



Laser Applications Addressing Joining Challenges for Electrification

EPIC
Online Technology Meeting on
Photonics for Mobility of the Future



JOINING
INNOVATION
AND EXPERTISE

TWI Ltd
Paola De Bono
17th October 2022

Contents

- Background
 - TWI - Profile
 - Lasers at TWI - Profile
- An overview of joining challenges and laser applications in the e-mobility sector
- Summary and conclusions

Scope of Laser Processing at TWI

- TWI is a Research & Technology Organisation
 - Multidiscipline Expertise: engineering, materials and joining technologies
- Involved in laser processing since the 1960's with circa £4.1Mn pa turnover in this field
- Core Laser Process activities:
 - **Laser joining** of metallic materials
 - Laser welding, hybrid laser-arc welding, laser brazing
 - **Laser specialist cutting** of metallic materials
 - **Laser (non-additive) surfacing** of metallic materials
 - **Additive Manufacture** – laser metal deposition and selective laser melting
 - Laser **processing of ceramic and polymeric materials**



Why laser welding is suitable

Process capabilities

Non-contact

High speed

Penetration range: typ. 0.2-2mm

2-, 3- and 4-ply lap joints: thin/thick *preferred*

Dissimilar joints



Materials

compatibility

High surface reflectivity

High thermal conductivity

Low heat input

Avoiding leaks, fire, thermal runaway...

Minimising intermetallics in dissimilar joints

Process variants

Concentrated IR beams

- Often wobbled...
- Fired with short pulses (at high frequency)

Less concentrated visible beams

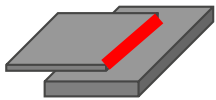
- Better absorption

Busbar-to-Terminal joints

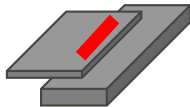


Battery Cases

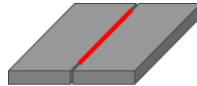
- Commonly Al (or steel) butt, lap/stake and edge lap joints



Lap/edge



Lap/stake



Butt



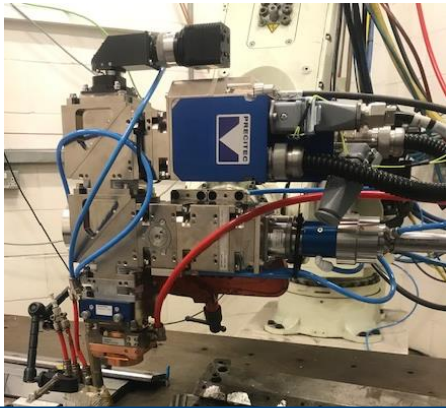
Thicker materials (1-5mm) involved

Example edge weld: made using a multi-mode 'wobbled' beam

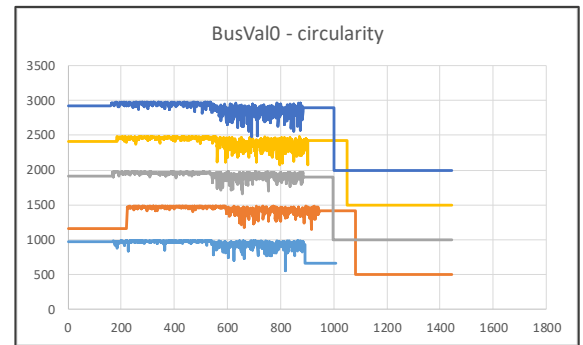
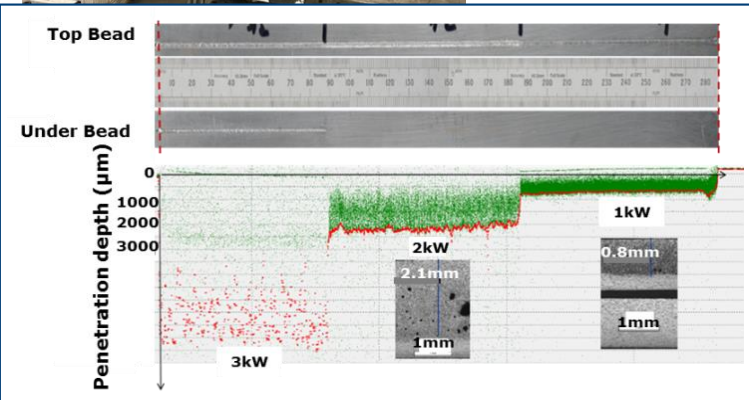
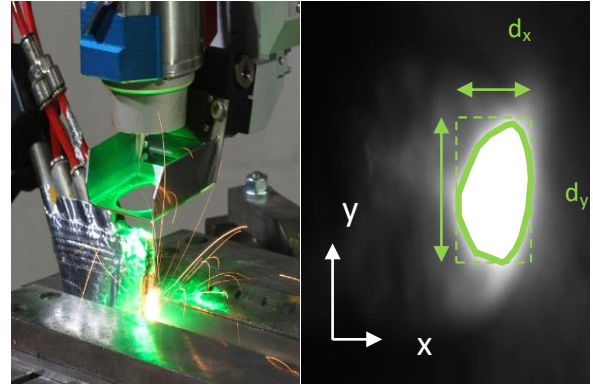
In-process monitoring

To ensure that process is robust

- Keyhole depth monitoring



- Image monitoring



Module Build Prototype Production

BMW-TWI collaboration within Advanced Propulsion Centre (APC) funded programme

- Tooling design & manufacture
- WPSs development
- Validation on HV module assemblies (dummy to live assemblies)
- Offline simulation
- Module production (assembly and welding)
- Logistics (storage, packaging, dispatch)



<https://www.twi-global.com/media-and-events/press-releases/2021/high-performance-automotive-with-a-green-future>

<https://www.twi-global.com/media-and-events/press-releases/2021/twi-meets-ev-battery-challenges-for-bmw>



ALBATROSS – Development of an integrated approach based on smart batteries combined with lightweight designs

TWI is working with Cleantron, Fraunhofer IWS and CRF, contributing with

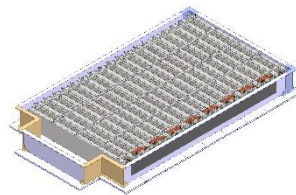
- Laser beam welding knowhow for thin section, dissimilar materials joints typical of busbar to cylindrical cell connections
- Weld quality characterisation (geometrical information, microstructure etc) and weld property measurements (resistance, strength, corrosion resistance etc)
- Support with prototype manufacturing



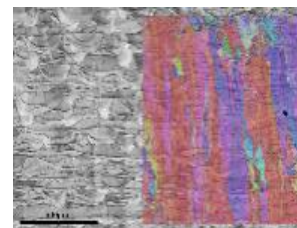
Dissimilar welding



Weld quality



Prototype manufacture



Materials characterisation and testing



Summary of TWI support

- Process development and knowledge transfer
 - Cylindrical, prismatic and pouch cells
 - Dissimilar materials joining
- Tooling design and build
 - Offline simulation
- Scale-up: coupons to live modules
 - Prototypes and low volume production (involving both assembly and welding)
 - Logistics (component receipt, storage, packaging and dispatch).
 - In-line process checks and procedures to ensure finished quality
 - >20,000,000 welds to date!
- Infrastructure and safety procedures for work with live cells and modules

Thanks... and... Contact us!



Paola De Bono

Section Manager

paola.debono@twi.co.uk



Chris Allen

Consultant

chris.allen@twi.co.uk

JOINING
INNOVATION
AND EXPERTISE