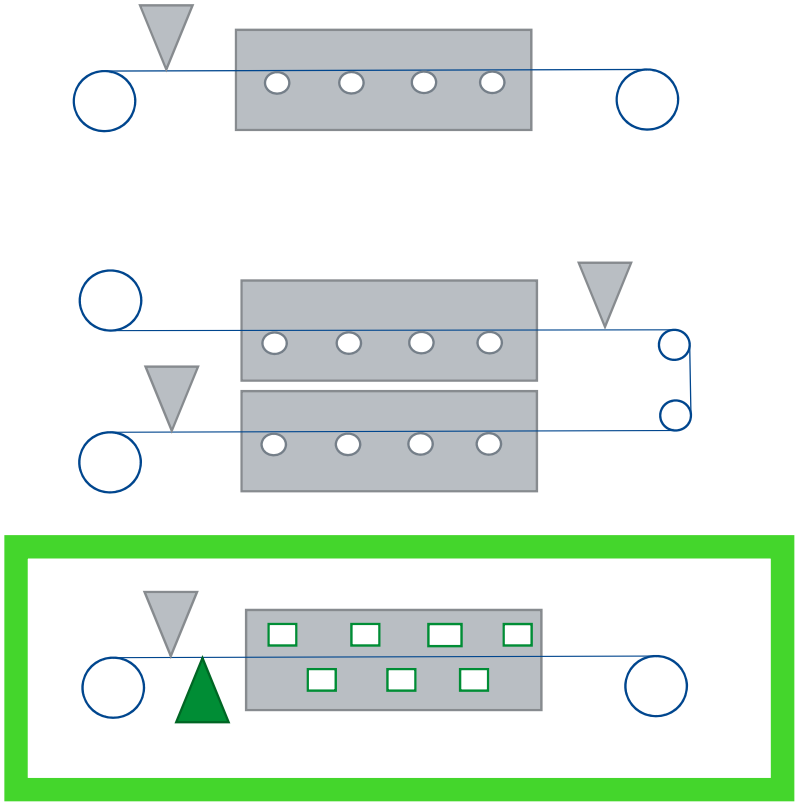
- Coat side A; dry; rewind
- Then coat side B; dry; rewind

Tandem Coater – 1 run for both sides

- Coat side A; dry; return
- Coat side B; dry; rewind

Simultaneous 2-Sided Coating

- Coat side A; coat side B; dry; rewind

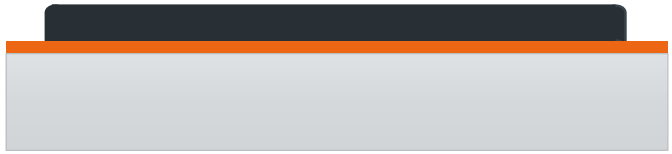


Dürr Product Portfolio: Li-Ion Cell Production

Li-Ion coating lines: Sequential vs simulaneous drying

Sequencial coating of 2 sides

coating side 1



after drying side **1**

coating side 2

edge curl: #1 Issue!

Quality

Less waste

Problems (and waste) in downstream processes

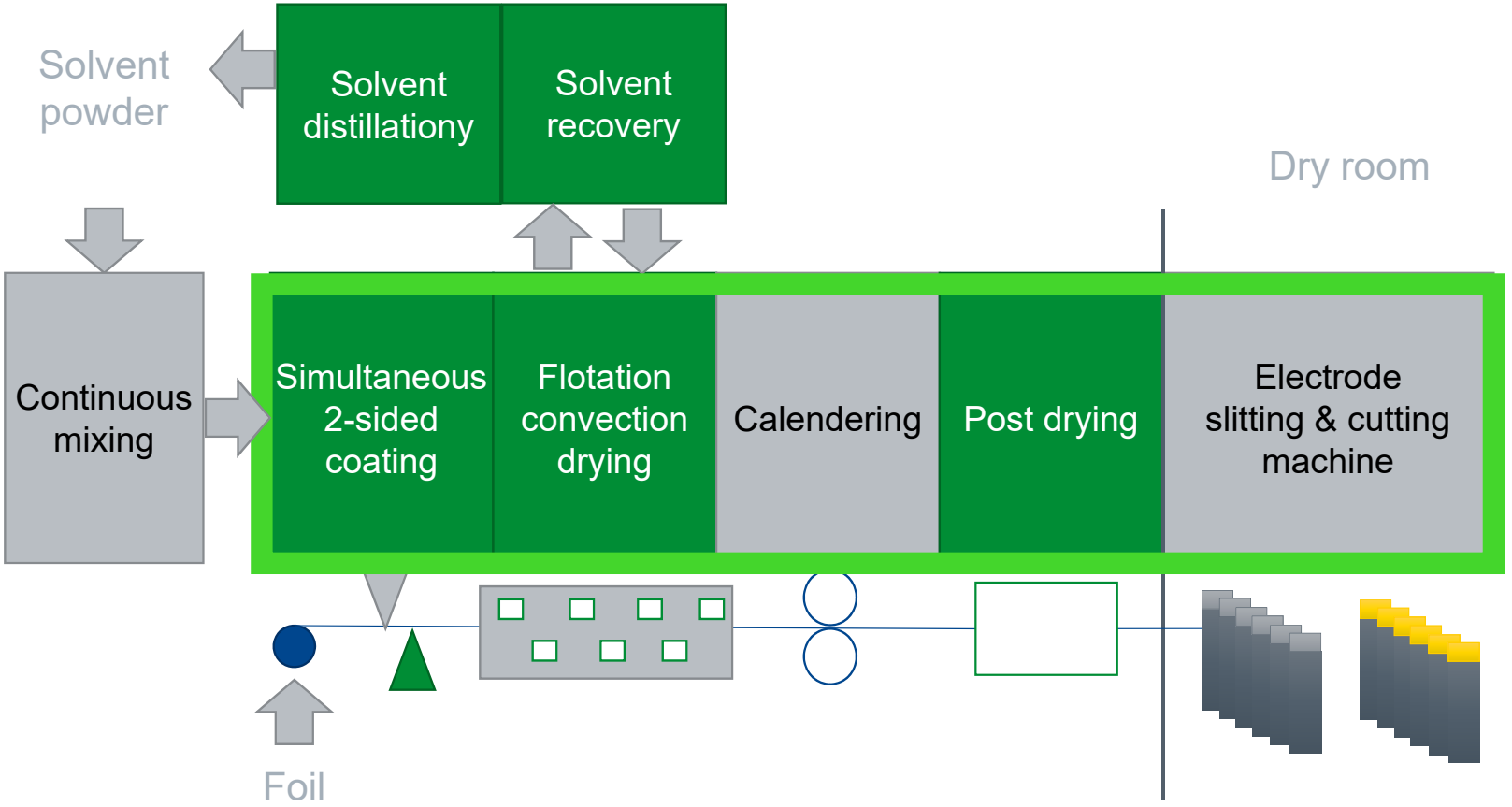
With simultaneous 2 sided coating

coating side 1 + 2

after drying

Dürr Product Portfolio: Li-Ion Cell Production

Process & physical integration - removal of intermediate steps



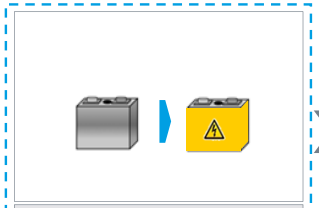
Dürr Product Portfolio: Battery Assembly Production

Focusing on can painting, gap filling, gluing, leakage testing & end of line testing

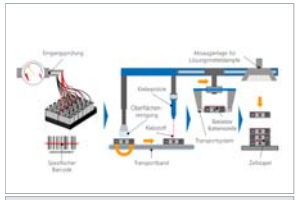
DÜRR Equipment

ASSEMBLY BATTERY MODULE

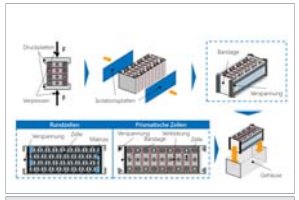
…



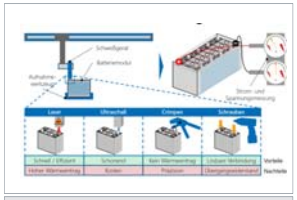
Insulation Can Painting



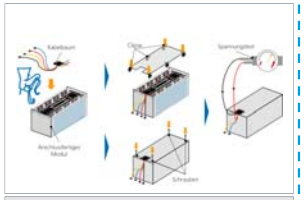
Unpacking & Check



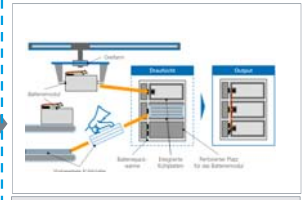
Module Stack



Interconnection of Cells



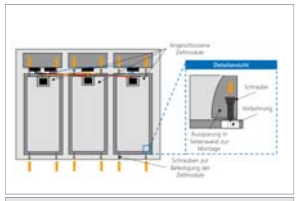
Closing & Testing



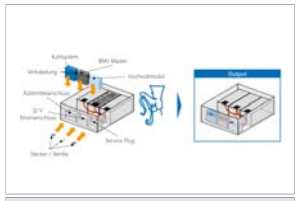
Inserting in Housing

ASSEMBLY BATTERY PACK

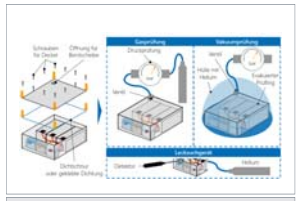
INTEGRATION



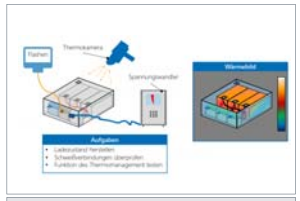
Connection of modules



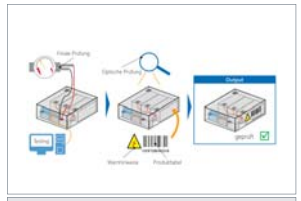
El. / thermal Integration



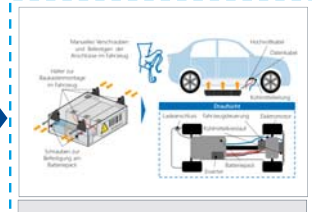
Closing & Leakage Test



Charge & Flash



End of Line



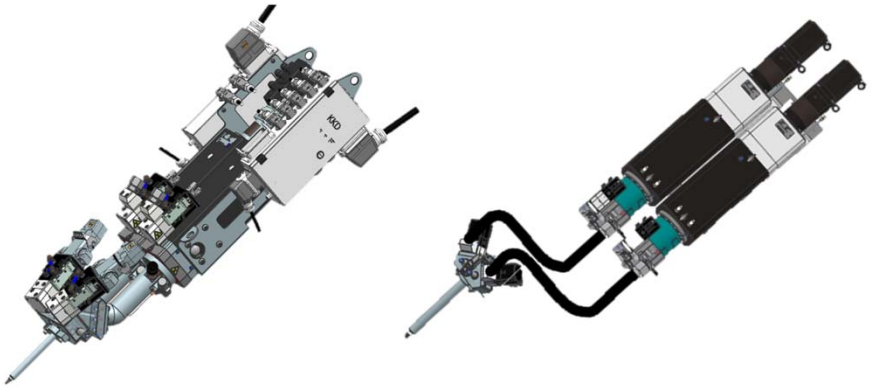
Integration

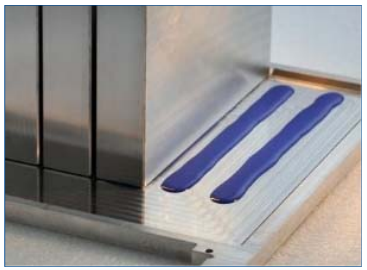
Dürr Product Portfolio: Battery Assembly Production

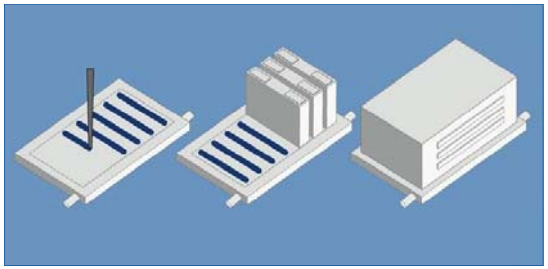
Bonding cooling find and battery stacks

- Pre treatment operations Cleaner, Primer, Plasma
- Filler material Aluoxid, Graphit etc…
  (unkritical – abrasion)
- Adhesives: 2-Components including thermal conductivity
- Pump: Standardsizes 20 – 200l

- Shotmeter: 2-Component
  - Size beginning at 10cm³
  - Materialflow < 1cm³/s
  - several mixing ratios
    (f.e. 1:1;1:2,1:4)







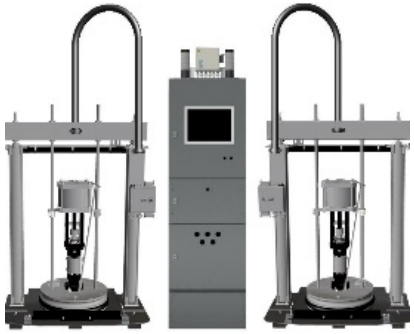
Quelle: pressebox.de, audi.com

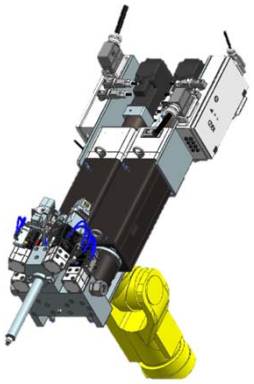
Dürr Product Portfolio: Battery Assembly Production

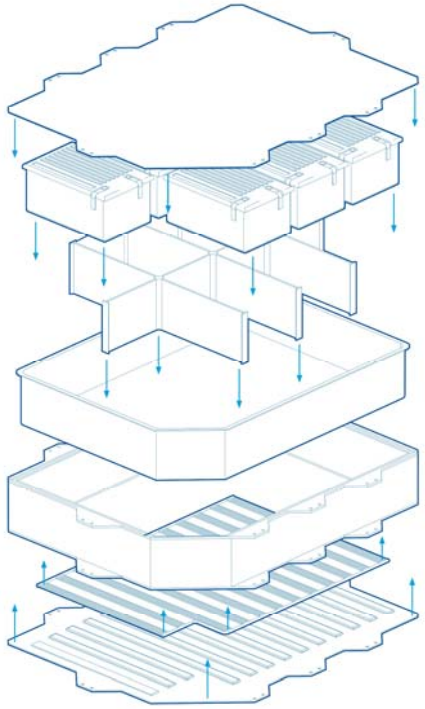
Application thermally conductive paste (gapfiller)

- Heat conduction out of batterycells
- Partial containing silicone
- Adhesives:1 or 2-Component thermally conductive paste with high density and high abrasive filler materials (Aluoxide-/hydroxide)
- Pump : Sizes 200l – 1000l

- Shotmeter: 2-Component
  - Size > 250cm³
  - Materialflow up to 30-40cm³/s (depending on used static mixer)







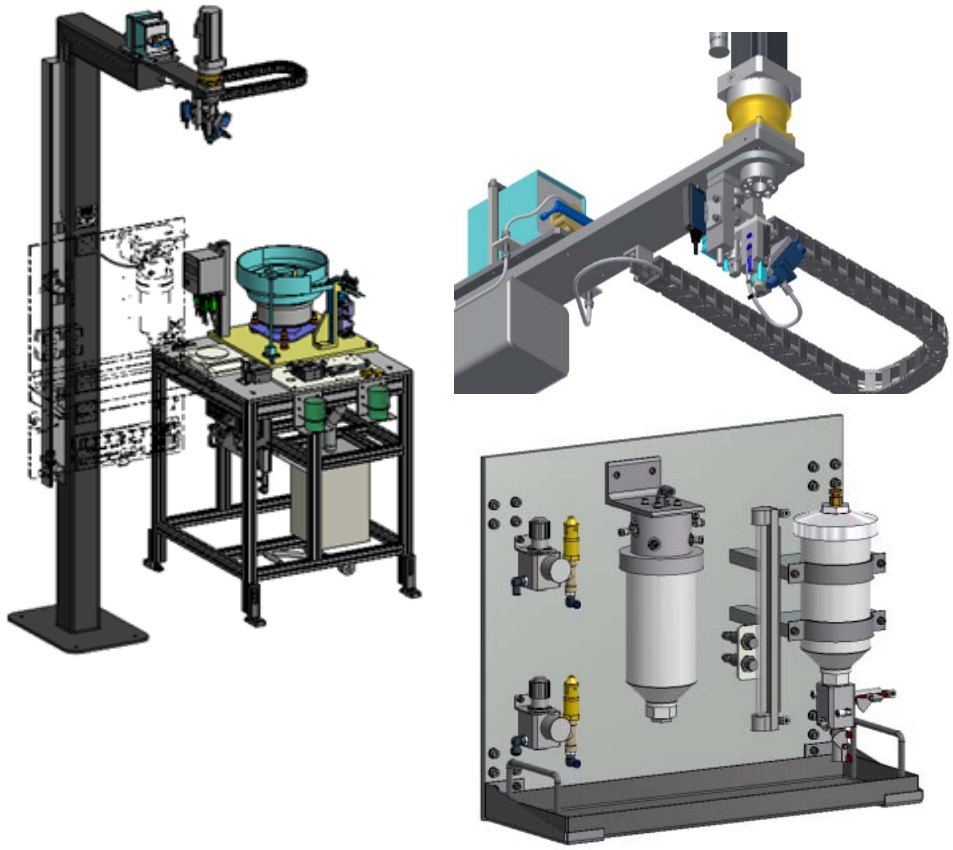
Dürr Product Portfolio: Battery Assembly Production

Pre-treatment for sealing process

- Pre-treatment system including material supply, felt exchange station, applicator and control system
- Cleaning, priming and activation

Nozzles

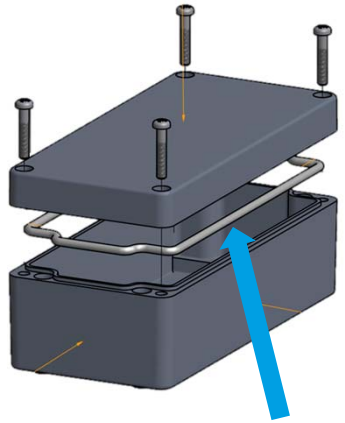
- Felt, brush & spray



Dürr Product Portfolio: Battery Assembly Production

Hot-Melt Cover Application

- Application temperature >140 -160°C
- Filling time < 30sec. (150cm³)
- Application material flow ~15cm³/sec.
- Single and tandem shotmeter
- Special Nozzle to avoid angel hair



sealing cord

Dürr Product Portfolio: Battery Assembly Production

End of Line Testing & Battery Pack Integration

High-Voltage End of Line Testing

- High-voltage circuits are in EVs are a particular focus in the End of Line testing
- The equipotential bonding test system ensures the conductivity of the connections between high-voltage components and the chassis

Battery Pack Integration

- Automated Batter Pack Integration in the Final Automotive Assembly
- References for several big OEMs (e.g. TESLA Fremont)

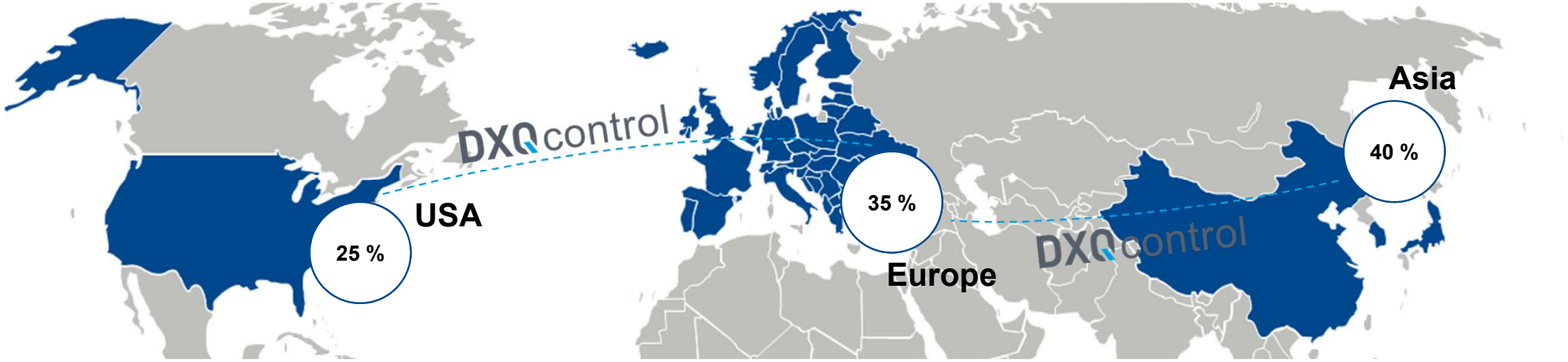
4

Outlook

Battery Assembly Outlook

Growing global market with strong focus on digitalization

Worldwide predicted allocation of battery productions around the globe



- Major worldwide volume distribution of electric vehicle battery manufacturing
- Dürr has competencies to support worldwide battery production and assembly business