Cell Welding in AVL Battery Development Process

18/11/2020, BI-REX - Bologna

Process Innovation and Industrialization

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Facts and Figures

Global Footprint

Represented in 26 countries

45 Affiliates divided over 93 locations

45 Global Tech and Engineering Centers (including Resident Offices)

1948

Founded

11,500

Employees Worldwide

10%

Of Turnover Invested in Inhouse R&D

70+

Years of Experience

65%

Engineers and Scientists

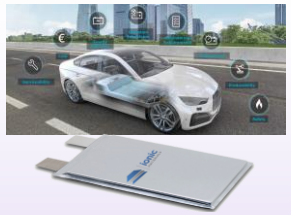
1,500

Granted Patents in Force

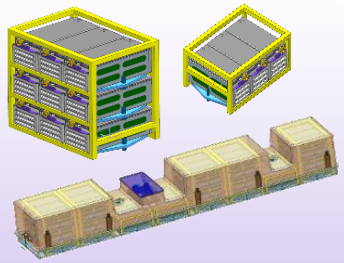
96%

Export Quota

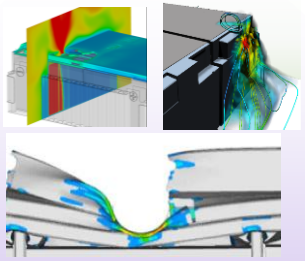
AVL Battery Competencies



Benchmarking & Battery Cell Research



Concept Development



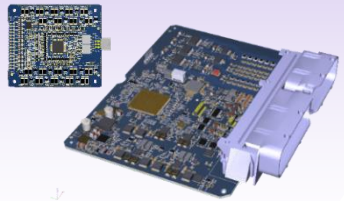
Module & Pack Simulation

Hardware Validation

Project References

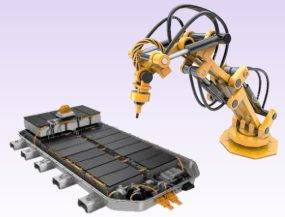
Battery Series Development

Battery Management System



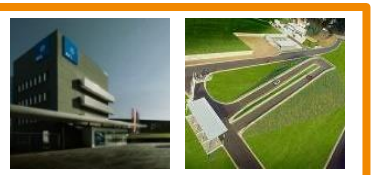
Prototype Built

Production & Cost Engineering



AVL supports **battery development** projects from first drawing to SOP with **battery module and pack development services**, as well as **BCU software** and **hardware**.

Global Battery Competence Team and Italian Branch


HQ Graz, **AUT**

Steyr, **AUT**


Budapest, **HUN**


Reggio Emilia, **ITA**

- 30 engineers on battery pack
- Full development capabilities
- 800 kW Climate container
- 50 battery prototypes for year
- Involved in 400V and 800V projects

Regensburg, **GER**

Remscheid, **GER**


Munich, **GER**


Södertälje,**SWE**

Istanbul, **TUR**


Basildon, **UK**


Coventry, **UK**


Ingolstadt, **GER**


Stuttgart, **GER**


Gothenborg, **SWE**


Massy, **FR**

Europe
Austria*
Hungary
Italy
France
Germany
Great Britain
Sweden
Turkey

Lake Forest, **USA**

Ann Arbor, **USA**

North America
USA

Asia
China
India
Japan


Delhi-Gurgaon, **IND**

Shanghai, **CHN**


Tokyo, **JPN**

> 400 engineers worldwide

> 10 years of experience

Battery prototype build and test facilities available

*Headquarters in Graz

Vehicle Recalls in 2020 for Battery Problems

Engadget

GM recalls 68,000 Chevy Bolt EVs after reports of battery fires

RNZ

Hyundai NZ recalls Kona electric car due to battery fire risk

Hyundai NZ recalls Kona electric car due to battery fire risk. 5:55 pm on 24 October 2020. Share this. Share on Twitter; Share on Facebook · Share via email ...

3 weeks ago

AutoExpress

Ford Kuga recall: Ford finds fix for faulty PHEV battery pack

The recall process was set into motion this summer, after Ford received four reports of Kuga PHEV models catching fire. The problem was ...

FleetNews

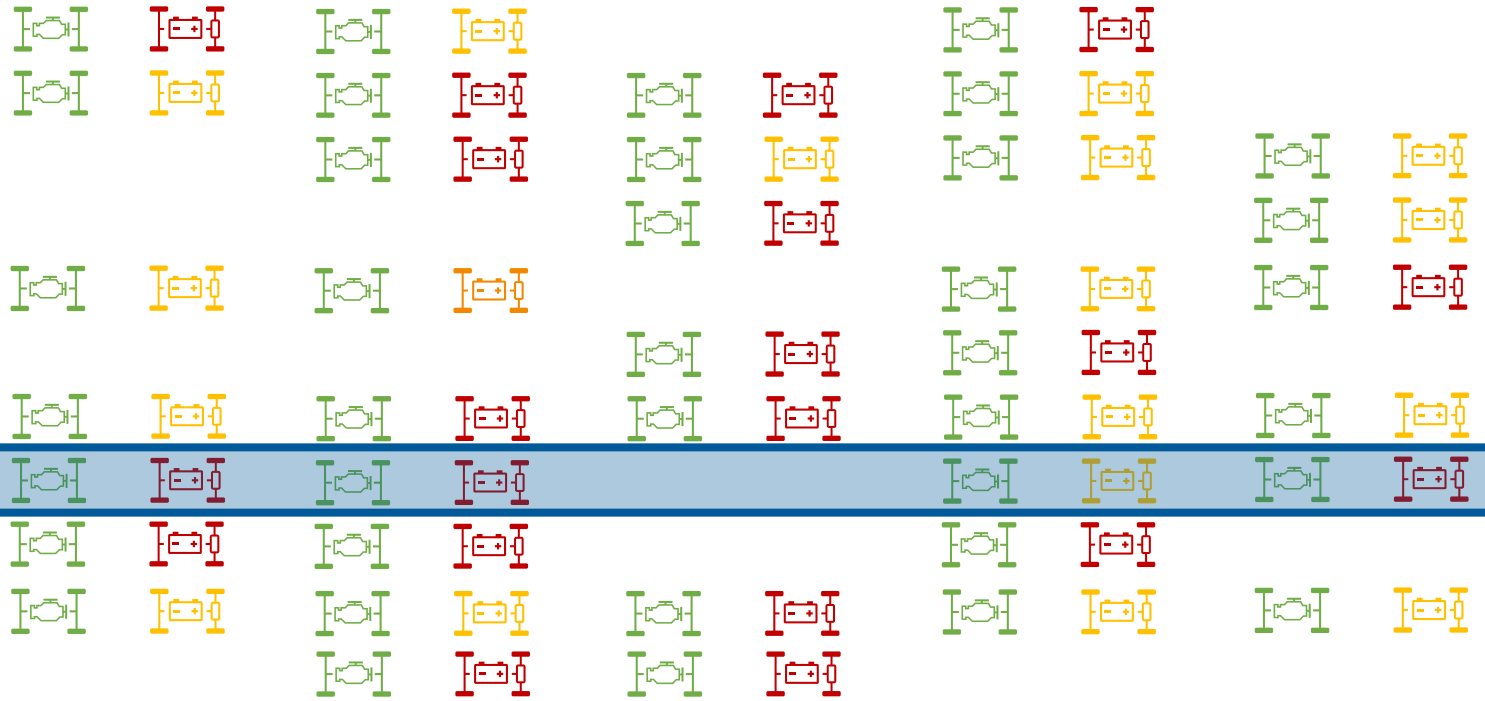
BMW recalls plug-in hybrid models due to fire risk

The recall affects plug-in hybrid versions of the 3, 5 and 7 Series, the X1, X2, X3 and X5 SUVs, the 2 Series Active Tourer and the Mini ...

Cell Welding influencing the electrical resistance and it could represent a trigger for Thermal Runaway

Conventional vs. Electrification - Production & Processes

Comparison	Modularity	Maturity	Volatility	Quality	Availability
Product architecture					
Assembly concepts					
OEM Assembly Standards					
Material Cost					
Component technology Concepts					
Quality Risks					
Supply Chain					
Welding technologies & Quality					
Gluing Processes					
Supplier Structure					
Process time					



Further Challenges for Traction Batteries:

- **Cost**
  -Dominance of cell costs
- **Safety & Quality Challenges**
  -Multiple, high-volume manual assembly steps
  -High Volume cell testing
  -EoL test concepts
- **Supply Chain Challenges**
  -Make-or-buy module / pack
  -Non-automotive supplier development

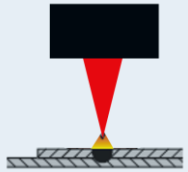
Welding in Electrification is not robust yet as in the Conventional Vehicle

Cell2Cell (Module) Manufacturing Core Technologies

Core Process	Issue/Challenge	Solution Approach	Activity during Development
Cell Testing	Automation to achieve cycle times & reliability	High-speed reading & automated handling of cells	Principle tests carried out within automated cell testers
	Automated check against outgoing inspection values	Big data competence	Currently built up
Stacking	Handling & alignment	Process (IP) development	Testing of production principle
Cell gluing	Application of correct amount / component tolerances	Application development w/ suppliers	Application development w/ suppliers
Welding	Cycle times, weld quality	Build-up of specific welding know-how, partnerships	Welding equipment & parameter tests
EOL testing	Cycle times vs. investments	EOL testing time minimization	Incremental test program development

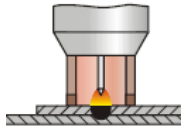
Areas of Innovation

Cell to Cell Welding Technologies Landscape



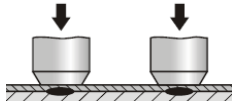
Laser Welding

+ High flexibility (thickness, mat. & combinations)
+ High speed operation
+ Different welding seams geometries
+ All cell types
± Low maintenance efforts
– Very high investment



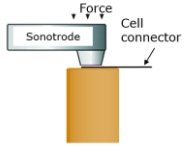
Micro Tig Welding

+ Prototype production
+ Low investment
– Long tact time (1 sec)
– Less electrical connection area
– High cleaning efforts
– Mainly cylindrical cells
– Limitation busbar thickness



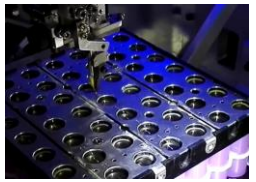
Resistance Welding

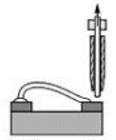
+ Very low investment
– Longer tact time (1 sec)
– Electrode cleaning
– Heat impact on cells
– Mainly cylindrical cells
– Limitation busbar thickness



Ultrasonic Welding

+ Flexible material thickness
+ Low heat impact
– High holding force
– Sonotrode cleaning
– High investment
– High efforts clamping/fixation





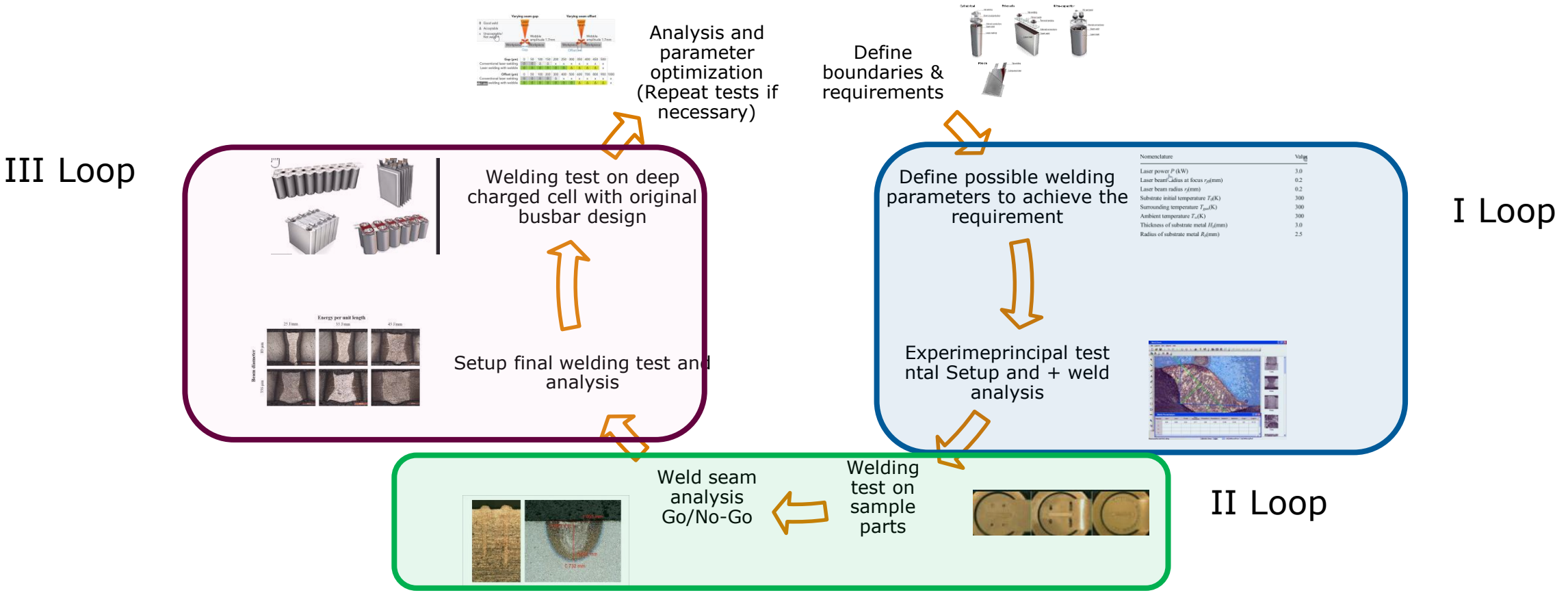
Wire Bonding

+ No melting of cell pole
+ Flexible material thickness
+ Low heat impact
– Less electrical connections area
– Cleanliness requirements
– High investment
– High efforts clamping/fixation

Welding Development Process

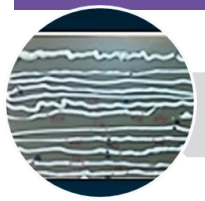
PRODUCT DEVELOPMENT PROCESS

Product Feasibility | Concept Design | Prototype Development | Development & Series Preparation | Product Validation | SOP | Product Life Cycle



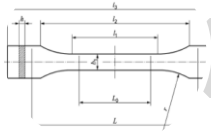
Component Testing & Welding Assesment
Battery Development

Characterization Adhesive, Foam & Sealing



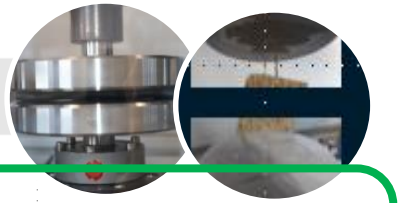
Hardness testing & curing time

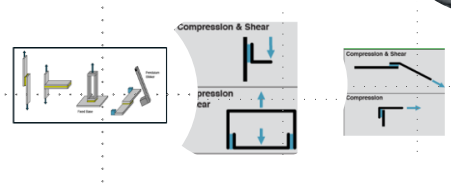
Shrinkage & thermal expansion



Tensile Test

Compression Tests



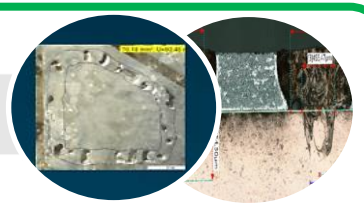


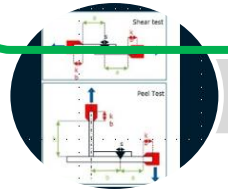
Pull, Shear, Peel Tests

Weldability test

Welding test on machine

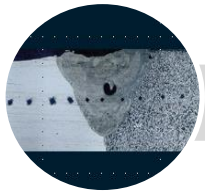
Micrograph Analysis





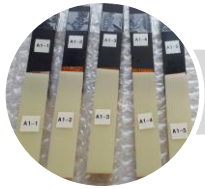
Shear peel test

Heat impact measuring



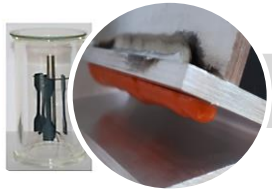
Hardness Profile

Simulation Validation in Component Level



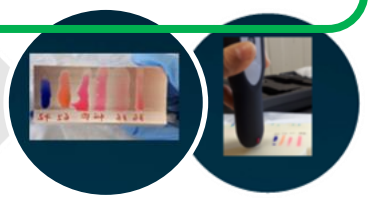
Lap-Shear Test (EN 1465)

Bonding Force Evaluation



Compatibility Test

Surface tension and pre-treatment



Qualification norms: BS EN 15614, EN 287, EN ISO 9606, BS 4872, ASME Section IX, CAA A8-10
Fabrication norms: PD5500, EN 13480, EN 13445, BS 4515, EN 1011, BS5400, DIN 6700, ASME B&PV Section VIII, Section III, Section XI, B31.1, B31.3, B31.4, B31.8, AWS D1.1, API 1104, API 510, API 620

AVL Battery Innovation Center:
Fusion of Function & Process Development

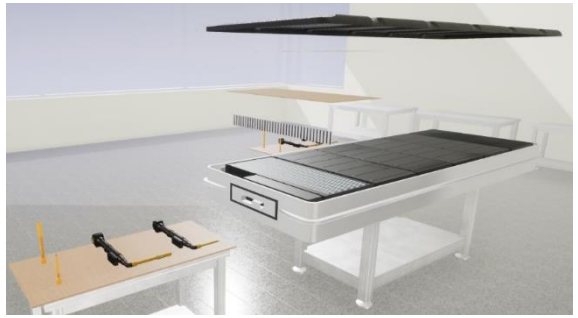
Flexibility in Manufacturing

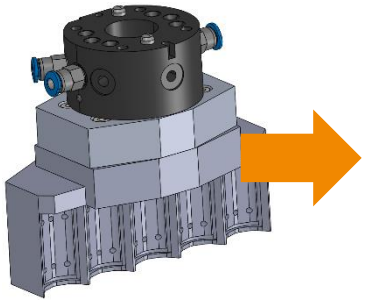
- Flexible center for production-oriented manufacturing of proto battery modules and packs
- Process development for specific assembly procedures in battery production
- Close loop feedback to product development (DfM - Design for manufacturing)
- Serve higher volumes in A- & B-samples
- Provide capacity for field test fleets, racing series and C-samples
- Provide industrialized designs and processes "ready for ramp-up"
- Leveraging of Engineering Business for battery development
- Verify Eco-Design products in respect to recycling and cost

VARTA micro innovation · ROSENDAHL NEXTROM KNILL GRUPPE · manz passion for efficiency · COMAU · Aalto University · TU Graz

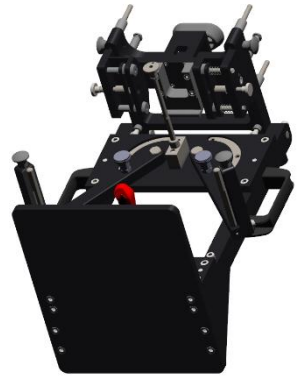
Virtual Steps in Industrialization for Welding Process Validation in Manufacturing

- VR concept review
- Preview of steps
- Safe worker training





- 2-part head / gripper design
- additive manufactured Grippers
- Robots within A-sample assembly



- Innovative processes
- Rapid Tooling
- VR manufacturing instructions
- Worker training on new parts or hazard steps

Thank you

www.avl.com

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