GREAT DESIGNS IN STEEL

MULTI-SPOT LASER JOINING APPLICATIONS IN BIW

Oleg Raykis
Sales Manager – Laserline Inc.
COMPANY IN BRIEF

- Head office, Mülheim-Kärlich, Germany
- Founded in 1997, privately owned and managed company
- Approx. 350 employees globally
- Approx. 6,000 laser systems delivered

- Global presence with Laserline subsidiaries and distributors
- Leading company in high power diode lasers
- Diode lasers, Converted diode lasers, Blue diode lasers
- Beam deliveries, optics, accessories, process know how
JOINING TASK – DIODE LASER SELECTION

- Depending on wavelength (blue or IR)
  - Base material: degree of absorption

- Depending on base material thickness
  - Laser power up to 45kW
  - Using the advantages of spot sizes

- Depending on joining task
  - Beam shaping: using the right beam shaping for special geometrical welding tasks or replacing other joining processes
LASER TOOLS FOR METAL WELDING

- Complete Welding Optics
- OTS-5 optics
- OTS-3 optics
- OTC-3 optics
- Spot-in-Spot Module
- Cross-jet
- Cover slide monitoring
- Camera with cross-hair generator
BEAM SHAPING – TRIPLE SPOT FOR LASER BRAZING

Power Distribution

Latest Developments
Enlarged range of settings
Switching front spots on/off by robot
BRAZING HOT DIP GALVANIZED STEEL

State of the art – critical processes

“OR”-Module integrated in Scansonnic ALO3

4,5 m/min
4,7 kW

Improved Quality and Speed

Critical Processes

[W. Reimann, VW, EALA 2015]
BRAZING HOT DIP GALVANIZED STEEL

- Process qualified since 2016
- Installed currently in many production lines
- HDG applications in tailgates and roofs all around the world USA, Mexico, Germany, Slovakia, Czech Republic, South Africa, China, Portugal and Russia
SPOT-IN-SPOT MODULE FOR WELDING

Module
E.g. integrated in Scansonic ALO3 (M1,7/ 1,1/ 0,9)
Designed for welding with max. BPP 40
Circular center spot
Square outer spot
SPOT-IN-SPOT MODULE: ADJUSTMENTS

Power Distribution

Latest Developments
Enlarged range of settings
70% of the total laser power can be shifted between inner and outer spot
Comparison Single Spot and Spot-in-Spot welding

- Same power of 7 kW and welding speed of 2.5 m/min
- Spot-in-Spot intensity shift leads to less dynamics in weld pool

➔ Less spatters
SPOT-IN-SPOT MODULE: SINGLE VS. SPOT-IN-SPOT

**Single Spot**

Al 6000 with AlSi 12 wire

- Uneven seam with notches
- Welding speed 3 m/min
- Risk of micro cracks

**Spot-in-Spot**

Al 6000 with AlSi 12 wire

- Smooth seam
  - $v_{\text{welding}} = 8 \text{ m/min @ 4.1 kW}$,
  - $v_{\text{wire}} = 10 \text{ m/min}$
  - 1.2 mm AlMg4.5MnZr wire
SPOT-IN-SPOT MODULE: ASYMMETRIC WELDS

- **Applications:**
  - Sheet / extruded aluminum
  - Tight seams
  - Fillet seams
  - T-joints

- **Parameters:**
  - $P = 5 \text{ kW}$
  - $v_w = 4 \text{ m/min}$

- **Material:**
  - AISi12 Ø1,6 mm
SPOT-IN-SPOT MODULE: ASYMMETRIC WELDS

Tailored welded blanks

Advantages of Spot-in-Spot Module
- Higher speed
- Improved gap bridging behavior
- Less seam undercut
- Bigger process window
SPOT-IN-SPOT MODULE: ASYMMETRIC WELDS

Advantages

- Improved appearance
- Reduced spatter formation
- Improved gap bridging behaviour
- Increased welding speed
Advantages

- Improved appearance
- Reduced spatter formation
- Improved gap bridging behaviour
- Increased welding speed
SPOT-IN-SPOT-MODULE WITH WIRE: REPLACING GMA
MULTI-SPOT-MODULE WITH COLD-WIRE: REPLACING GMA

Advantages

- Higher welding speed
- Less distortion
- Gap bridging
- Less spatters
MULTI-SPOT-MODULE: WELDING IMPROVEMENT
BUTT- AND FILLET WELDS

- Mild steel
- Free root formation
- Pore and crack free welding
- Spot Ø 0.9-1.12 mm

<table>
<thead>
<tr>
<th>t = 5 mm, g = 0, PA</th>
<th>t = 5 mm, g = 0.1, PA</th>
<th>t = 10 mm, g = 0, PA</th>
<th>t = 5 mm, g = 0, PB</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{\text{Laser}}$ [W]</td>
<td>$v_w$ [m/min]</td>
<td>$P_{\text{Laser}}$ [W]</td>
<td>$v_w$ [m/min]</td>
</tr>
<tr>
<td>7,700</td>
<td>2.0</td>
<td>7,700</td>
<td>2.0</td>
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<tr>
<td>8,500</td>
<td>1.5</td>
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</table>

$P$ = Power, $v_w$ = welding speed, $v_{\text{Wire}}$ = wire feed rate, $g$ = gap dimension, $t$ = thickness, PA/PB = welding position A/B
**APPLICATION EXAMPLE**

$t = 11$ mm, $g = 0$, PA

<table>
<thead>
<tr>
<th>$P_{\text{Laser}}$ [W]</th>
<th>$v_w$ [m/min]</th>
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<tr>
<td>11,000 (wp)</td>
<td>1.5</td>
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<table>
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<tr>
<th>$P_{\text{GMA}}$ [W]</th>
<th>$v_{\text{wire}}$ [m/min]</th>
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<tbody>
<tr>
<td>0</td>
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Multi-Spot Laser Joining Applications in BIW
INACCURATE SEAM PREPARATION

- Seam preparation: flame cut
  - Rough surface and inaccurate seam preparation
  - Wide gap range (depending on quality cutting process)
  - Gap has to be filled with wire

- Positioning of flame cut forms a V-gap
  - 0.8 - 2.0 mm

rest of scale

20 mm
INACCURATE SEAM PREPARATION: BUTT WELD WITH FILLER METAL

- Free root formation in PC
- No counter pressure necessary
- Steel with yield strength 355 MPa
- Tends to hardness increase

$P = \text{Power}, \ v_w = \text{welding speed}, \ v_{\text{wire}} = \text{wire feed rate}, \ g = \text{gap dimension}, \ t = \text{thickness}, \ PC = \text{welding position C}$
HIGH POWER WELDS

Butt weld with inaccurate seam preparation

<table>
<thead>
<tr>
<th>$P_{\text{Laser}}$ [W]</th>
<th>$v_S$ [m/min]</th>
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</thead>
<tbody>
<tr>
<td>50,000</td>
<td>0.6</td>
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$t = 20$ mm, $g = 0$, PA
FOR MORE INFORMATION

Name: Oleg Raykis
Company: Laserline Inc.
Email: oleg.raykis@laserline.com