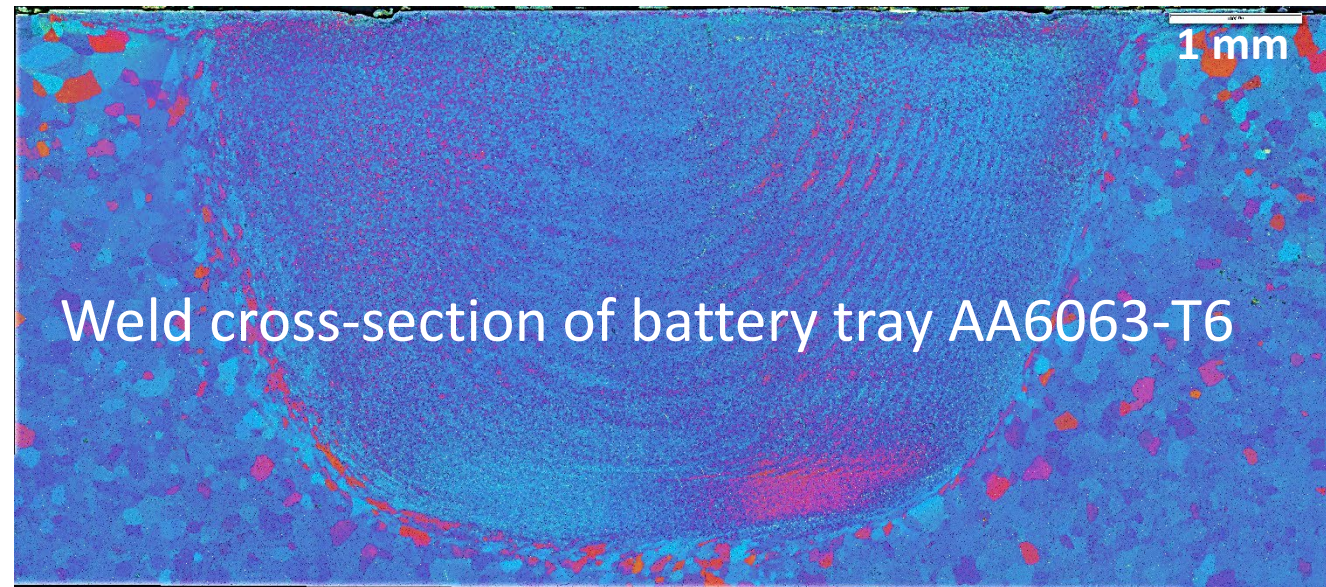


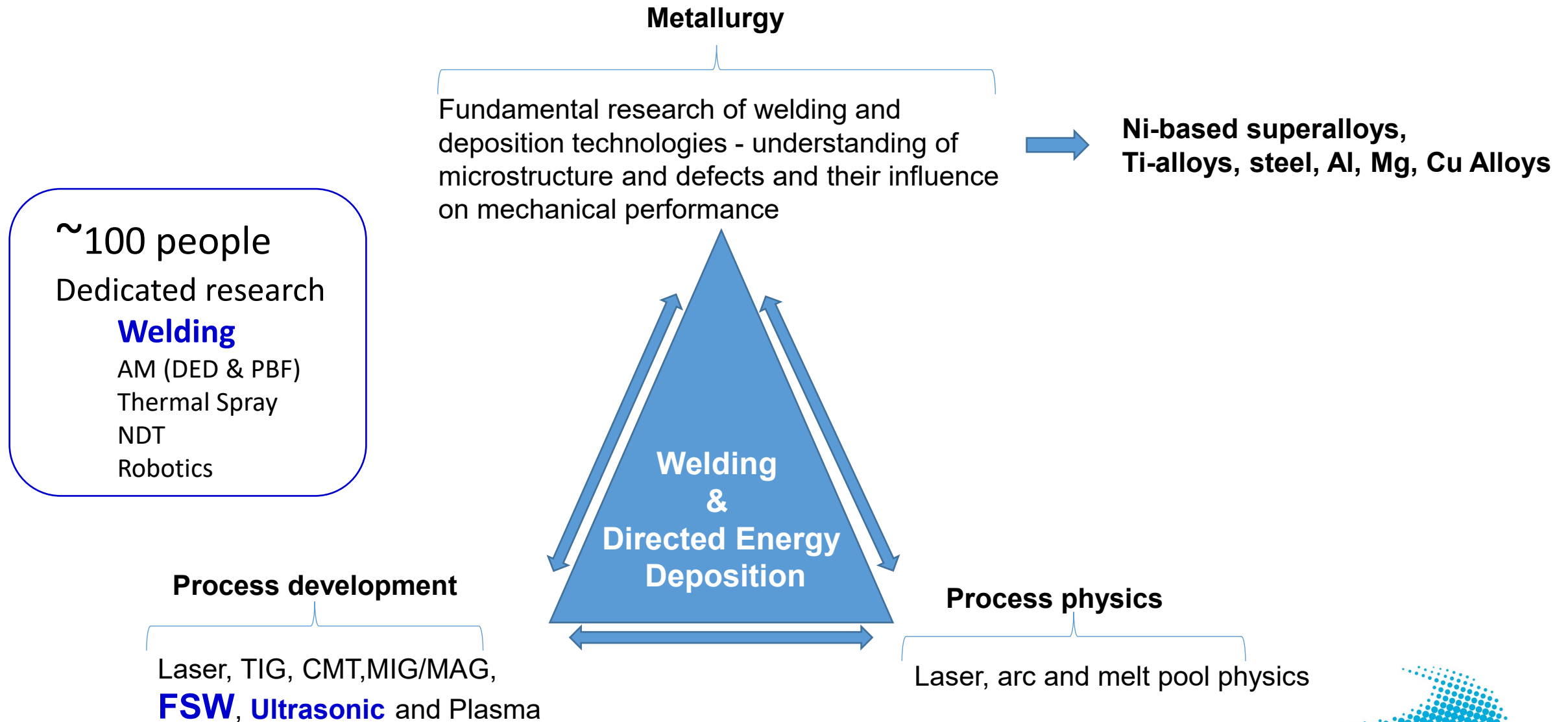
Lightweight and leakproof assembly by Friction Stir Welding in EV industry



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Division of Welding Technology,
Department of Engineering Science
University West, Trollhättan, Sweden.

University West- Production Technology Centre



Friction Stir Welding (FSW): Overview

Solid-state Welding Technology

Green and Clean Process

Eliminate/minimize Heat treatment

Superior Joint Quality

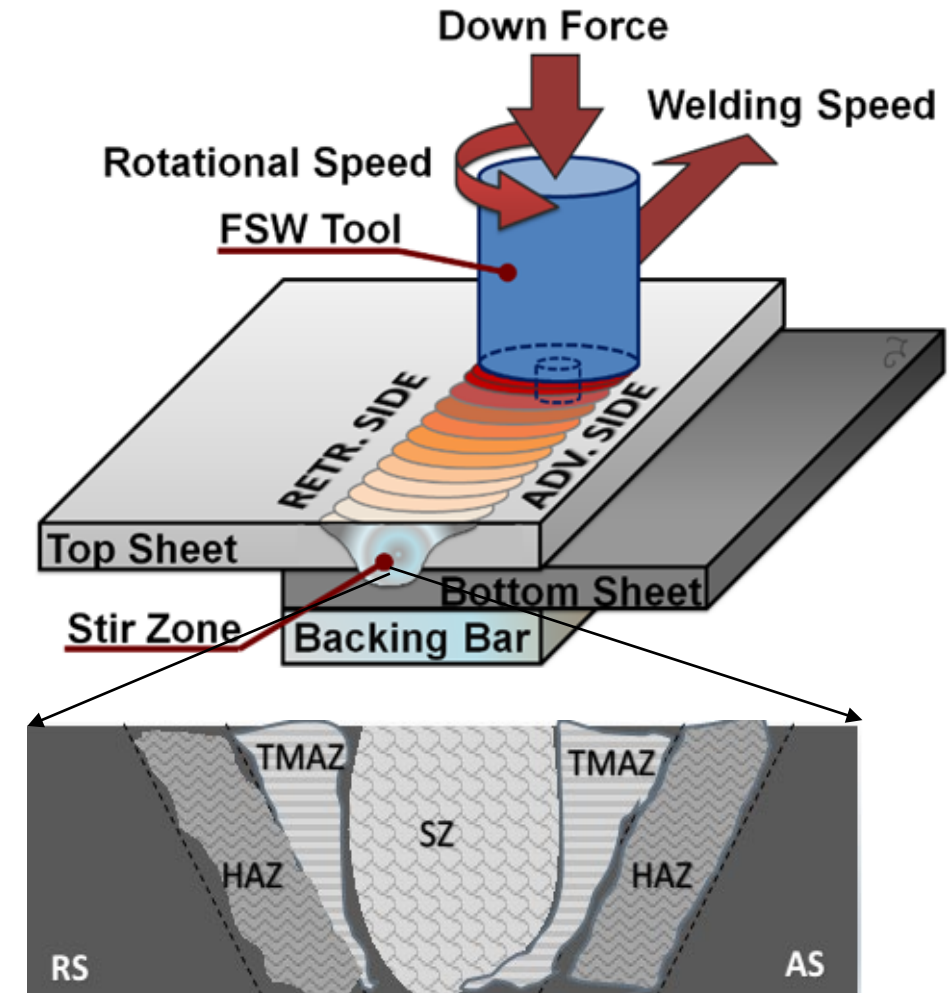
Promises Leakproof Assembly

Endorses Several Dissimilar Combinations

High Productivity

Sustainable Process

Special Tooling and Fixture Requirements



SZ: Stir zone

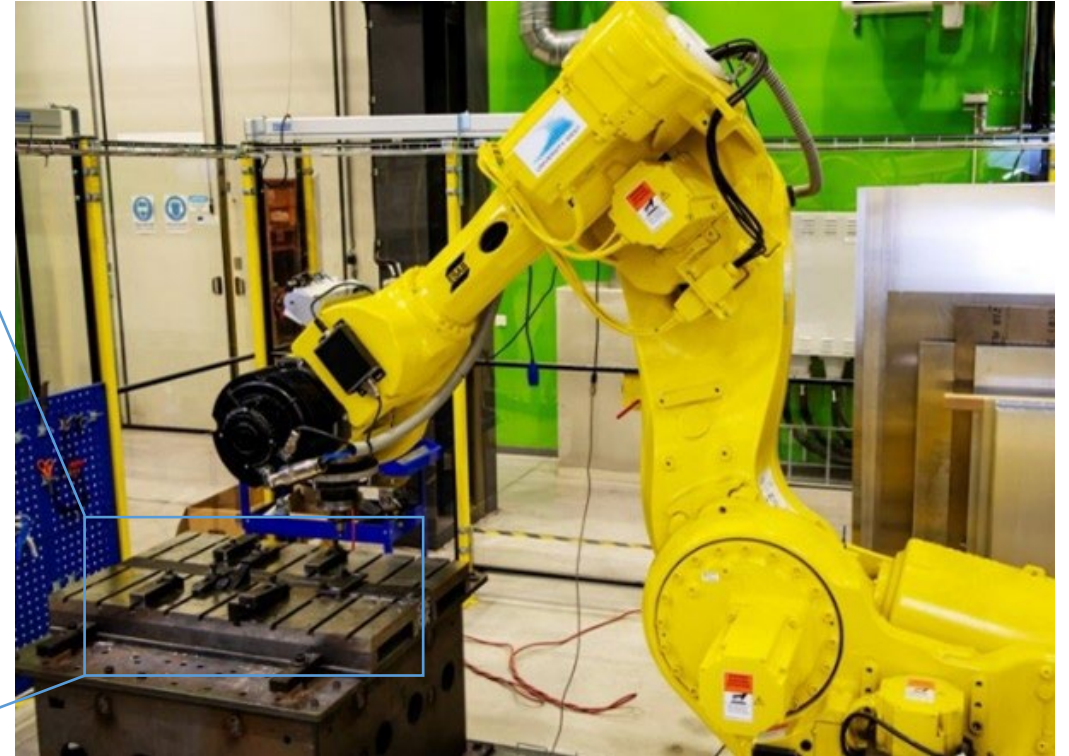
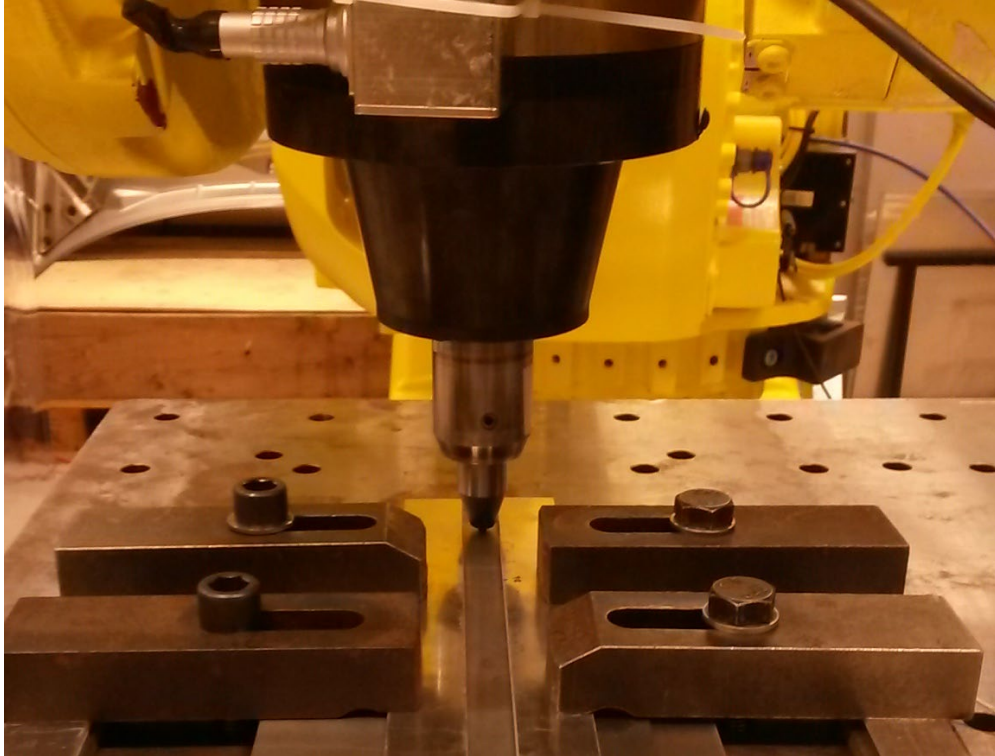
HAZ: Heat affected zone

TMAZ: Thermo-mechanically affected zone

AS. Advancing side

RS: Retreating side

Robotic Friction Stir Welding: State-of-art infrastructure



- ✓ Force control robotic system
- ✓ Tool design and development i.e., stationary shoulder tool
- ✓ Process development through structure-property evaluations
- ✓ Plan for upgrading with online monitoring control

Friction Stir Welding projects

1

High-Speed FSW of Aluminium alloys for battery trays assembly in EVs (2019-2022)

- EVASTIR: welding speed of 5 m/min and extrusion-cast joining

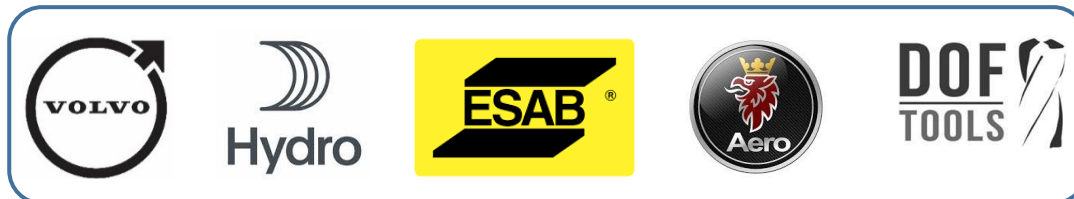
Multimaterial & multiconfiguration welding of dissimilar aluminium alloys (2023)

- INTDEMO : Engine wall Demonstrator-T-Joints for aerospace application

2

Lightweight and leakproof electronic heat exchanger (2023)

- LEAFSTIR: HPDC Aluminium alloy joining



Friction Stir Welding: EV- joining applications

- ✓ Battery trays
- ✓ Battery frame structure
- ✓ Battery Cell joining
- ✓ Cooling plates/Heat exchanger for electronic components

Friction stir welding: Lightweight battery trays assembly

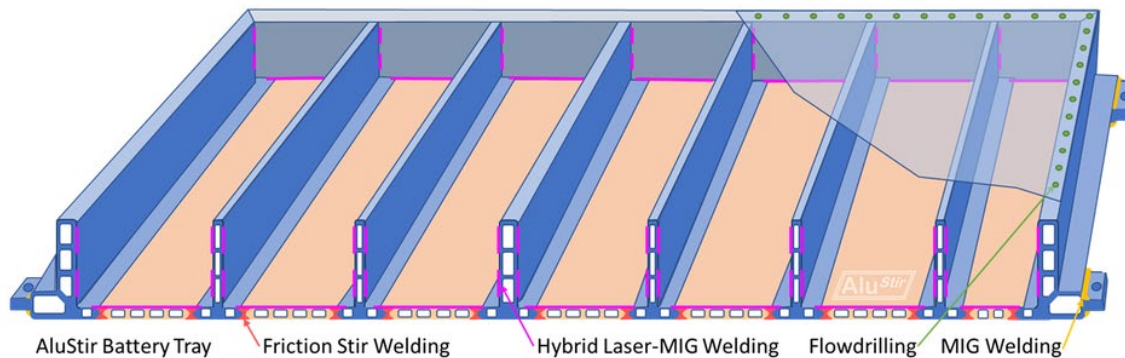
Source: HAI-Aluminium



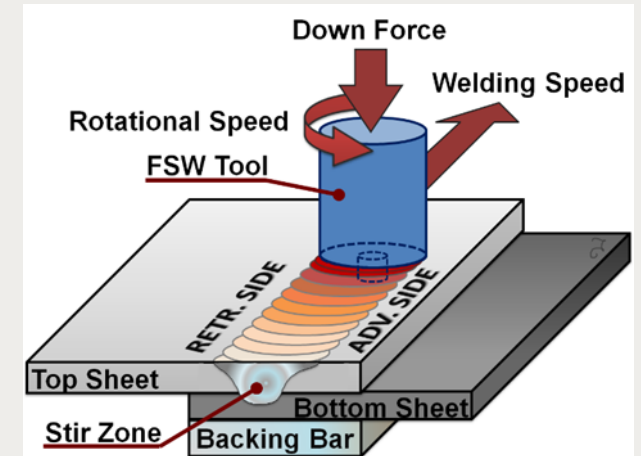
Source: MARPOSS



Source: AluStir



Why FSW?



- ✓ Clean and Green process
- ✓ Leakproof
- ✓ Superior joint integrity
- ✓ **Production Volume**
> 2 m/min ??

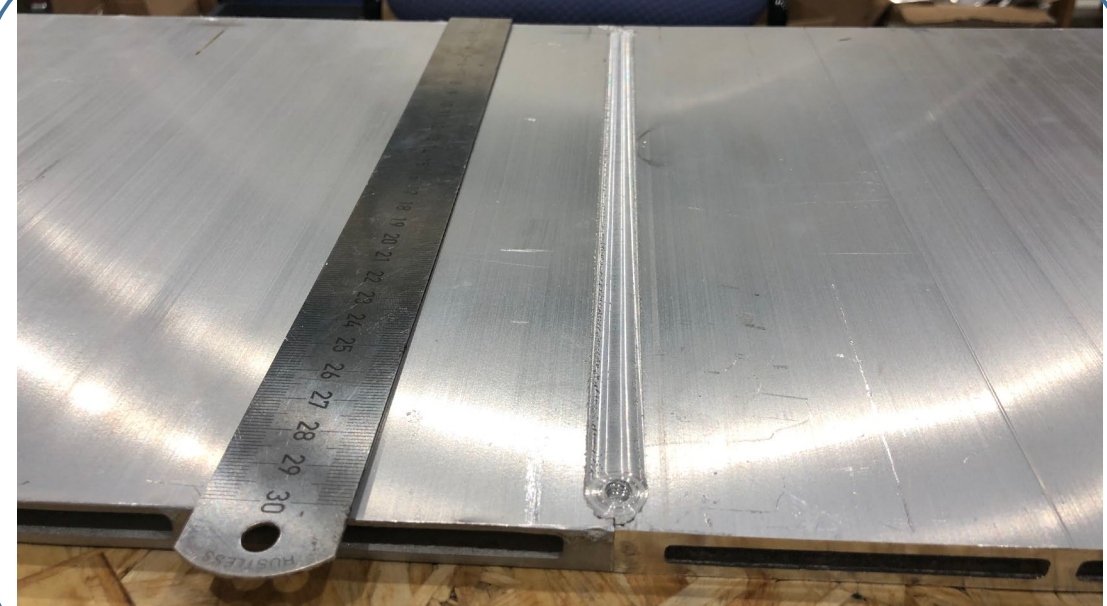
EVASTIR

High-speed Friction Stir Welding of battery trays assembly in EV industry

Introducing new sustainable and green manufacturing process i.e., **Friction Stir Welding** to support design and fabrication a cost-effective, scalable, lightweight and crash-resistant **battery tray for EVs**.

The key innovations:

- Achieved **welding speeds up to 5 m/min** for extruded Al alloys
- Develop repeatable joining process for **high-integrity joints between cast and extruded aluminium alloys**, using Friction Stir Welding.

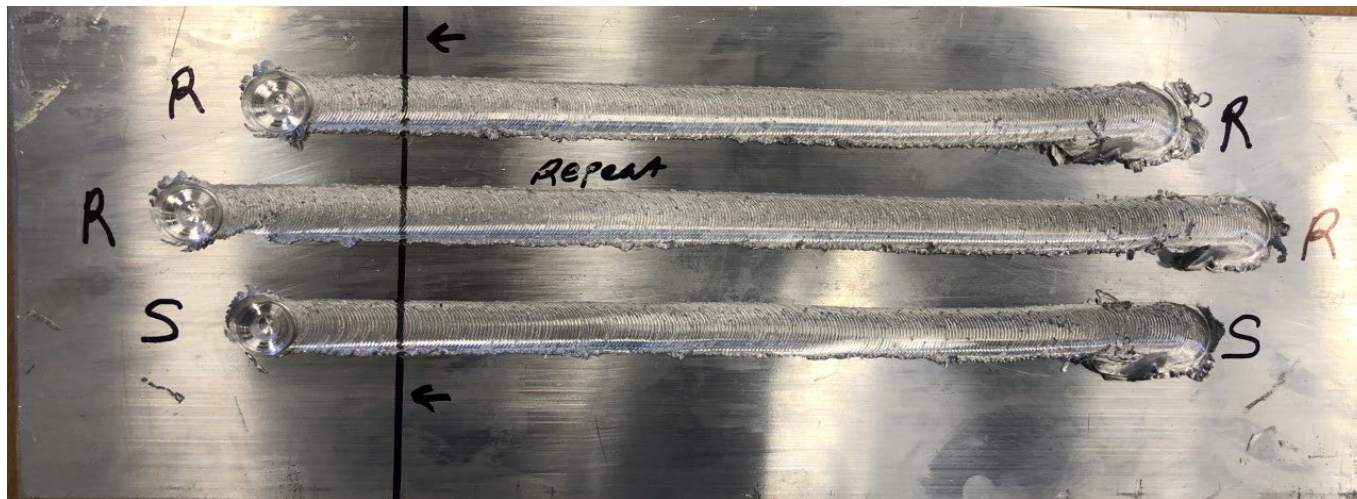
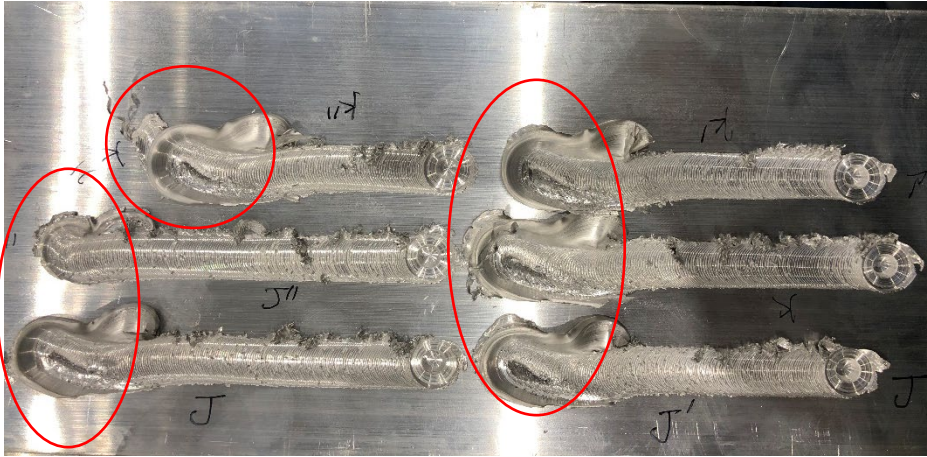


Friction Stir Welded Aluminium alloy Battery trays



How we started: Bead on plates >2 m/min

Starting with 0.5 m/min to 4.0 m/min



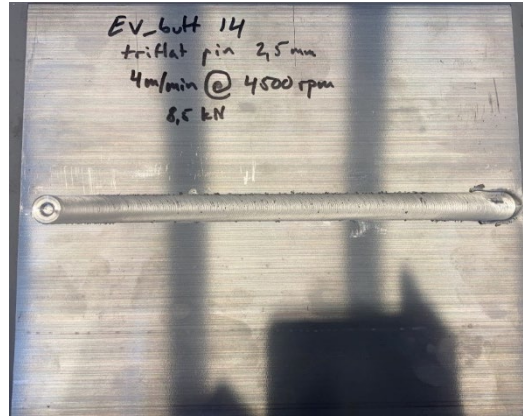
@ 4500rpm-8.5kN

- Good surface appearance
- No surface tunnel
- No excessive flash

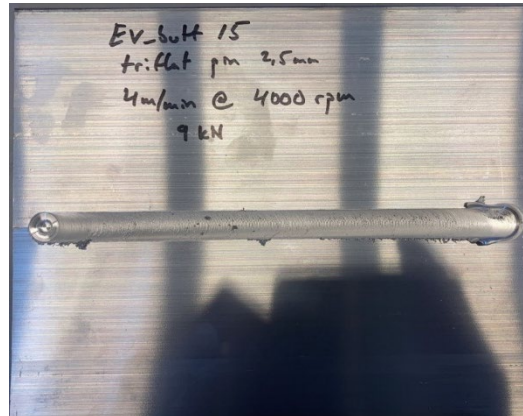


High speed butt welds: Surface appearance

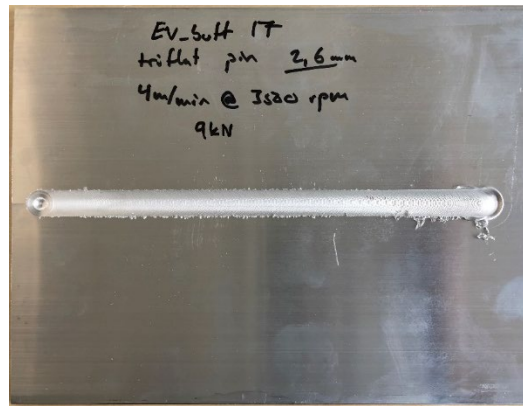
4500
rpm



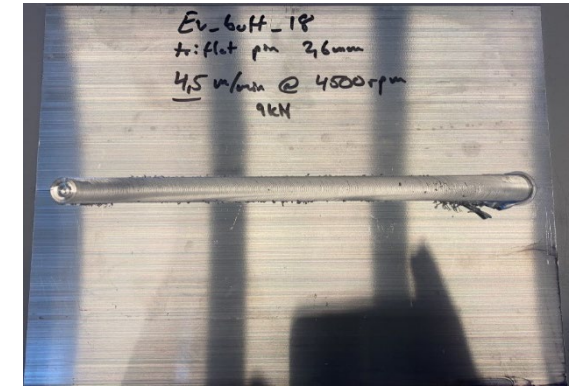
4000
rpm



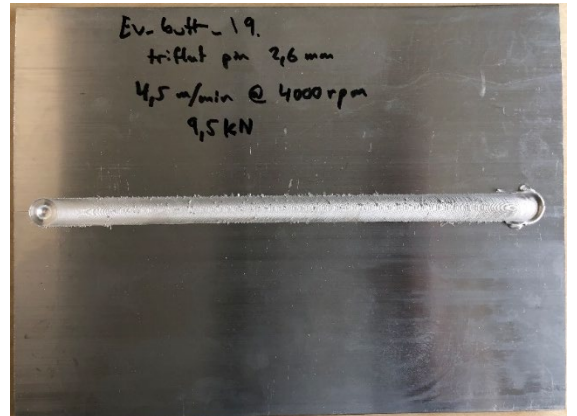
3500
rpm



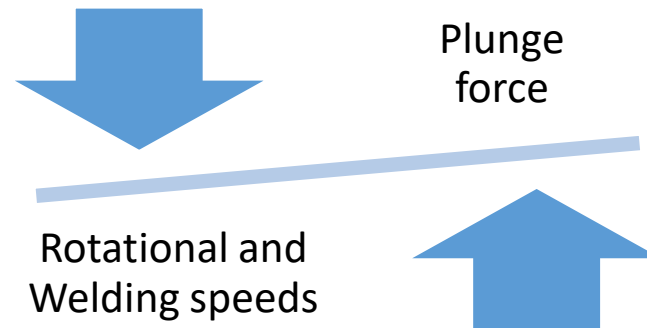
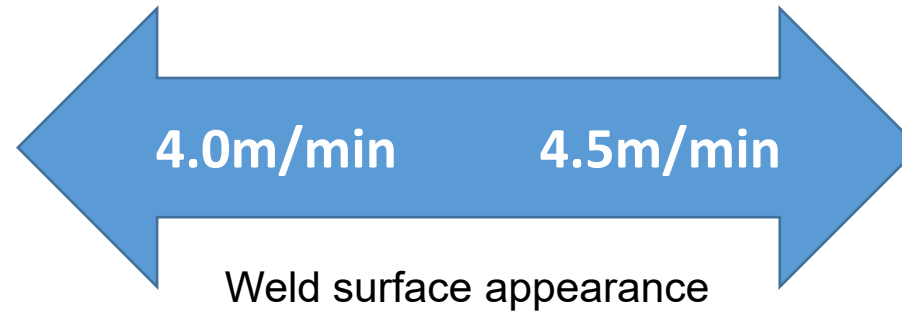
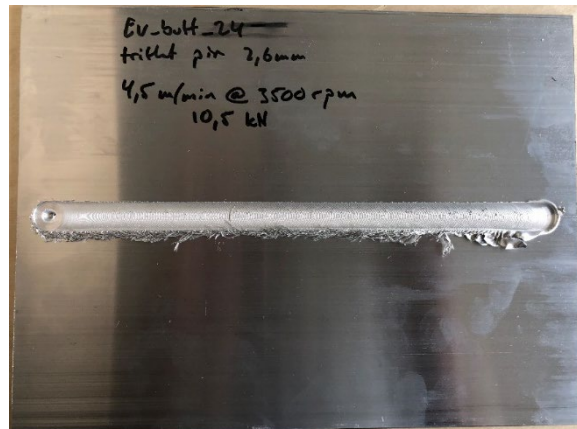
4500
rpm



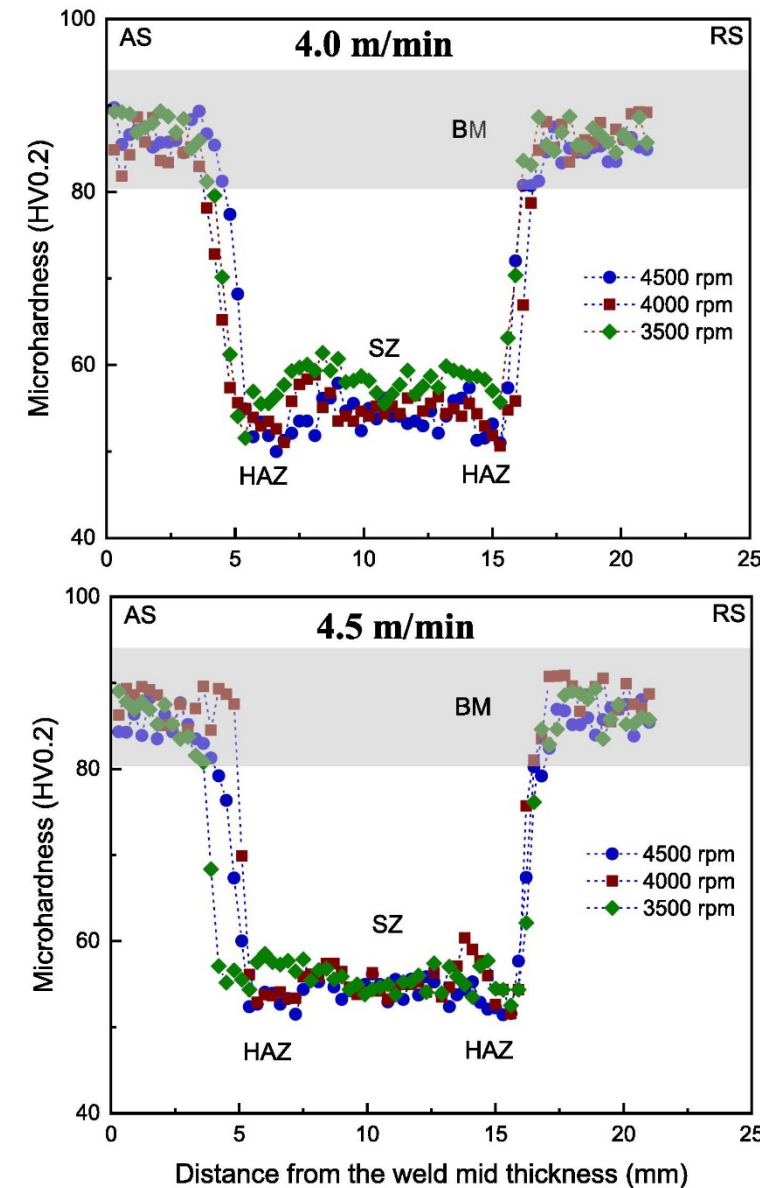
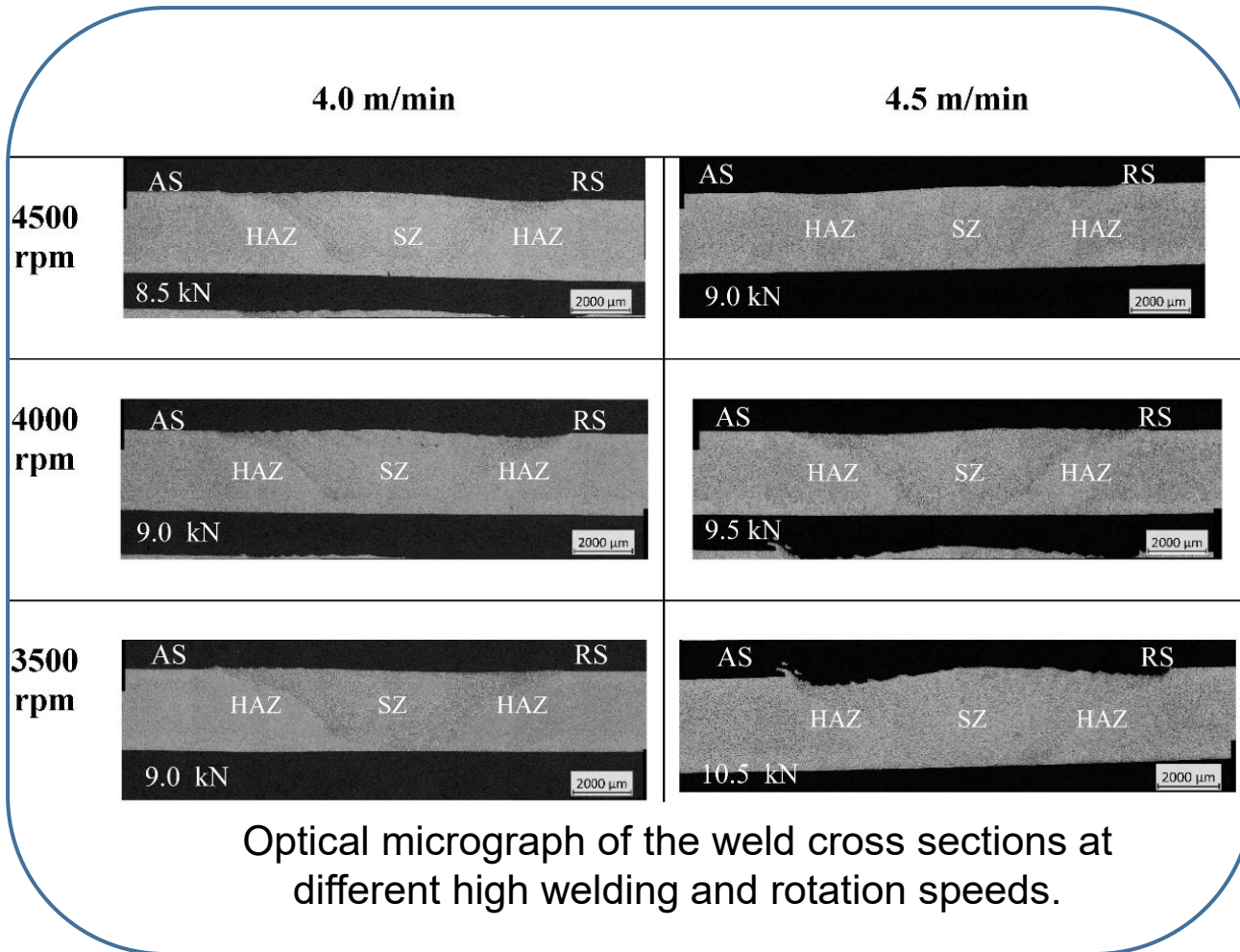
4000
rpm



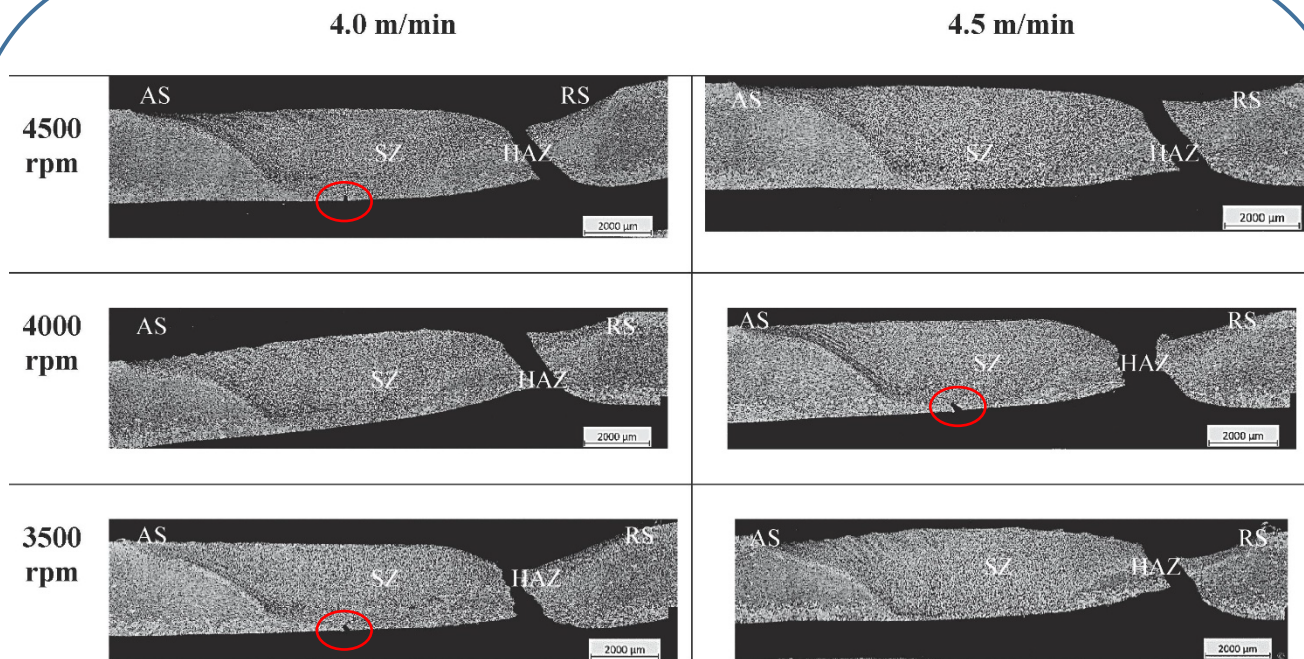
3500
rpm



High speed butt welds: Surface appearance



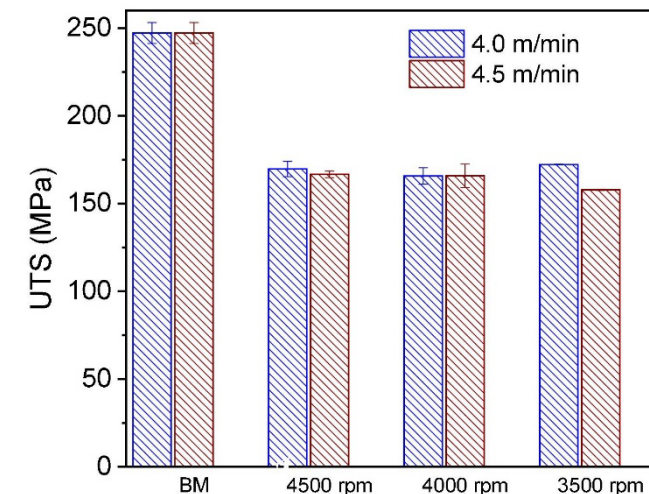
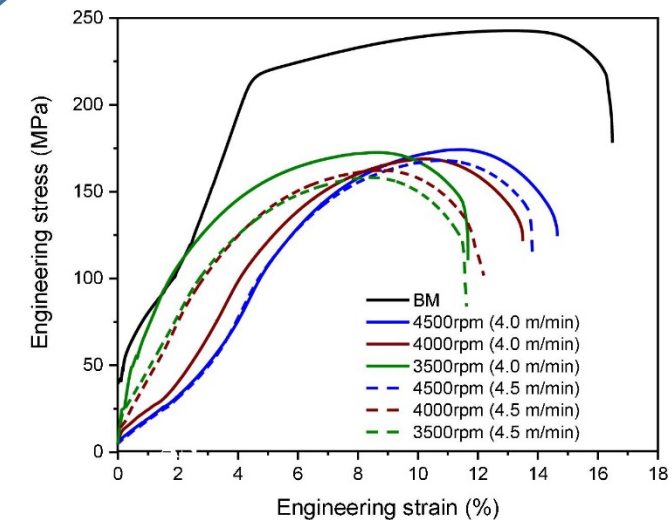
High speed butt welds: Joint strength



Optical micrograph representing fracture location and mode of failure:

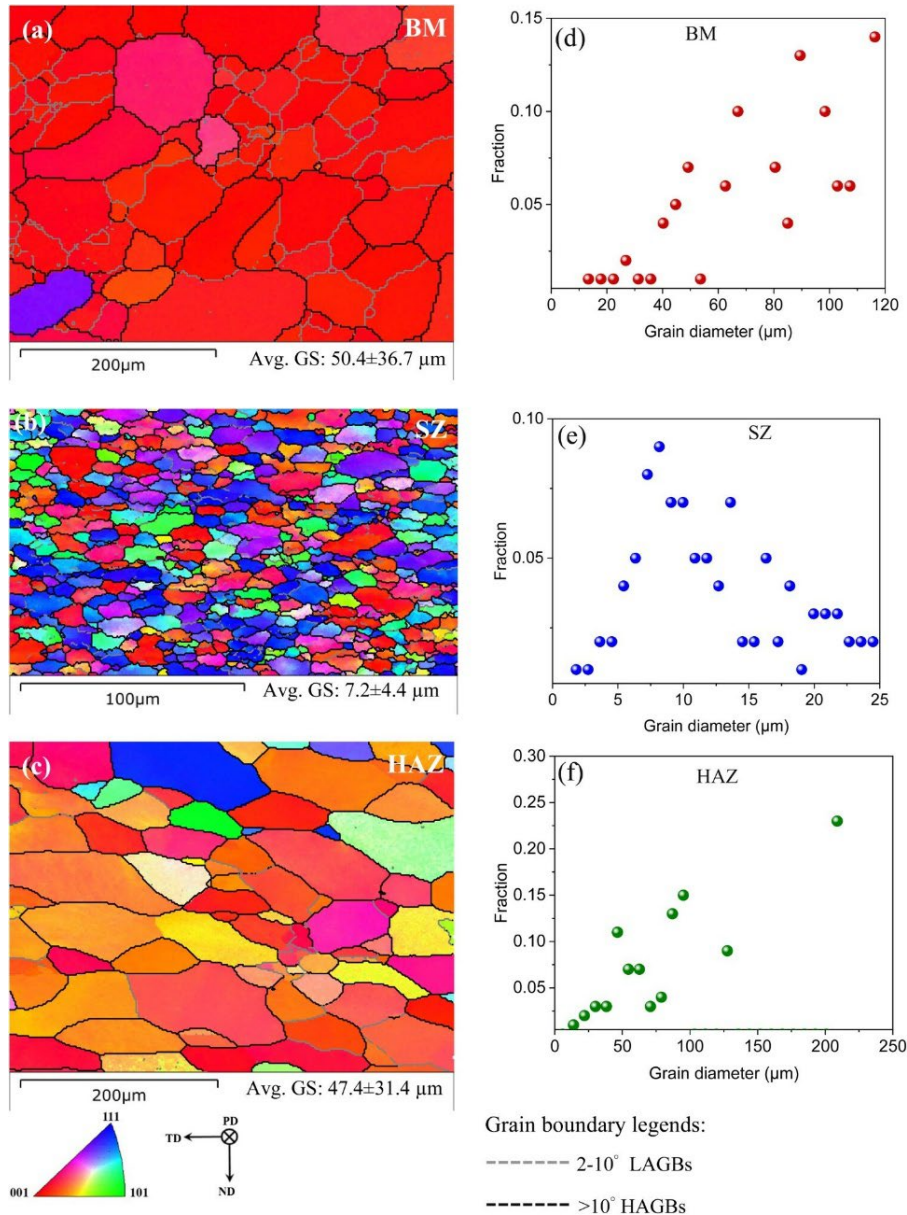
1st mode: fracture starts from the weld top surface near RS

2nd mode: fracture is further progress towards the bottom of the weld via lower hardness zone i.e., TMAZ/HAZ hardness~50 HV



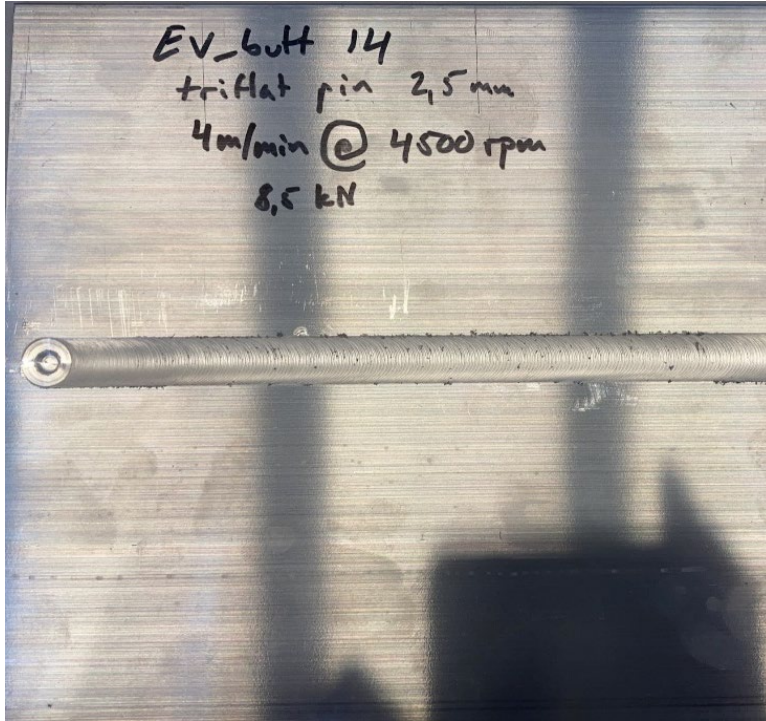
Tensile behaviour at different welding and rotation speeds along with BM

High speed weld: structure-property relations

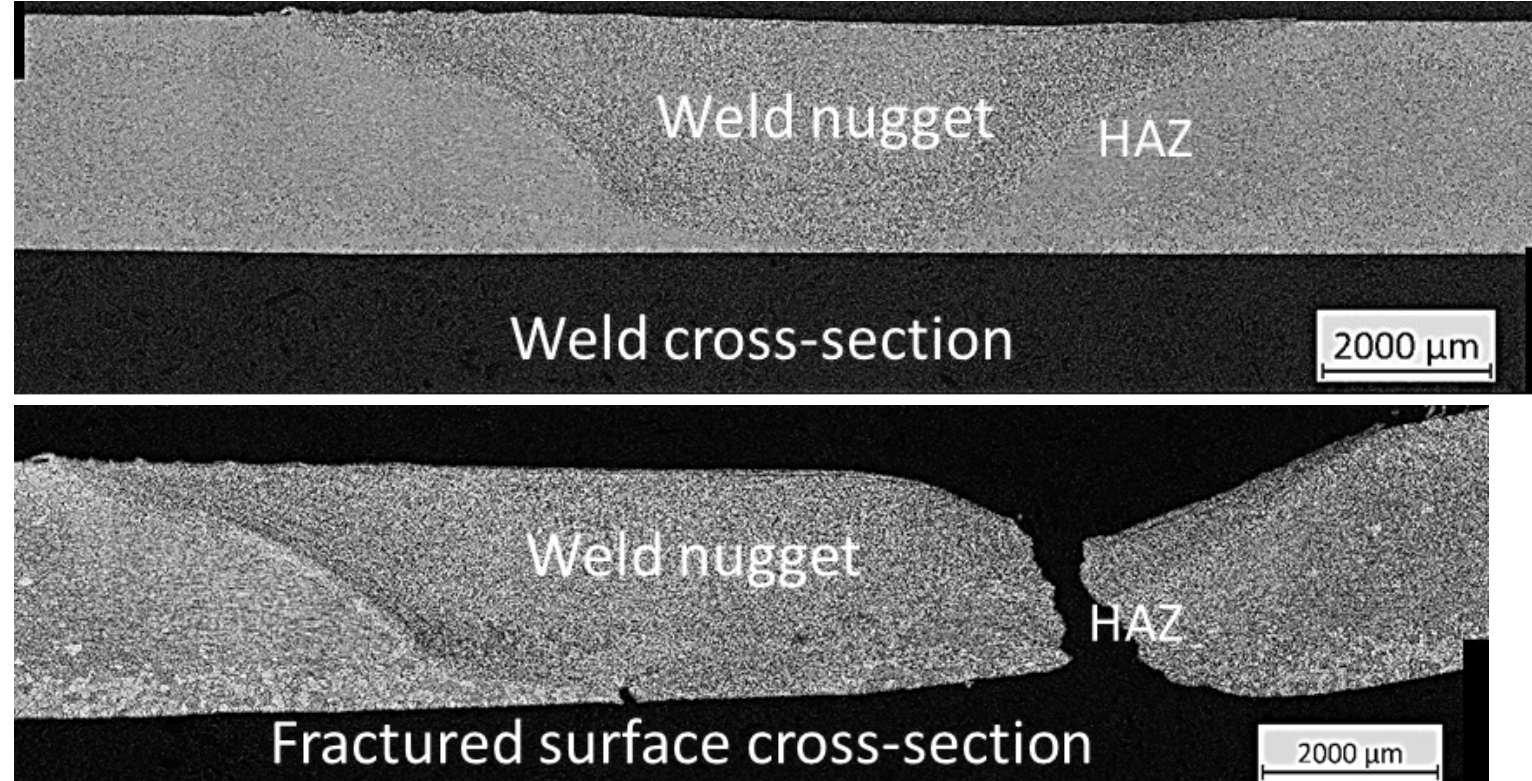


EBSD of the different microstructural zones of fractured weld cross section of 4 m/min: Crystallographic orientation maps (a) BM, (b) SZ, (c) HAZ; and grain size distribution of corresponding maps (d) BM, (e) SZ, (f) HAZ corresponding grain size distribution.

High speed FSW butt joint @ 4.0 m/min: Summary



- ✓ Good weld surface produced at high welding speed



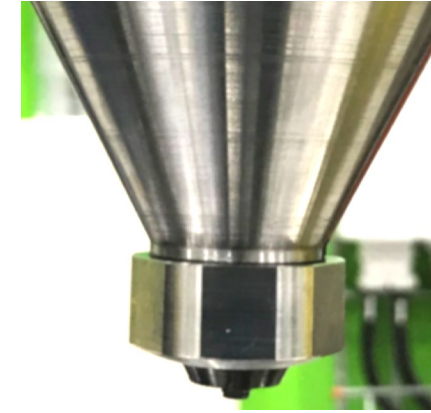
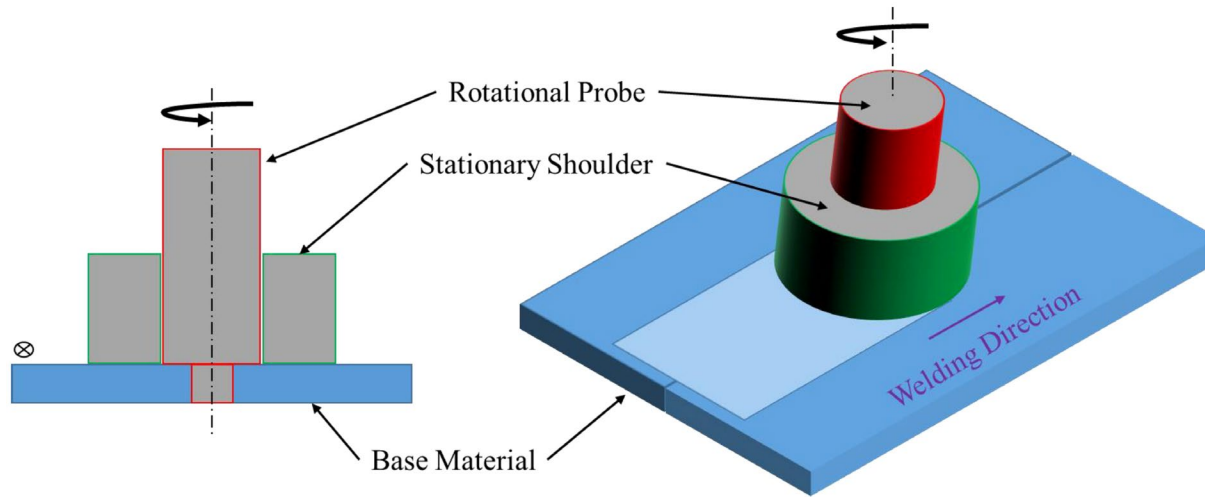
- ✓ Full penetration
- ✓ Defect free
- ✓ Tensile Failure occurred from HAZ

High speed FSW: Challenges/ Learnings



- ✓ Fixtures
- ✓ Tool failure
- ✓ Defect free welds
- ✓ Full penetration
- ✓ Joint strength

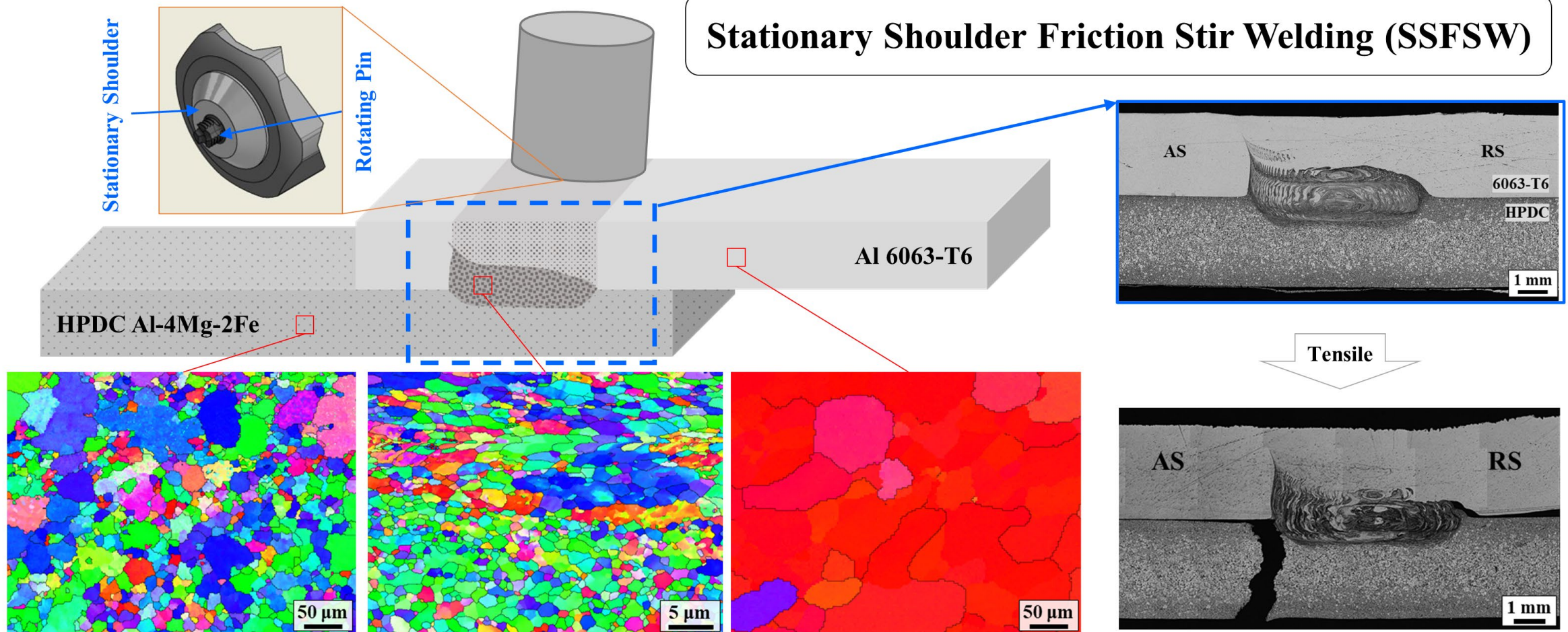
Tool development: Stationary shoulder FSW



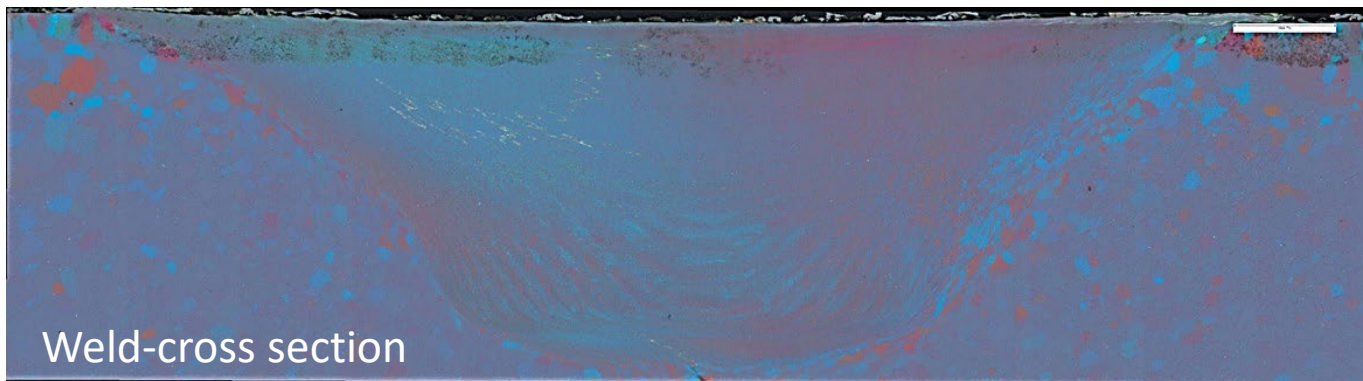
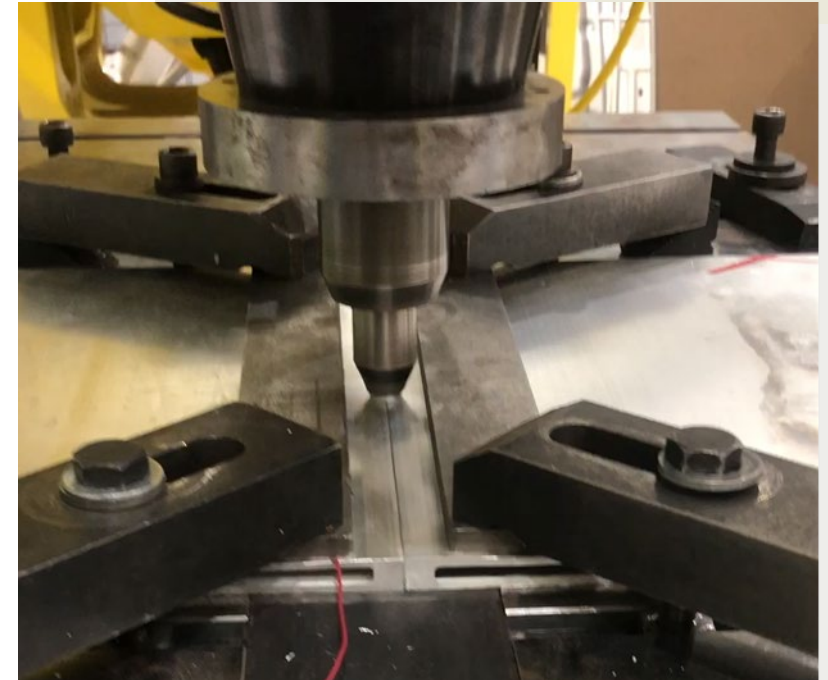
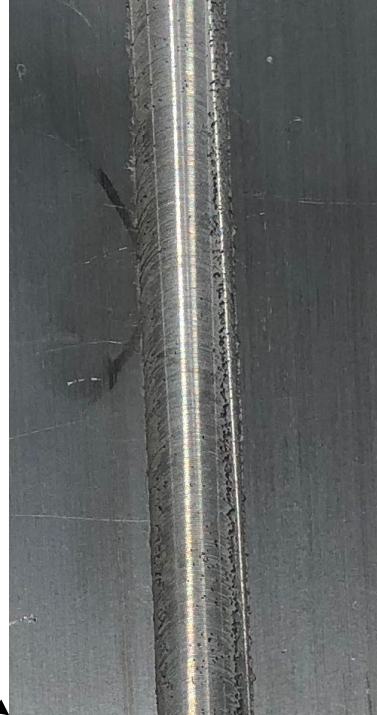
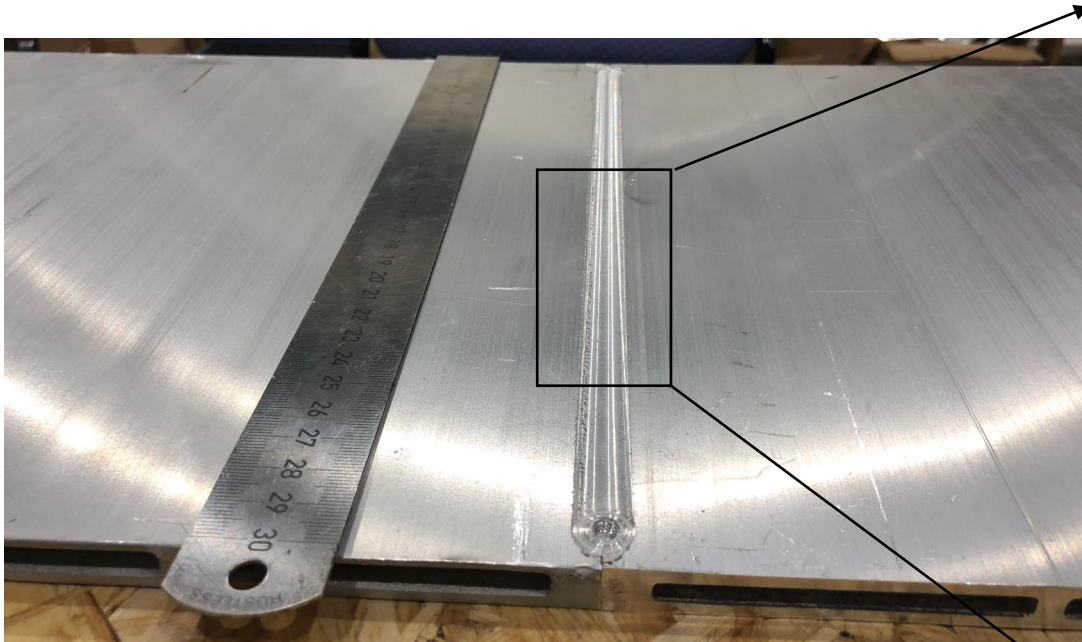
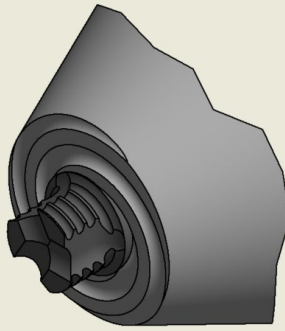
- ✓ Flash-Free surface finish
- ✓ Smaller temperature gradient across the thickness
- ✓ Probe/Pin dominated weld nugget
- ✓ Sticking of aluminium increases on increasing the plunge force
- ✓ Probe failure



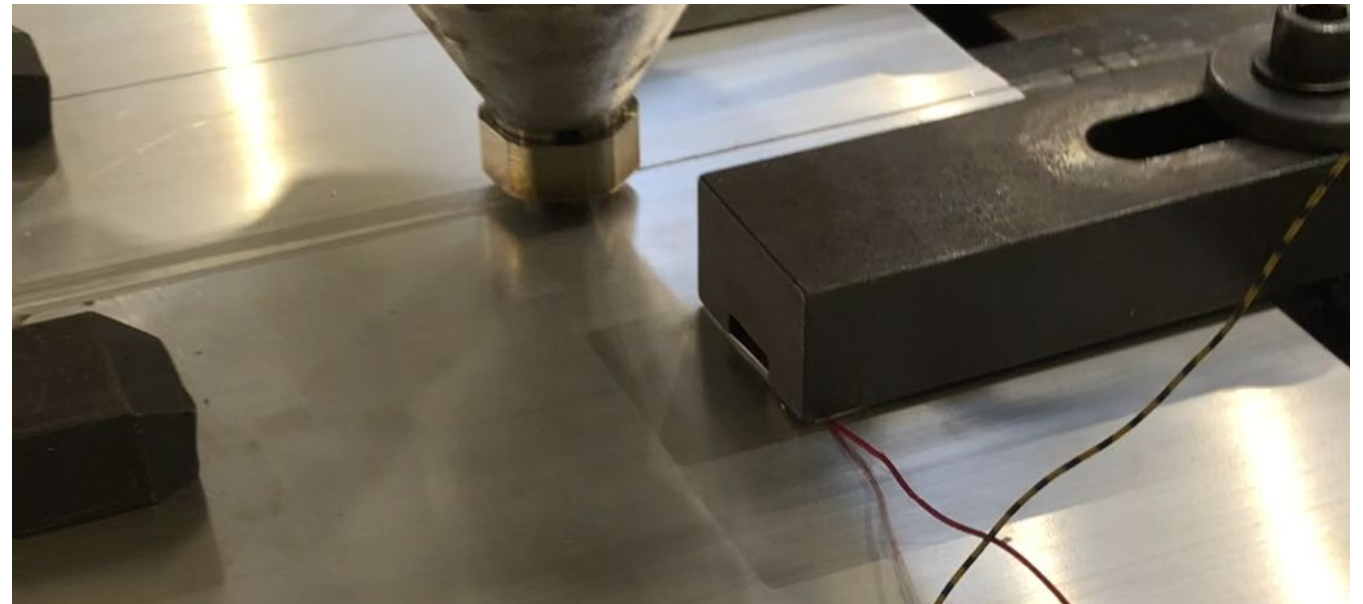
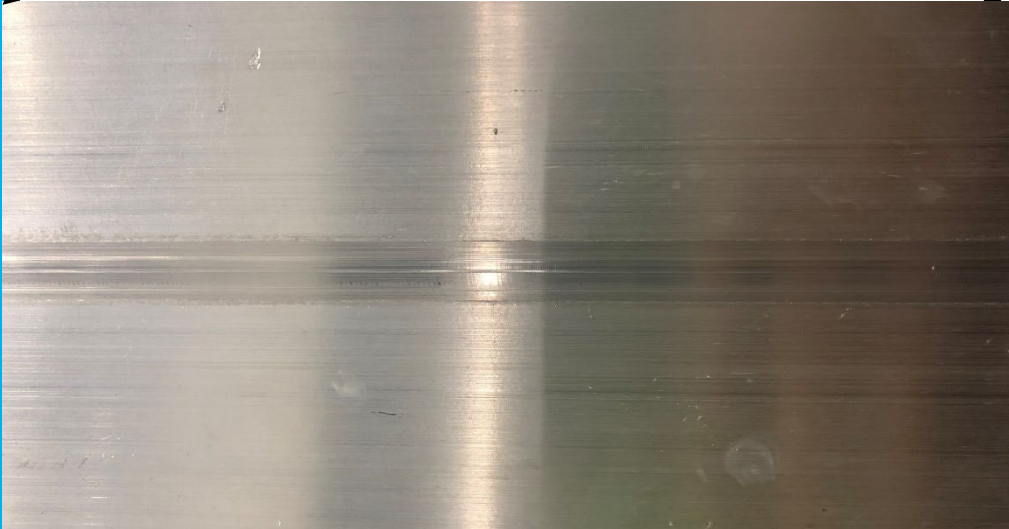
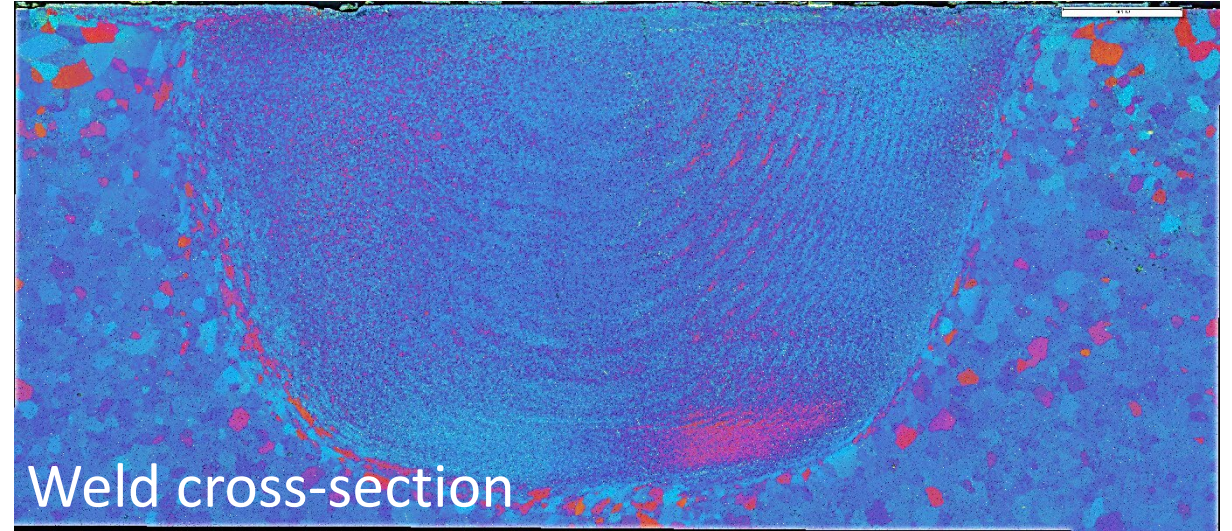
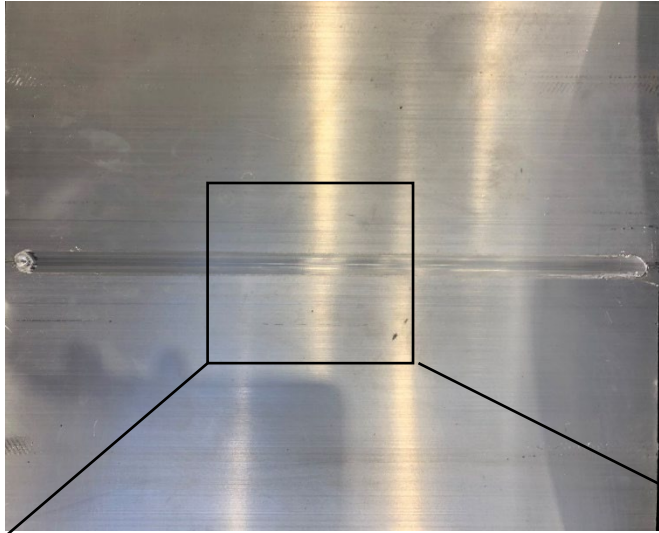
Dissimilar Al alloys: Extrusion to Cast



Demonstrator 1: Conventional FSW battery tray

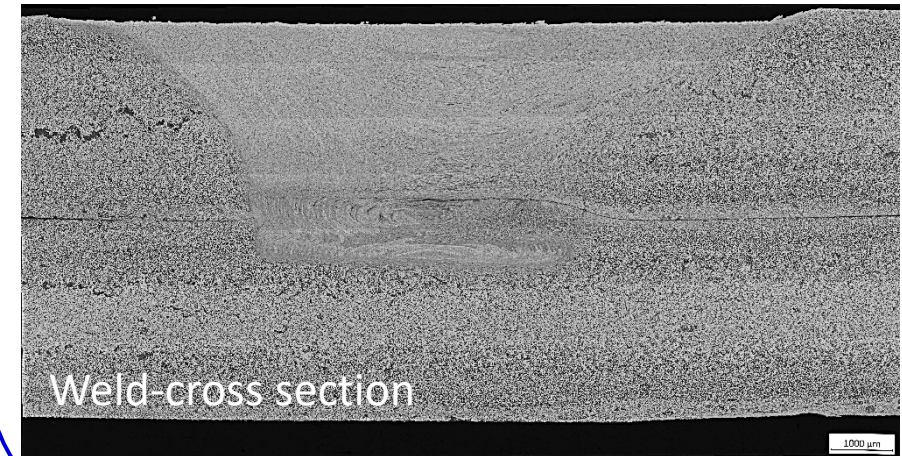
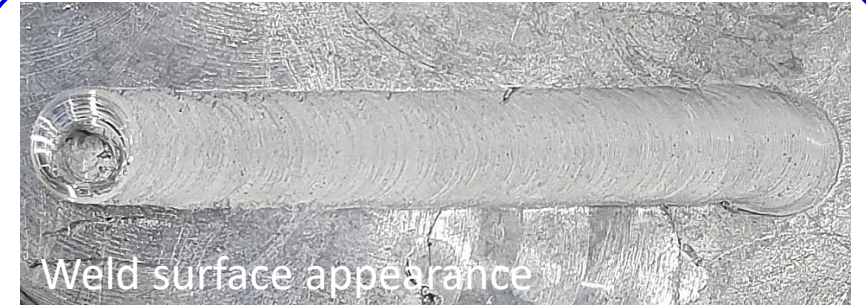


Demonstrator 2: Stationary shoulder FSW battery tray



Lightweight and Leakproof Electronic Assembly by FSW in BEV: LEAFSTIR

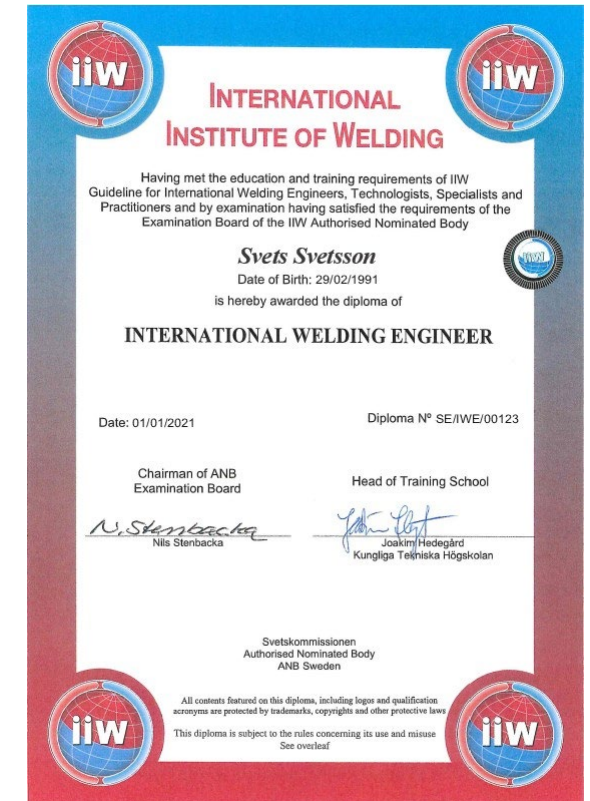
- Replacing fastener/screws by FSW to achieve lighter, strong, leakproof and cost-efficient assembly for electronic heat exchanger unit in Swedish BEV.



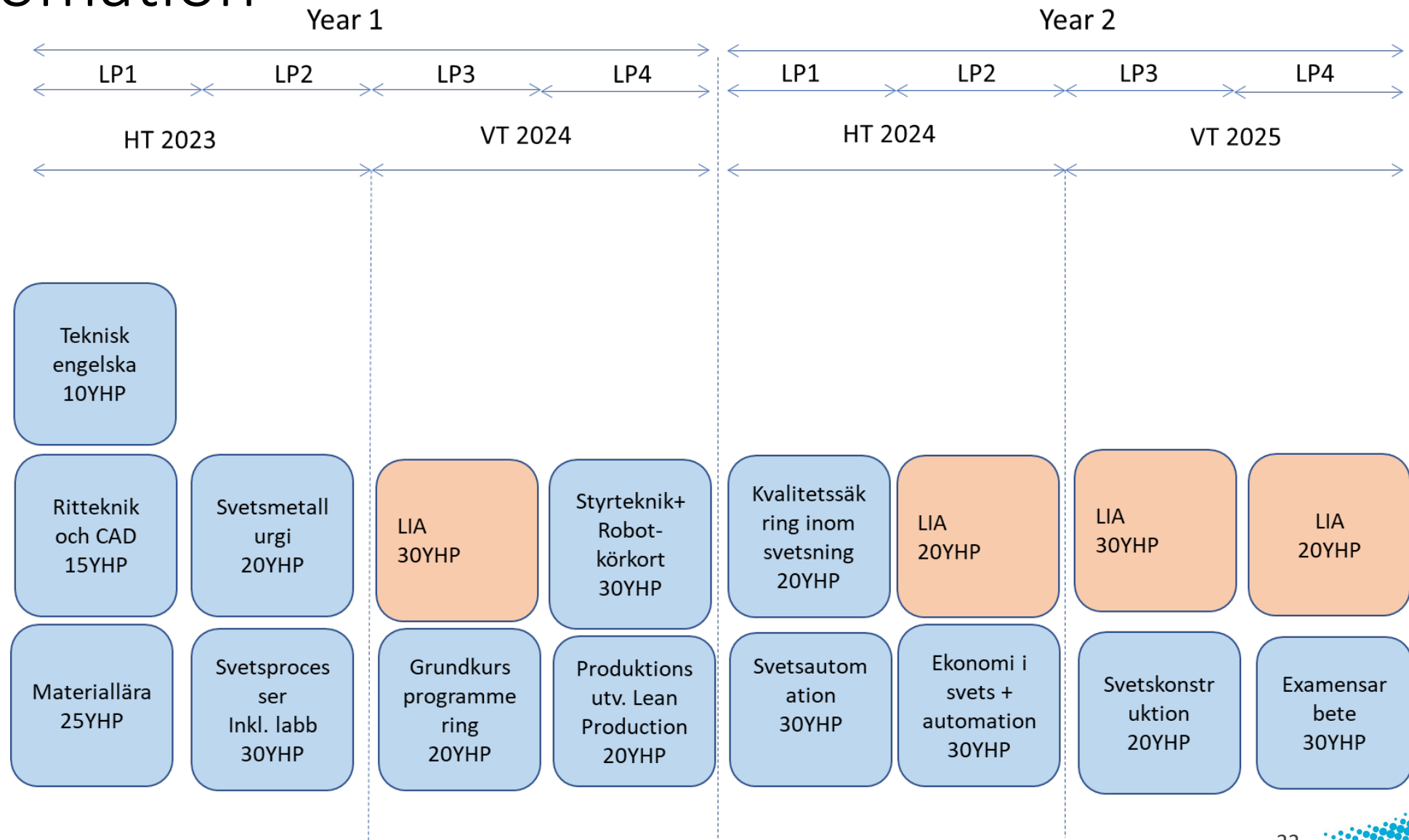
TWO QUALIFICATIONS IN ONE PROGRAMME

Master in Welding Technology

1. Degree of Master of Science (120 ETCs) Technology
2. Plan for International Welding Engineer qualification



Vocational Education – Specialist in Welding Automation



Better Effect of Training (BET)



Photo:
Meldal VET school

WHAT CAN **BET** DO FOR YOU?

AT YOUR WORKPLACE

- Identify the industry's needs?
- Effective training at your own workplace?
- How can VET schools become more responsive towards industry needs?
- Other needs?

Better Effect of Training (BET)

Joel Andersson

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Co-funded by the Erasmus+ Programme of the European Union

This project has been funded with support from the European Commission. This publication reflects the views only of the authors, and the Commission cannot be held responsible for any use, which may be made of the information contained therein.

KURSERBJUDANDE



Svetssteknologi - Provning och kvalitetssäkring vid svetsning

Kursen ger en översikt inom provning och kvalitetssäkring vid svetsning. Vi analyserar hur olika svetsprocesser, arbetsrutiner och materialval kan påverka kvaliteten av svetsade produkter. I samband med detta diskuterar vi materialkaraktärisering och provningsmetoder samt reflekterar kring hur dessa metoder för inspektion och kvalitetskontroll av svetsade produkter kan användas.

Kursen vänder sig till dig som vill lära sig mer om hur man säkerställer kvalitet vid svetsning eller redan har praktisk erfarenhet i ämnet men vill utveckla sin teoretiska kunskap.

Innehåll

Kursen tar upp följande moment:

- Kvalitetssäkring av svetsade produkter.
- Svetsprocesser som MMA, TIG, MIG/MAG, FSW, lasersvetsning, konstruktionskrav och riktlinjer.
- Mekaniska egenskaper och mikrostruktur av följande svetsade material: Aluminium, Nickelbaserade superlegeringar samt olika stålsorter.
- Utvärdering och provning av mekaniska egenskaper och mikrostruktur.
- Svetsbarhetsprovning med hjälp av Varesstraint och Gleeble.
- Introduktion till oförstörande provning.

Industri och akademi

Denna kurs är framtagen i samverkan med industrin inom ramen för ett av våra utbildningsprojekt. Projektet syftar till att ge kurser till en mix av studenter och yrkesverksamma för att förstärka den svenska industrins konkurrenskraft.

Gennomförande och pedagogik

Kursen bedrivs enligt Högskolan Västs koncept *Arbetsintygenst lärande* som syftar till att integrera teori och praktik på olika sätt i kursen. Teoriföreläsningar varvas med verklighetsbaserade fallstudier och exempel.

Webbaserad kursform med enstaka träffar

Kursen genomförs huvudsakligen på distans i flexibla och nätbaserade former med en eller två fysiska träffar. On-lineföreläsningar varvas med handlednings- och redovisnings-tillfällen via webbmötesystem. Vissa tillfällen kommer att kräva obligatorisk närvaro on-line.

Kursmaterial

Bok, kompendier, föreläsningsteckningar.

Målgrupp

Yrkesverksamma inom tillverkningsindustrin.

Förkunskaper

Tre års högskolestudier med teknisk inriktning (högskoleingenjör eller kandidat inom teknik 180hp). Alternativt relevant arbetslivserfarenhet. Bifoga meritföreteckning om du söker baserat på arbetslivserfarenhet, du hittar mall på vår hemsida www.hv.se/produktionskurser

Examination

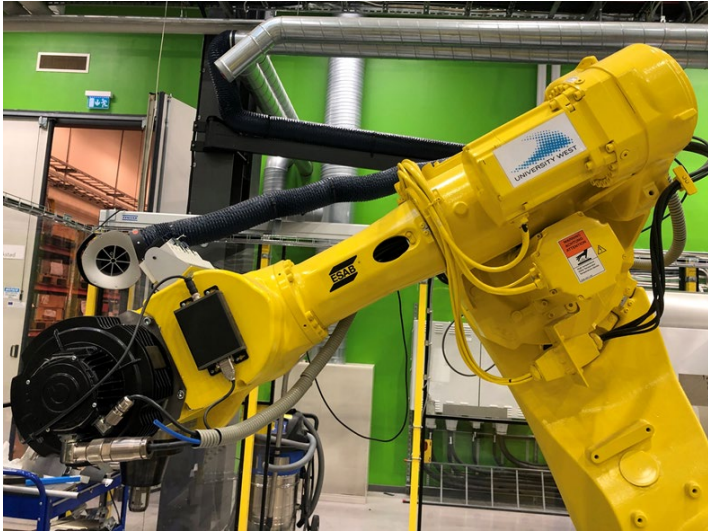
Examination kommer att ske löpande under kursens gång genom inlämningsuppgifter.

Anmälän

Anmälan till kursen sker via Högskolan Västs webbsida www.hv.se/produktionskurser

Övrig information

Frågor kan skickas till produktionskurser@hv.se



Solid-state Welding R&D

- ❑ Friction Stir Welding
- ❑ Ultrasonic Welding



Vivek Patel: vivek.patel@hv.se



Thank You 😊

