HYBRID LASER WELDING
of Aluminium

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OUTLINE

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The process

- Laserinduced plasma
- Shielding gas
- Keyhole
- Workpiece
- Laser beam
- Electrode
- Arc
- Fusion zone
- Direction of welding
Synergies

ARC
Low-cost energy source
Gap bridgeability
Microstructure can be influenced

LASER
Great welding depth
High welding speed
Low thermal load
High tensile strength

HYBRIDPROCESS
Better metallurgical quality
Higher welding speed, big throat thickness
Saving expensive laser energy
Low distortion, Higher bridgeability
High weld seam quality
Process combination

Alu 6082 T6, thickness 4 mm
Welding speed = 1.2 m/min
Nd:YAG Laser power = 3.8 KW
MIG parameters: 90 A, 16 V, wire speed = 2.2 m/min
**Process parameters (1)**

**MIG**

**Arc:**
- Voltage
- Current
- Power source (DC, AC, pulse)
- Pulse frequency
- Stick out

**Wire:**
- Speed
- Diameter
- Type

**Other:**
- Torch orientation
- Gas shielding
- Edge preparation

**LASER**

**Source:**
- Type (CO₂, Nd:YAG, ...)
- Power
- (Pulse frequency)

**Optics:**
- Focal length
- Spot size
- Focal position
- Single – double focus

**Other:**
- Welding speed
- Gas shielding
- Edge preparation
Process parameters (2): interactions

Distance between laser focal point & impingement of the arc:
- Determination of weld pool geometry
- Bigger weld pool = easier outgassing
- Small distance: interaction laser – MIG
- Larger distance: interaction will become negligible

Geometrical formation of laser beam and arc torch
- Angle between laser & MIG (normally fixed to 30°)
- Laser leading or trailing (normally laser leading)

Shielding gas
- CO\textsubscript{2} laser: helium needed (to suppress plasma formation)
- Nd:YAG: Ar pure or Ar/He (He gives higher penetration)
Experimental process parameter determination

1. Laser only: determination of laser power
   - full weld penetration

2. Hybrid: determination of MIG parameters, based on:
   - visual inspection on weld appearance
   - no undercut, full penetration

3. Hybrid: interaction parameters
   - distance laser/MIG and gas shielding

4. Hybrid: fine tuning of laser & MIG parameters, based on
   - visual inspection, RX inspection
   - tensile tests, bend tests
Joint geometries

Single: max. 5; double max. 8mm

Fillet or Lap joint: max. 5 mm

T-joint: single 4, double max. 6mm

Lap-joint: max. 4 mm
Experimental setup LCV
Applications

Automotive
Volkswagen: Wolfsburg
Audi: Neckersulm
Mitsubishi: alu space frame

Aviation
Airbus Germany

Research
University of Aachen
Fraunhofer Laser Institute
Force Denmark, Vito
CSIRO Melbourne, Institut de Soudure (FR)
TWI Cambridge, JWRI Osaka

Other businesses
Piping, shipbuilding, construction, ...
Demonstration: alu 6061 T4, 4mm thick, 1.2 m/min
Continuation:
Experimental results by W. Van Haver

Thank you