RI.
SE

An overview of RISE's research in adhesive bonding, welding and mechanical joining

Svetskommissionens forskningsseminarium
Kista, 2025-10-16

Oscar Andersson, RISE

A united force for a better future

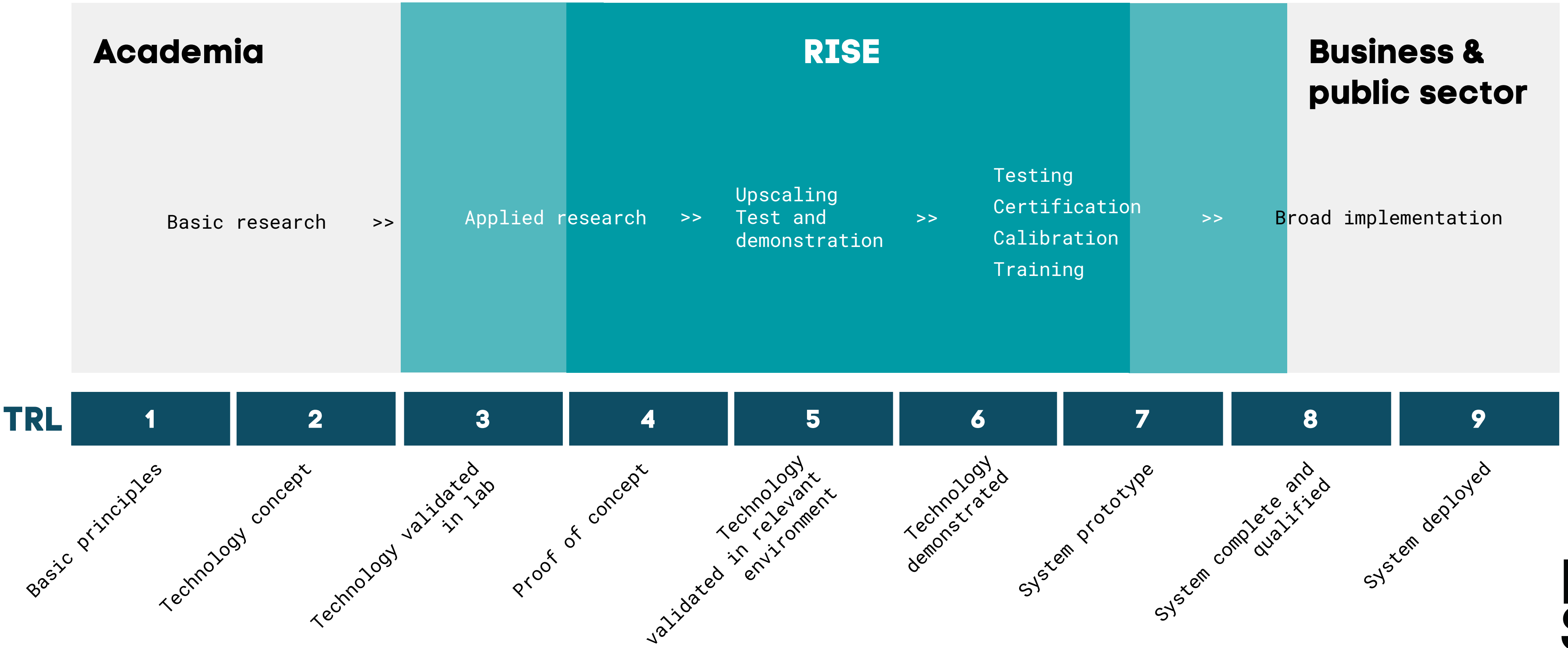
An introduction to RISE – Research Institutes of Sweden

RI.
SE

Sweden's research institute

- We are a state-owned company with approx. 3,300 employees who contribute to transforming knowledge from research into new products and services.
- Our mission is to work with our customers and partners to develop competitive solutions that drive sustainable development forward.
- With our unique breadth and collective expertise, we can take a systemic perspective on complex sustainability issues.
- In our more than 130 testbeds and demonstration environments, products and processes of the future can be tested and scaled up.

RISE in the innovation value chain

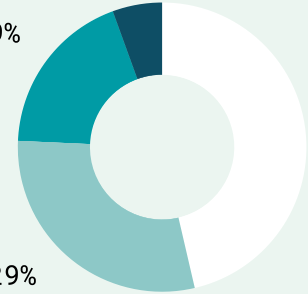


4,212

SEK million, net sales

Operating results: 74 SEK million

Operating margin: 1,8%



Distribution of net sales

Business sector	1,953 MSEK
Public funds	1,236 MSEK
State funds	789 MSEK
EU funds	234 MSEK

Approx.

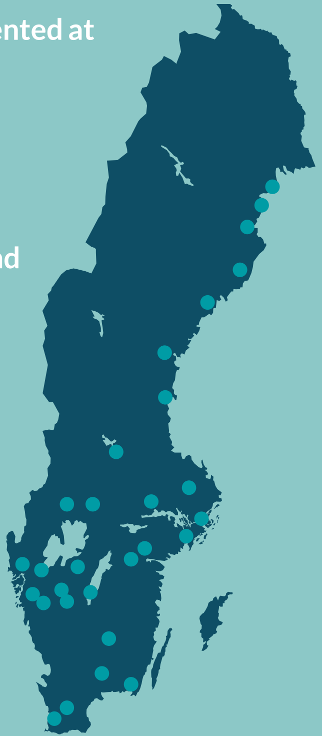
3,300

employees

We are represented at

35

locations around Sweden



130+

Testbeds and demonstration environments

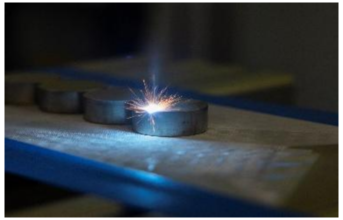
77 (2024)

Customer Satisfaction Index

All data refers to 2023.

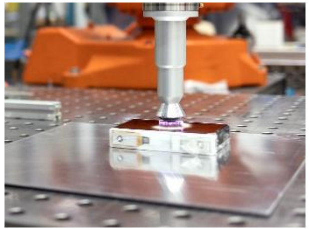
Test bed for joining RISE Mölndal

Pre-treatment with laser



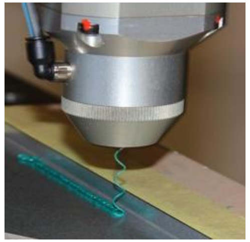
- Pre-treatment and cleaning of metallic surfaces
- Improved adhesion

Pre-treatment with plasma



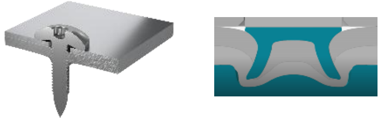
- Pre-treatment and cleaning of plastic surfaces
- Improved adhesion

Adhesive bonding



- Strong joints
- Mix-material joining

Mechanical joining

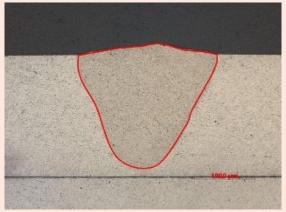


- Mix-material joining
- Dismountable joints

Robots for automatization

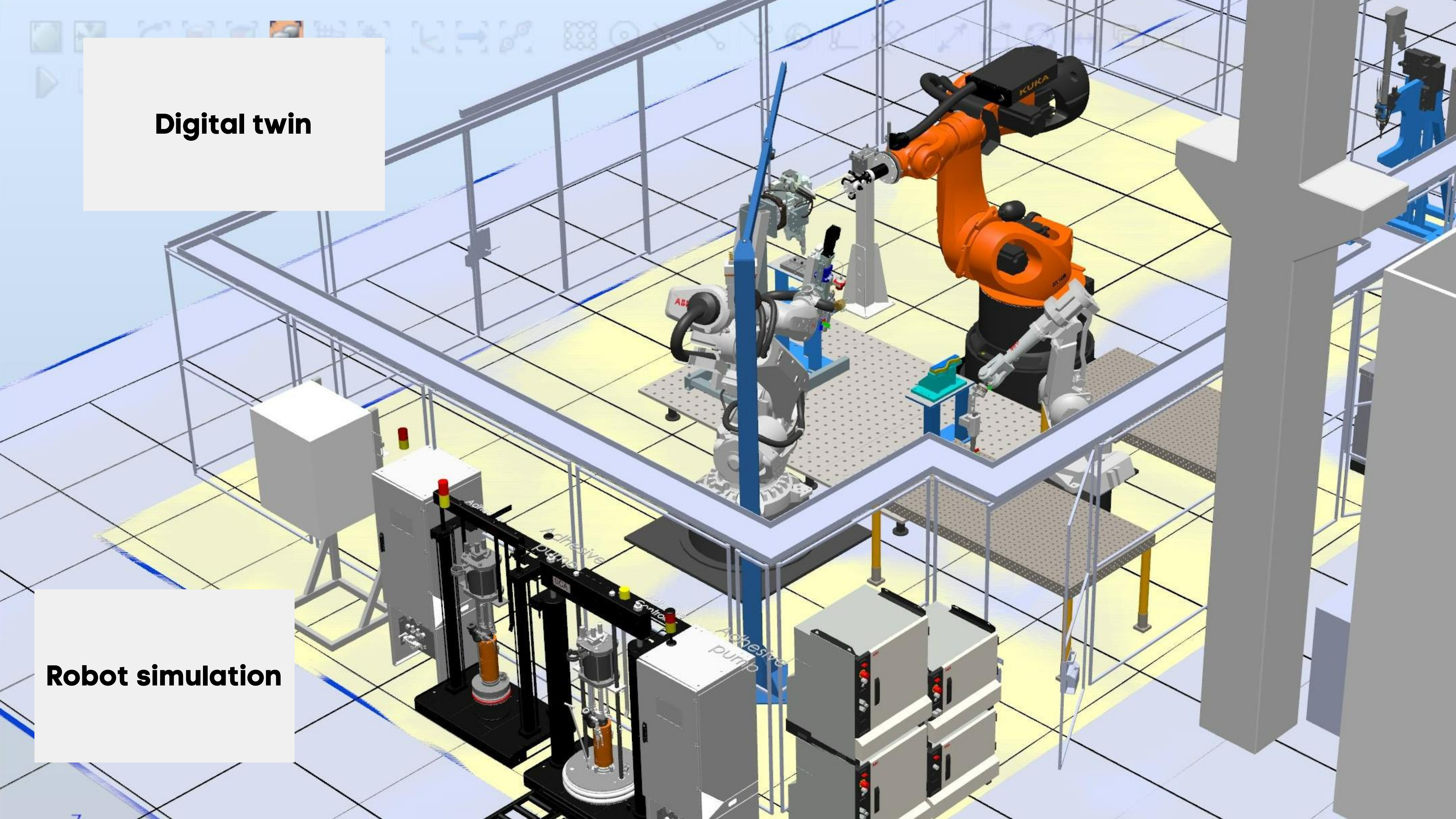
- Automized processes
- Industrial robots

Welding



- Analysis and evaluation of welds

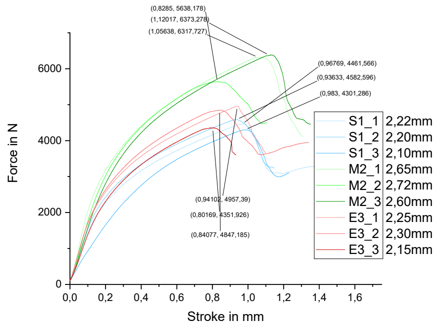
Digital twin

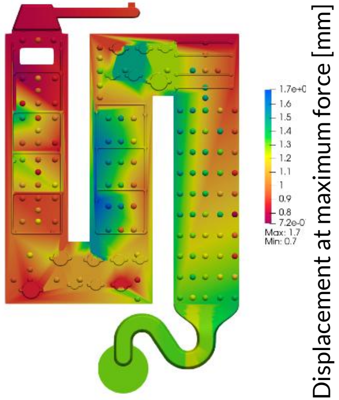


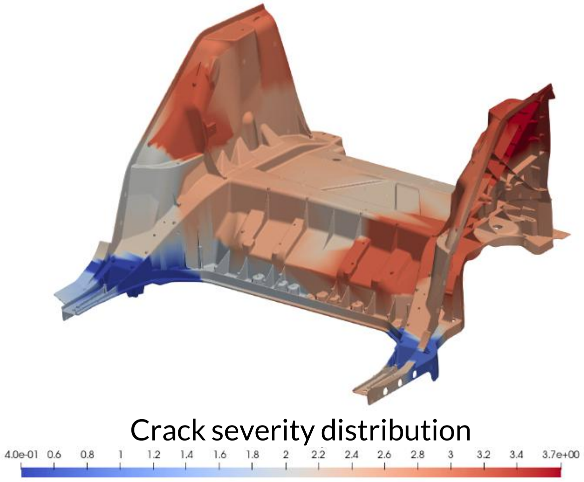
Robot simulation

Robust mechanical joining of cast aluminium parts (RobuCAP)

- Focus on joining of aluminium megacasting components to steel sheets.
- Challenge with cracks in joints.
- Factors that affect joint quality
  - aluminium ductility.
  - casting flow length.
  - porosity and microcracks.
- Follow-up project focusing on quality assurance methods and efficient joinability testing.







Crack severity distribution

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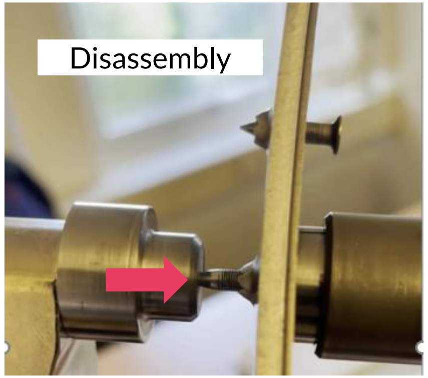
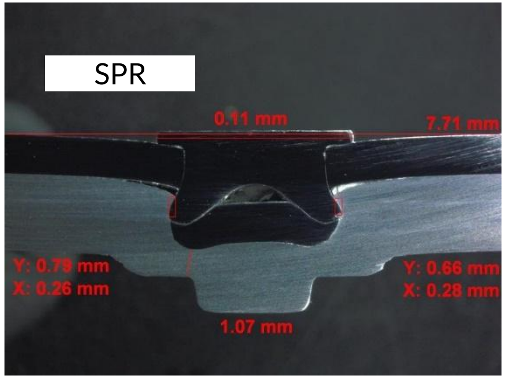
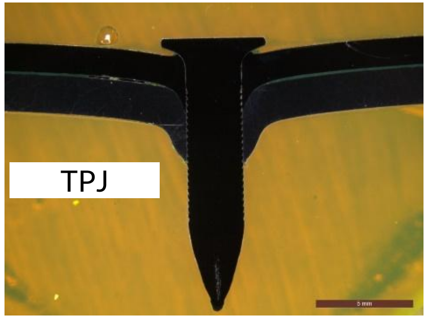
Fordonsstrategisk Forskning och Innovation

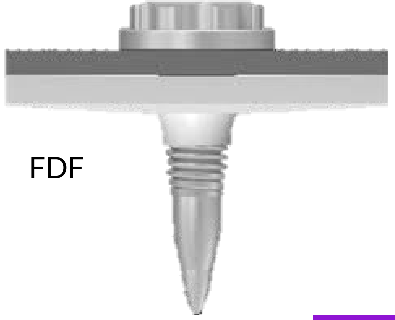
Mechanical joining of advanced steels
(MECOFAST)

- Trend towards higher strength steels and mix-material designs.
- Project focus on evaluating mechanical joining methods to join high strength steels:
  - Flow-drill fastening (FDF).
  - Self-piercing riveting (SPR).
  - Tucker plasma joining (TPJ).
- Materials include DP1200, USIBOR and AL6082-T6.
- Single-sided joining of USIBOR to alu possible.
- Disassembly methods for circularity demonstrated.





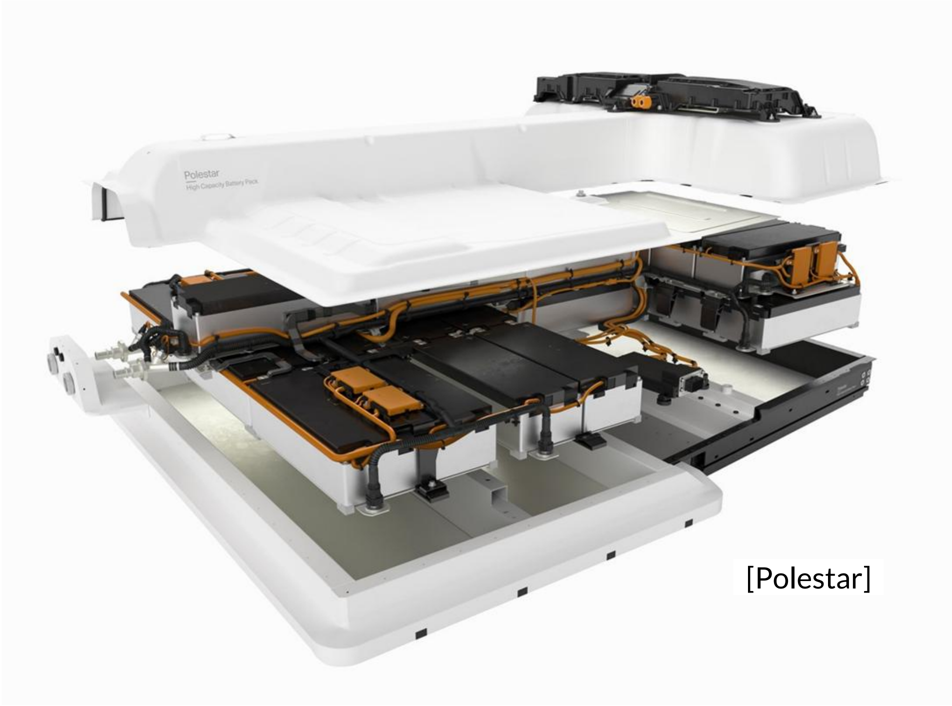




Swedish Metals & Minerals
impact innovation

Disassembly methods of joints for circular battery packs (DIJON)

- High requirements on battery packs w.r.t. stiffness, crashworthiness, tightness, cost-efficiency, etc.
- High economical value of raw materials and high need for efficient recycling.
- Disassembly methods in industry are not up to speed for high volume recycling and repair operations.
- DIJON develops and evaluates dissasembly methods incl.
  - Debonding on demand of adhesive bonds.
  - Laser cutting of welds.
  - Vision technologies for joint inspection.



[Polestar]

2 Component Adhesive Process (2-CAP)

Purpose and goal

- 2C applications are a strong trend within **electrification.**
- Adhesive joints give the possibility of new material combinations and with longer service life.
- 2C-based bonding with **short curing times** and secure geometry fixation is essential. The goal is a **robust** process for high-volume manufacturing with automated application of 2C adhesive and thus also reduced **work environment risks**.

Expected effects and result

- The goal of the project is therefore an automatic handling of all parts of the process to obtain a stable robust process, optimized material consumption and minimized chemical risks for personnel.

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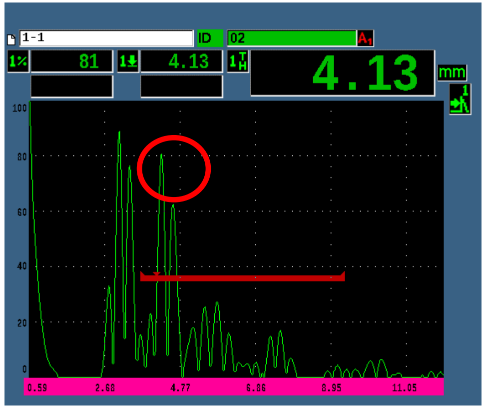
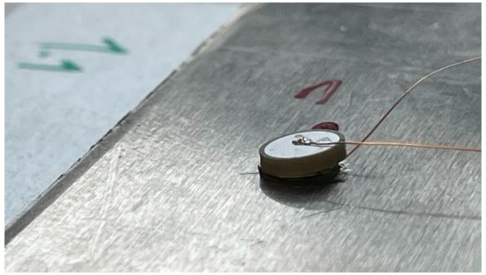
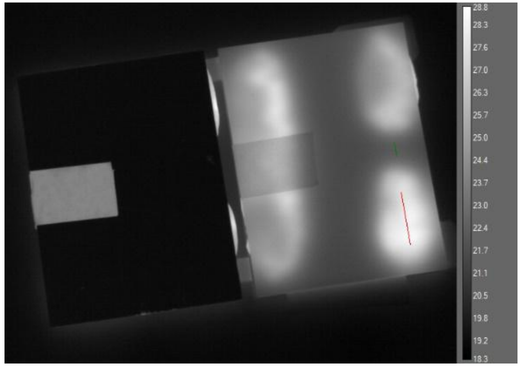
Quality assurance and quality control of adhesive bond joints in battery packs (QABB)

The main finding from the pre-study are…

- Potential methods for QA have been mapped
- The most potential methods for QA for adhesive bonding have been experimentally assessed
  - Ultrasonic testing (UT) show promising capabilities to detect lack of adhesion and lack of bonding.
  - Electromechanical impendence (EMI) measurements also show promising results. Lack of adhesion and lack of debonding can potentially be detected by EMI, but more data and data analysis is needed.
  - Thermography (both passive and active) is not suitable for applications where aluminium is used as the inspected surface. However, thermography could be more suitable for other materials such as PP or other thermoplastics.







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Research projects within dry pretreatment at RISE

Laser pretreatmen t for thermal spray LaTex (2021-)

Laser pretreatment for Bipolar plates YtBi (2021-)

Laser pretreatment of metallic surfaces difficult to bond or join. Dry Pretreatment 3/Prebond (2021-) *Joining of float glass with plasma pretreatment*

Deep chemical study within plasma and laser pretreatment for bonding with epoxy and PU. Dry Pretreatment 2 (2017-2019)

Comparison of plasma and different laser pretreatment methods for metals and CFRP. Dry pretreatment 1 (2014-2016) *Plasma and laser pretreatment before adhesive bonding*

Bonding study including comparison of flame, corona and plasma for improved bonding of vacuum formed components. Robust bonding (2018)

Plasma treatment of glass for improved automotive glass bonding. FF (2013-2016) *Joining of float glass with plasma pretreatment*

Plasma treatment of painted and plastic surfaces before adhesive bonding PERU (2011-2013) *Plasma treatment for efficient windscreen bonding.*

First plasma trials for improved bonding with internal funding

Industrials and virtual solutions for automated plasma treatment before painting of plastics. APPLY (2020-)

Improved print adhesion with plasma deposition Digi bond (2020)

Plasma treatment for improved adhesion for painting of plastics Laplas (2016-2019)

Plasma treatment of fibers for stronger composites. Starkare fibrer med plasma (2021-)

Start 2008

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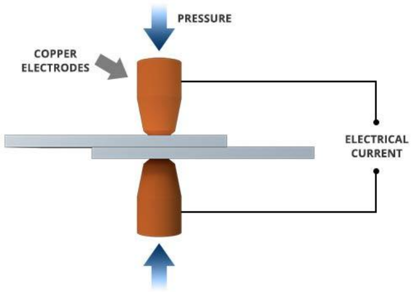
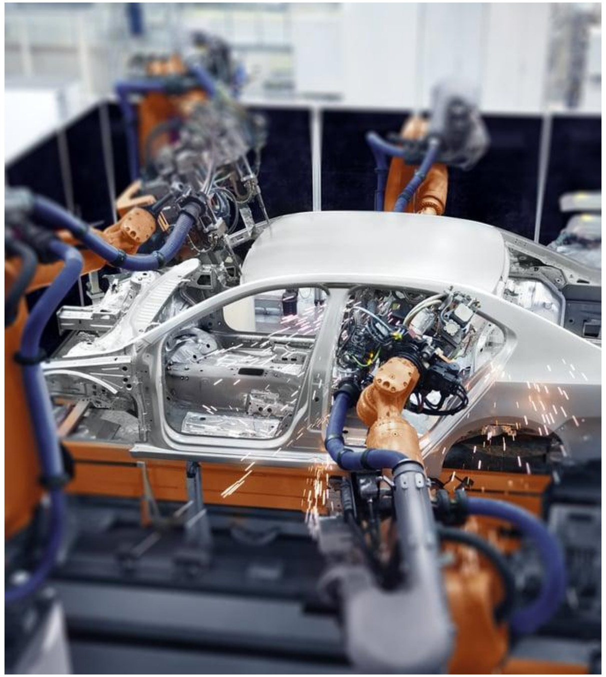
Graphene reinforced copper electrodes for high productivity resistance spot welding (GRACE)

- RSW electrode degradation leads to
  - smaller welds.
  - higher variation of weld size.
  - more frequent spatter/expulsion.
- Research has shown that electrode material can affect electrode degradation. **Higher hardness and higher electrical conductivity is beneficial.**
- **Is graphene reinforcement an enabler?**
- Focus on manufacturing methods for graphene reinforced electrodes and electrode lifetime evaluation.





SIO GRAFEN

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Analysis of a laser weld

Study:

Point wise mapping with small measurements spot over a laser weld for joining two 316 sheet.

Approach:

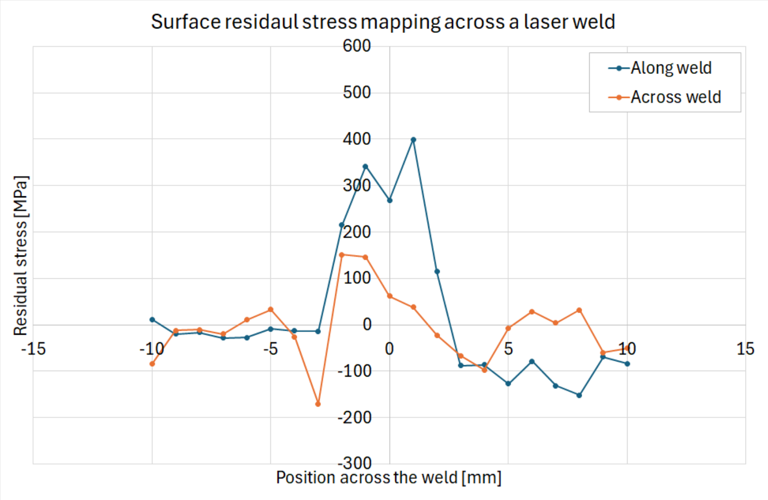
Measure the surface stresses non-destructively using x-ray diffraction. This is a fast and standardized method (follows: SS-EN-15305)

Results:

- Laser welding induce high tensile stresses in the weld that is counterbalanced by a low compressive stress in the substrate.
- Stresses differs along and across the weld.

Outcome:

- Data has been used to calibrate FE models of the process, which showed good agreement.
- The results will further be used to optimize the processing parameter (power, travers speed, etc.), in order to suppress high gradients and tensile stresses.



Outlook and future trends

- Artifical Intelligence and Machine Learning
- Quality Assurance
- Defence applications
- Industrialized circularity

Test bed for disassembly

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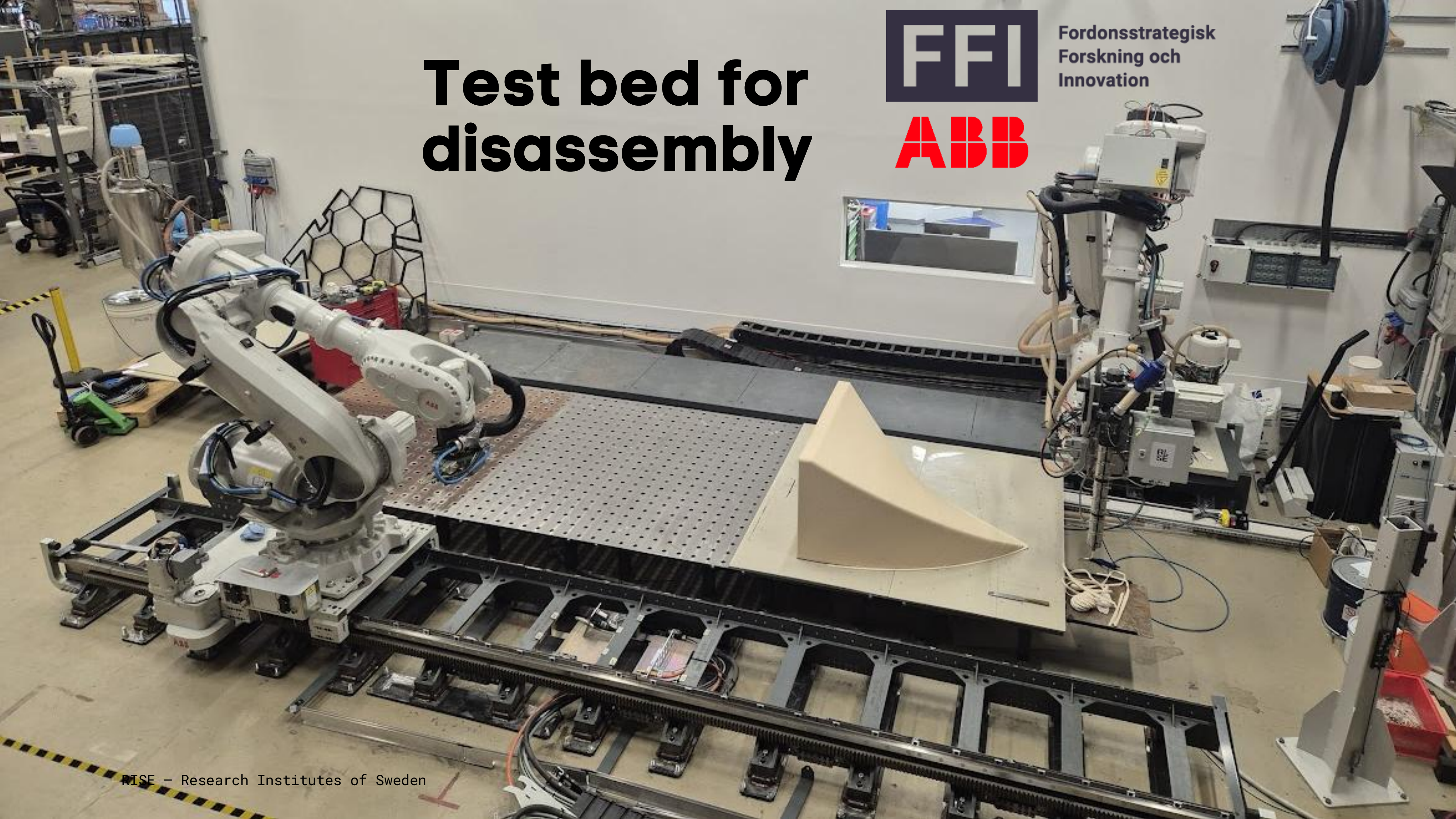
ABB



Thank you!