Cell contacting by laser welding

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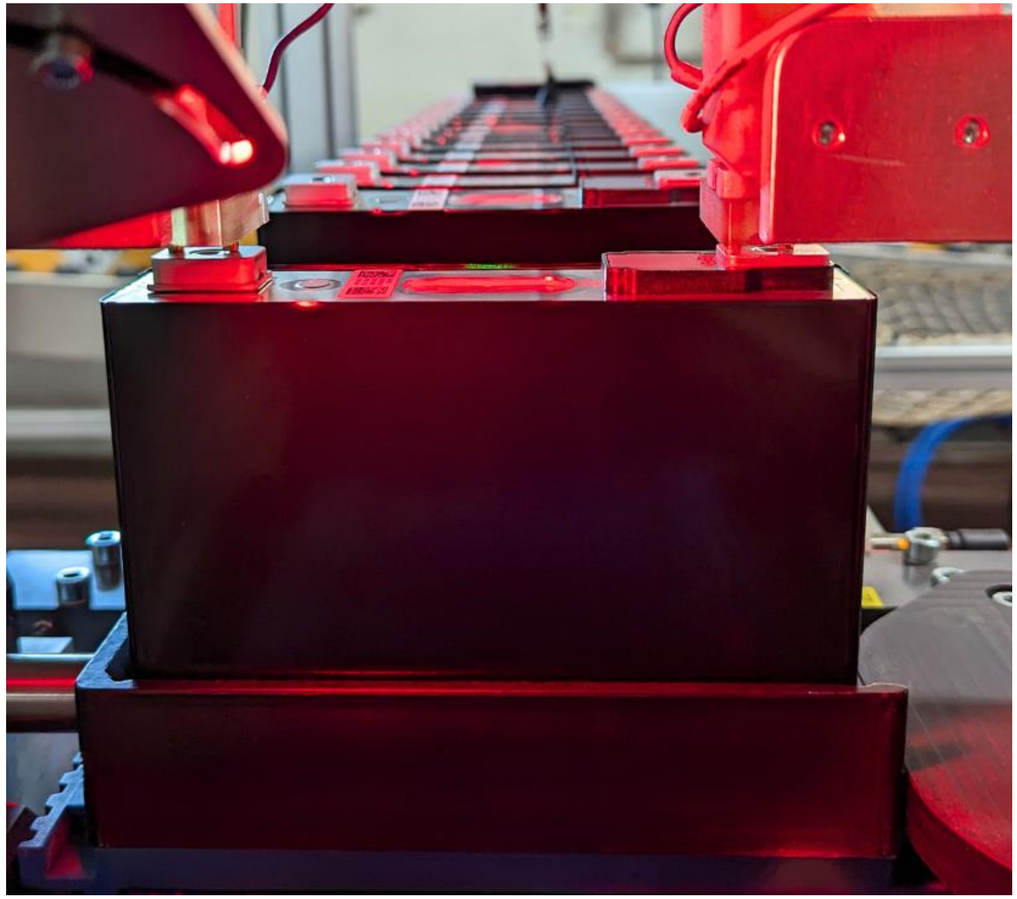
Epic-Meeting ARENA2036

AGENDA

- BBW Lasertechnik GmbH
- E-Mobility at BBW Lasertechnik
- Overview laser welding
- Cell contacting by laser welding
- Quality assurance measures
- Process chain battery module production at BBW



BBW LASER TECHNIK

Contract manufacturing through innovative laser material processing:

From the first experiment to industrial production.

Additional services

Process development

Construction

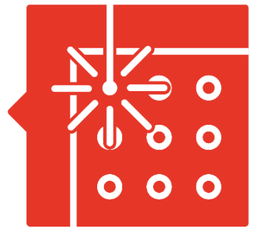
Mechanical processing

Our focus

Laser welding

Laser cutting /
Precision laser cutting

Laser drilling



Surface structuring

Quality & metallography

Assembly

Sheet metal forming

BBW Lasertechnik heute

Family company & leading manufacturing service provider

In-house construction departement

Complete processing of assemblies

In-house R&D

Comprehensive quality management (ISO 9001, DIN 2303)

50 laser systems

200 qualified employees

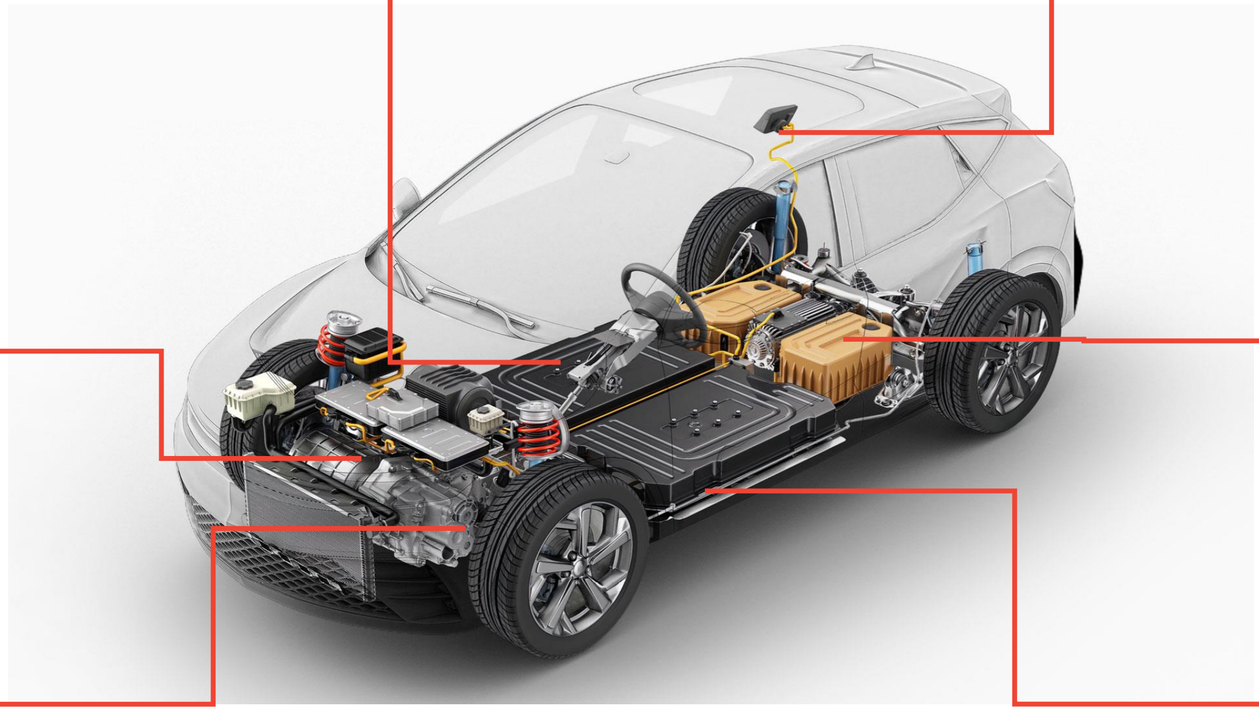
In-house training & education

E-Mobility at BBW Lasertechnik

Battery cooler

Connector

Electric motor



Busbar

Housing
Power Electronics

Batterypacks

Source: Adobe Stock

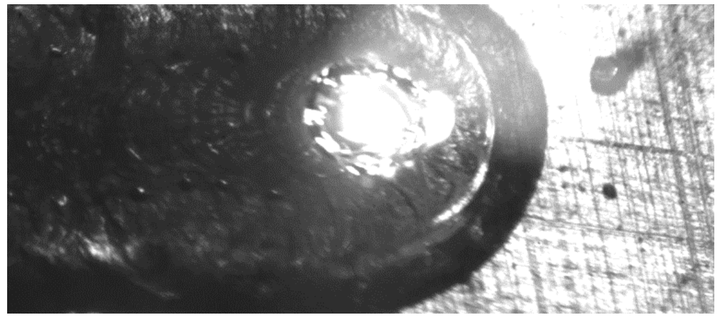
BBW‘s involvement in product development process

Involvement

Results

Process development and trial production

- Feasibility studies
- Technical check for weldable design



Sample and prototype production

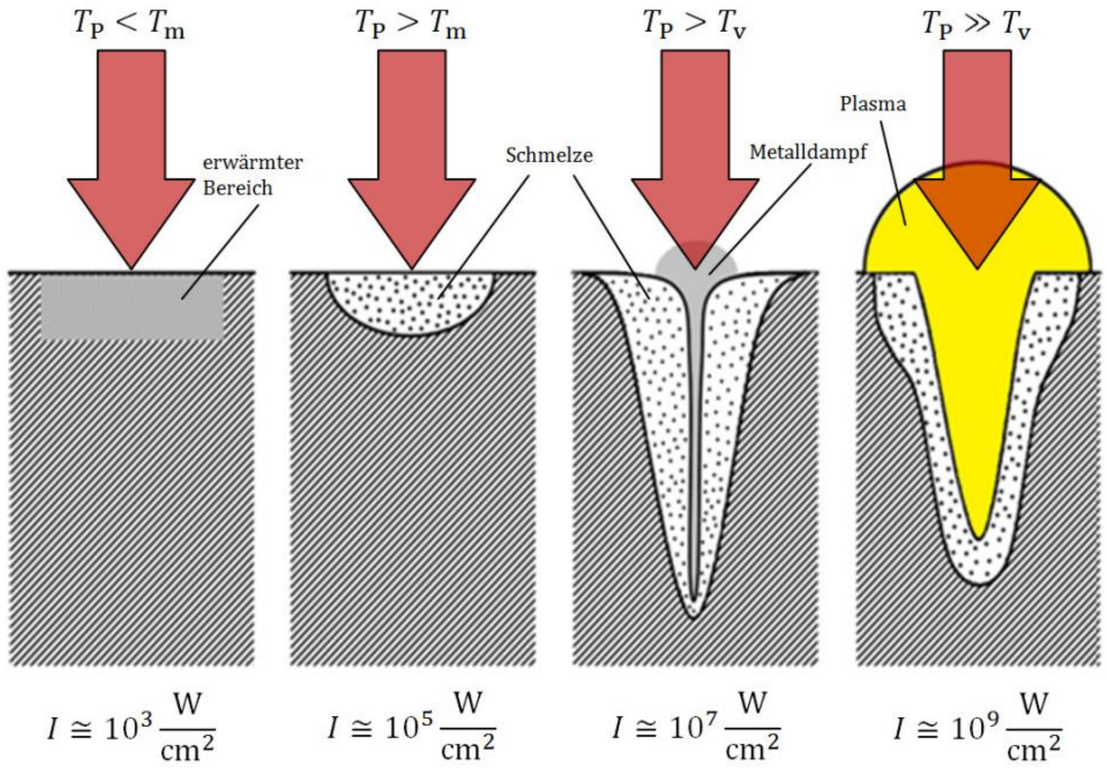
- Production of first complete parts
- Support for fast ramp-up
- Quick in-house support with fixtures
- Initial sample test report

Serial production

- Part produced under serial production conditions
- Statistical process control
- Sufficient capacity and redundancy

Absorption and heating mechanism

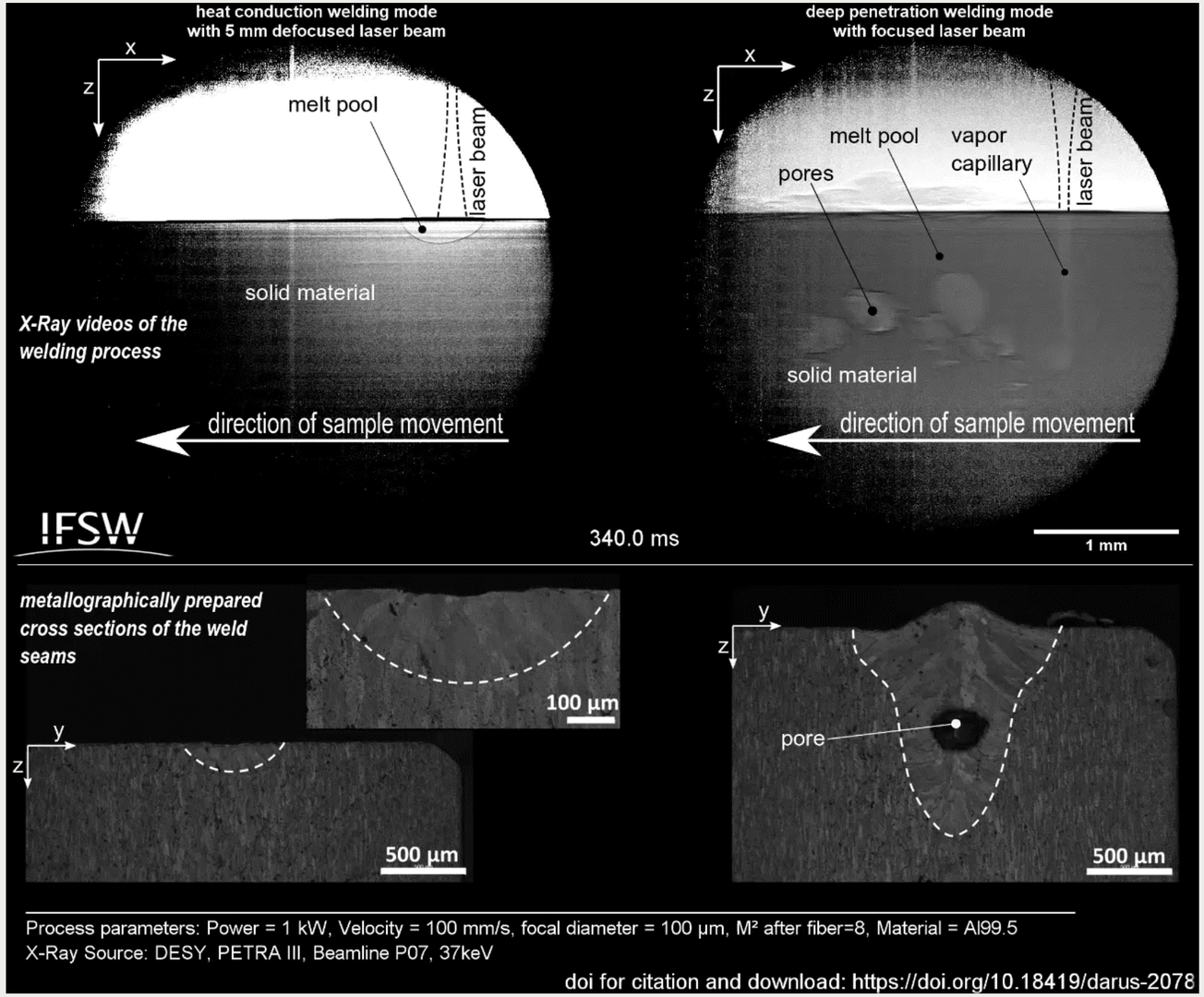
- Heating by conduction at low tntensity (10^3 – 10^4 W/cm^2)
  e.g. laser hardening
- Melting and formation of a melting front (10^5 – 10^6 W/cm^2)
  e.g. laser heat conduction welding
- Evaporation in a vapor capillary at higher intensity (>10^6 W/cm^2)
  e.g. laser deep welding
- Sublimation and plasma formation at even higher power density (>10^9 W/cm^2)
  e.g. laser marking, laser ablation



Source: Hochschule München

X-ray analysis: welding process

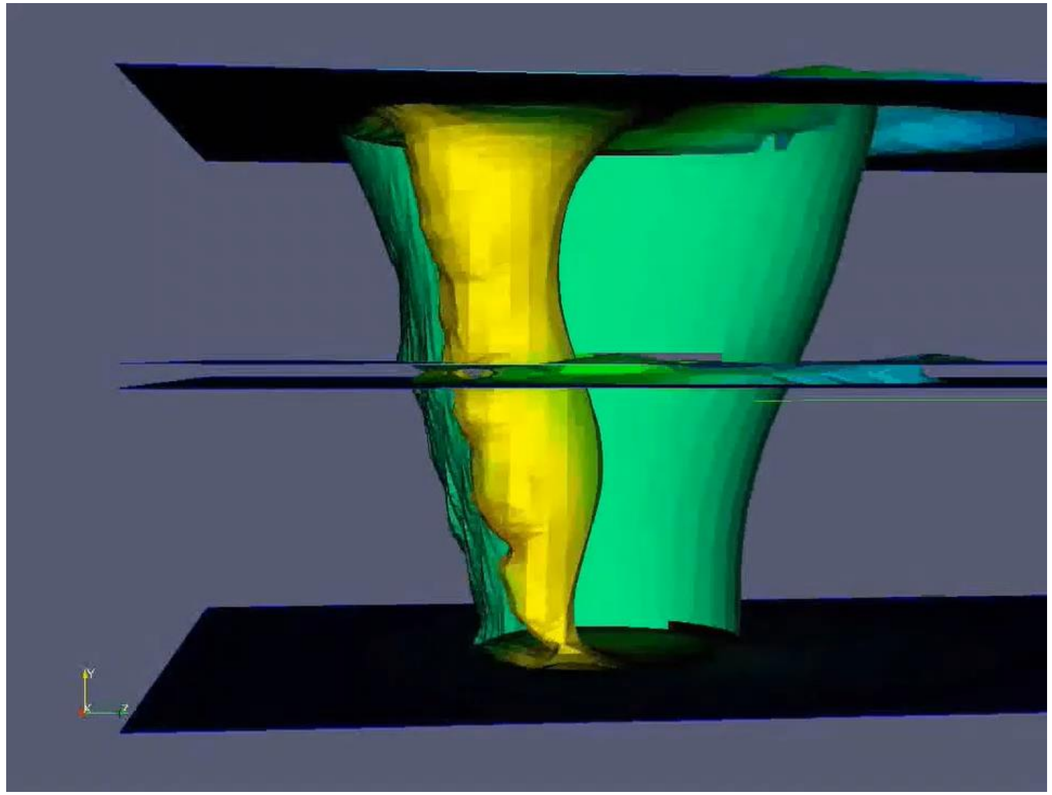
- Heat conduction welding (left), Pure melting of near-surface areas
- Deep penetration welding (right) with vapor capillary and, in the case of an unstable welding process, also formation of process pores



Laser deep welding

Principle:

- Formation of a vapor capillary
  - Absorption
  - Pressure equilibrium
  - Circulation
- Convection in the melt pool
- Solidification of the melt



Source: LPT

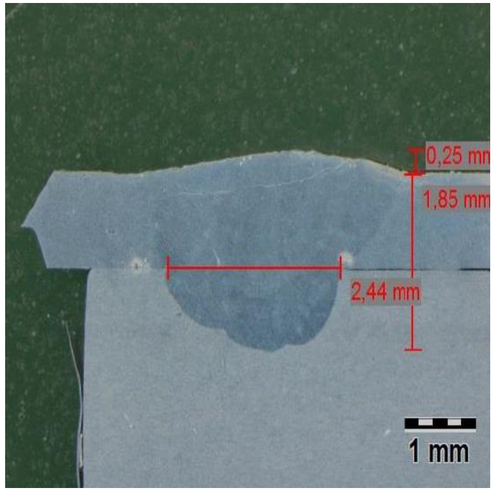
Cell formats and weldet joints (examples)

Prismatic cell	Round cell	Pouch cell
		
Aluminum 1 mm Aluminum 1 mm	Copper 0,3 mm Steel 0,3 mm Aluminum 0,3 mm Steel 0,3 mm	Copper 0,3 mm Aluminum 0,5 mm Aluminum 0,5 mm Copper 0,3 mm

Challenges:

- High Quality requirements: zero defect tolerance
- Safety: Avoid short circuits and damage
- Material variety: Welding of dissimilar welding
- Technology: Specific clamping technology and suitable laser required
- Cots: Minimum cost per weld

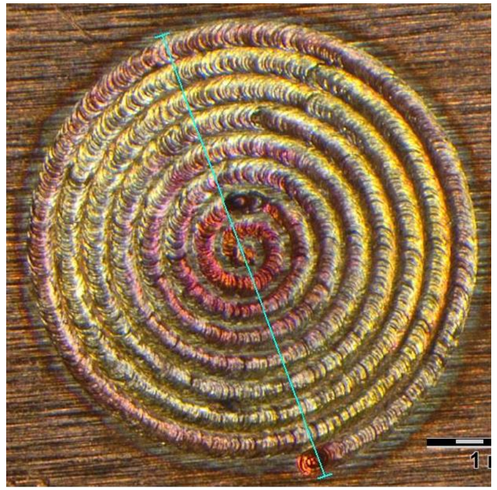
• Prismatic cell

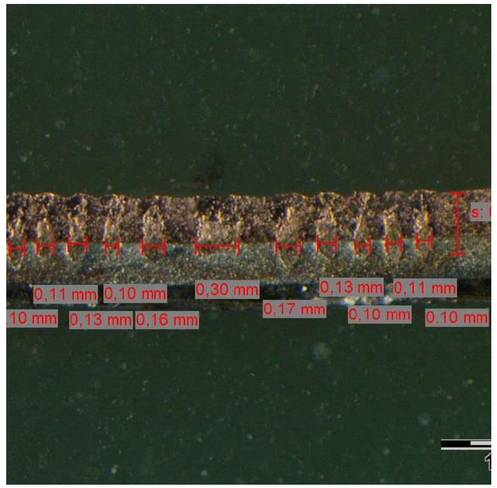


BBW solution approach:

- Overlap welding with the laser beam
- Beam shaping
- Zero defect tolerance through inline process monitoring
- 100% traceability through laser marking
- Chemical cleaning or laser cleaning

• Round cell

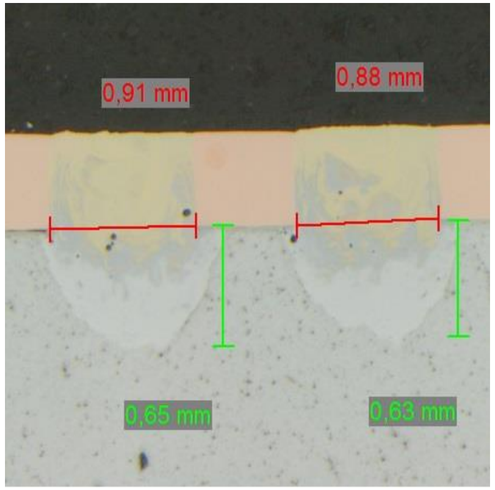




BBW solution approach:

- Overlap welding with the laser beam
- Low penetration welding to avoid intermetallic phases
- Lowest heat influence
- Beam shaping and/or high-speed
- Zero defect tolerance through inline process monitoring

• Pouch cell

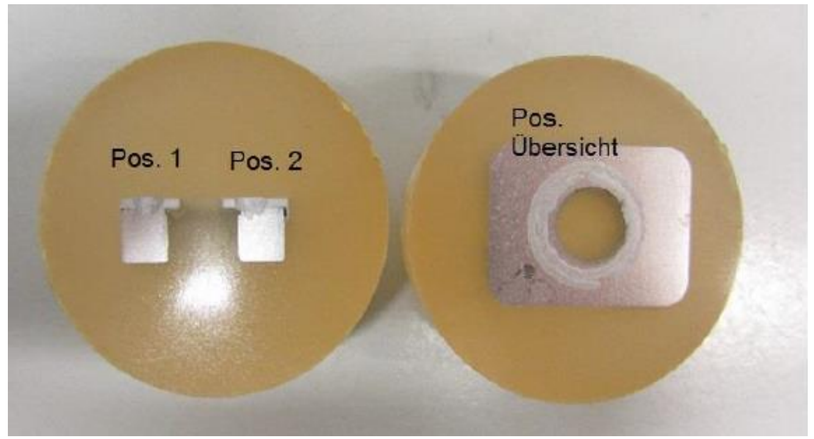


BBW solution approach:

- Overlap welding with the laser beam
- Single or multilayer welding
- In case of dissimilar metals only low weld penetration allowed
- Beam shaping
- Zero defect tolerance through inline process monitoring

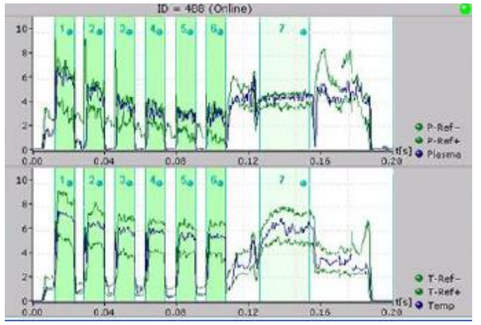
Metallography

- Destructive testing
- Preparation by: Separating the specimen, embedding, grinding, polishing, contrasting by selective etching.
- Evaluation by: Microscopy, documentation.
- Up to 1 µm with light microscope, 10-100 nm with scanning electron microscope
- Distinction between macro and micro cross section.
  - Macro: Evaluation of layer structure, firing ratios, HAZ, segregations, and location and type of defects (pores, cracks).
  - Micro: microcracks, micropores, microstructure, non-metall. inclusions
- Detection of all defect patterns
- **Used by BBW Lasertechnik in process development and during series production**

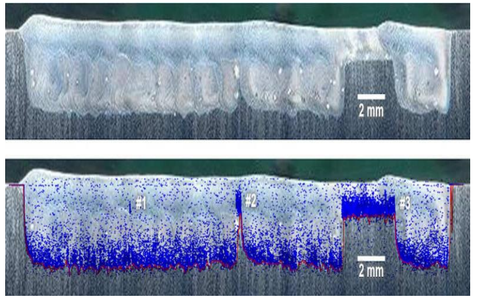


Online-Prozessüberwachungen

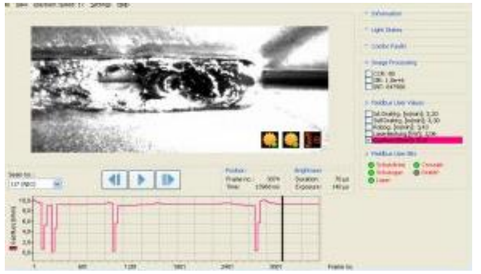
- **Process light**: is generated by workpiece, melt, metal vapor
  - Detection principle: A photodiode detects the process light in a limited wavelength range, comparison with a reference signal



- **Welding depth measurement**: Optical coherence tomography
  - Detection principle: Comparison of back-reflected measuring radiation with a reference beam → Interferometer

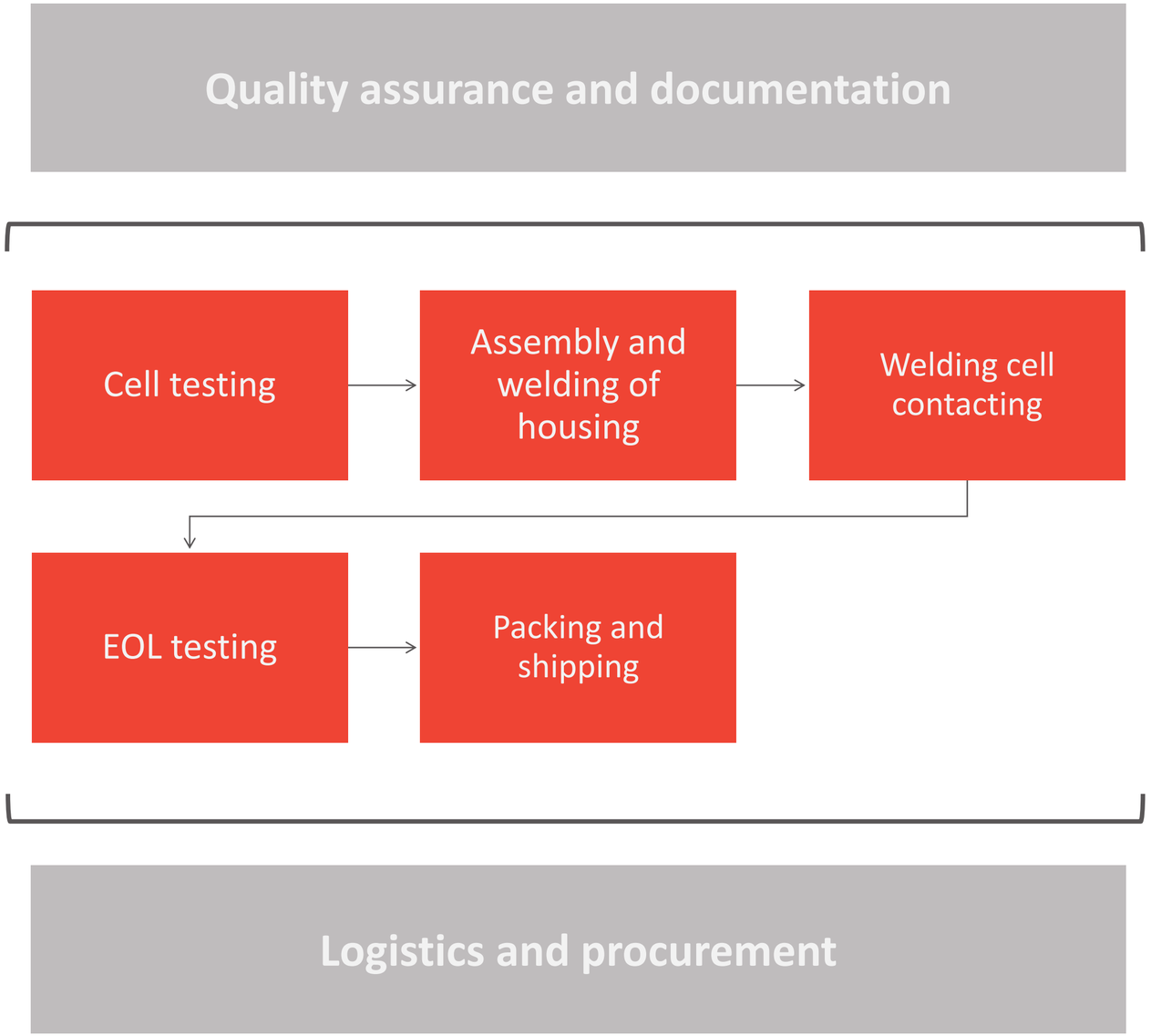


- **Monitoring of seam contour**:
  - Variant 1: Camera monitoring: Detection of the seam by evaluating image data
  - Variant 2: Imaging OCT: Light-sectioning method by scanning the surface



Source: Precitec, Lessmüller

Battery module production process chain



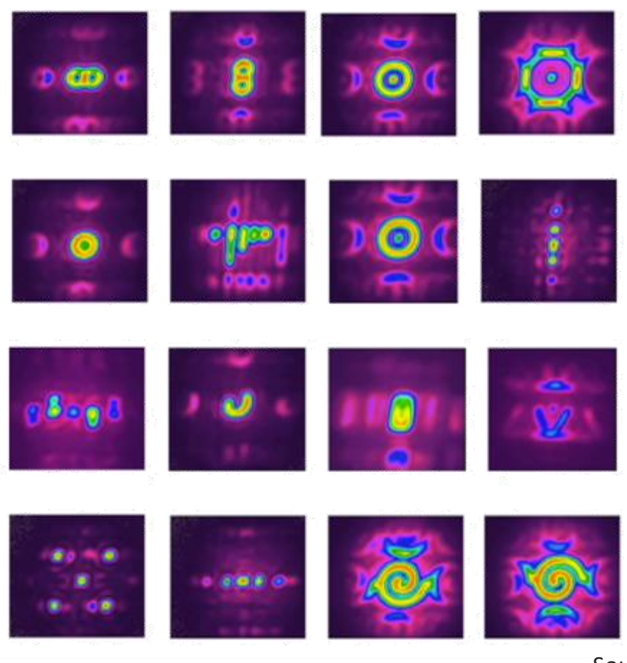
Project data:

- Battery module with prismatic cells
- Application in logistics
- Online process monitoring: traceability at cell and weld seam level
- First test to series production
- Automation through in-house engineering and mechanical engineering
- Capacity up to 200.000 modules p. a.

Outlook: Dynamic Beam Shaping

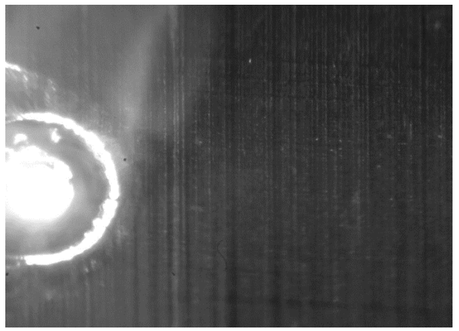
- @BBW: 32 individual laser modules are combined
- Each channel can provide 10 - 500 W
- Modulation within nanoseconds

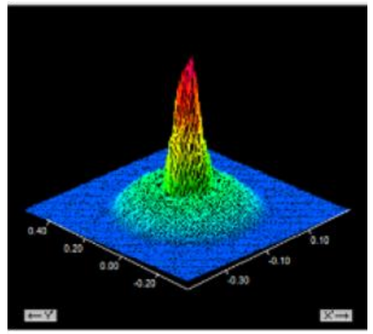
→ Principle of constructive and destructive superposition, wave components cancel each other out or reinforce each other

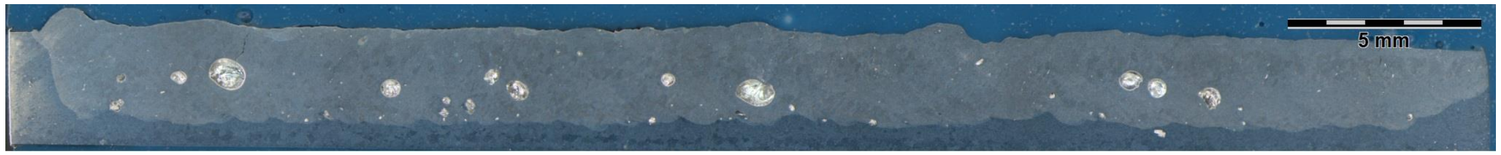


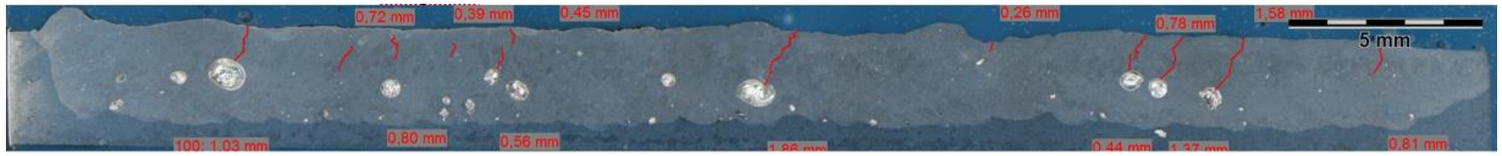
Source: Civan

Example: Aluminum AW 6060 & Beam shaping

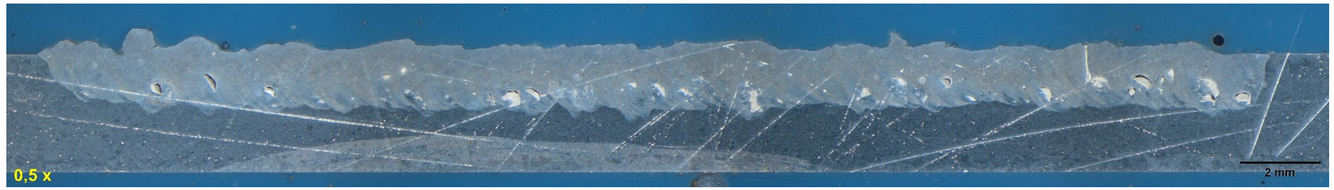


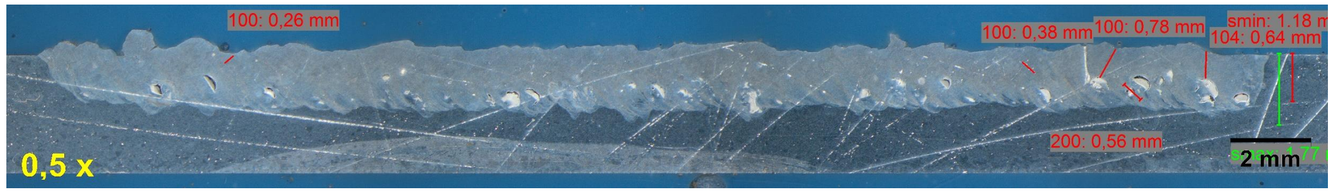


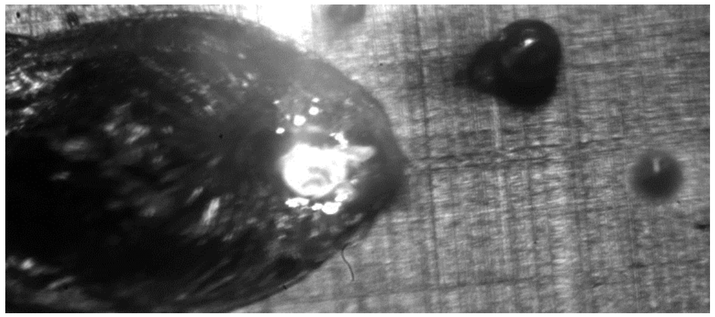


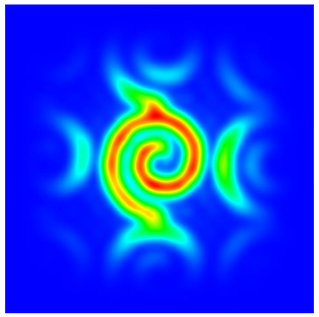


Parameter: Disk laser, BLW 50/50, focal diameter 250/1000;
power = 4,5 kW, speed = 100 mm/s

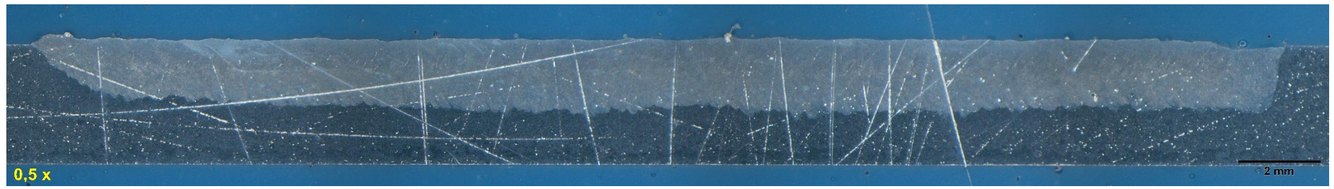


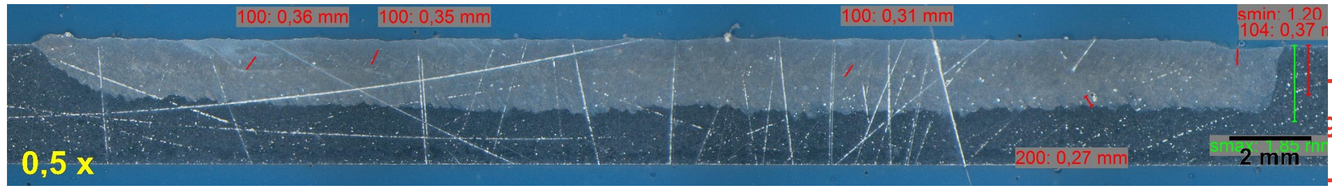


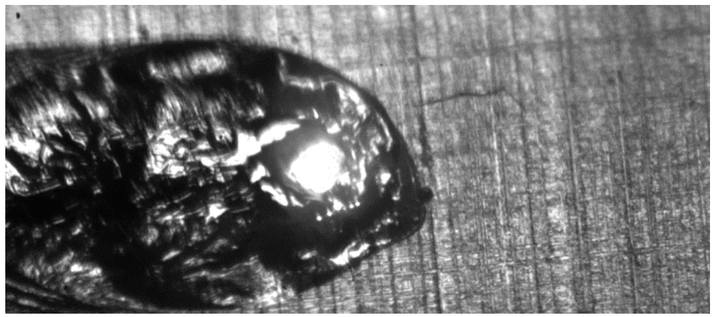


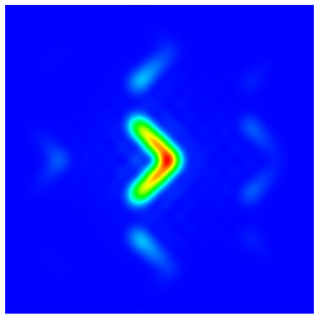


Parameter: frequency = 500kHz; power = 1,8 kW, speed = 100 mm/s









Parameter: frequency = 222,2kHz; power = 1,8 kW, speed = 100 mm/s

CONTACTING

Send us your project or product idea!

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Thank you!

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