Trumpf - Soluzioni per la mobilità elettrica: dalla consulenza applicativa alle sorgenti laser e sensori di controllo

18-11-2020
TRUMPF is...

Family business since 1923
Technology leader in two business divisions
Close to its customers with 77 subsidiaries
Innovation promise – holistically and constantly

Machine tools for flexible sheet metal processing
Laser technology

Laser Beam Sources
Optics & Waveguides
Sensor Systems
Process Development
At a Glance
Company figures 2019/20

<table>
<thead>
<tr>
<th>Category</th>
<th>2019/20 (Mio. €)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>3.487</td>
</tr>
<tr>
<td>Orders received</td>
<td>3.278</td>
</tr>
<tr>
<td>Income before Taxes (EBIT)</td>
<td>309</td>
</tr>
<tr>
<td>Net operating margin</td>
<td>8.9%</td>
</tr>
<tr>
<td>Employees as of 30.06.2020</td>
<td>14,300</td>
</tr>
<tr>
<td>R+D Expenditures</td>
<td>377</td>
</tr>
<tr>
<td>R+D Quota</td>
<td>10.8%</td>
</tr>
<tr>
<td>Investments</td>
<td>194</td>
</tr>
</tbody>
</table>
E-cars made by Laser

- **Welding**
- **Cutting**
- **Heat Treatment**
- **Surface Treatment**

**Batteries**
- Battery Pack
- Prismatic Cell
- Can Cap

**Car Body**

**Interior Design**

**Electrified Powertrain**
- Rotor Shaft Welding
- Stator with Hairpin
- Stator Package

**Low and High Power Electronics**
- Electronic Control Unit
- Direct Copper Bonding
CONTACTING TECHNOLOGY
HAIRPIN DECOATING & WELDING

REMOVAL OF THE ISOLATION
Hairpin Build

**Isolation Layer**

- Prevents Electrical Short-Circuit
- Different Materials are used
- PAI (Polyamid-Imid)
- PEEK (Poly-Ether-Ether-Keton)
- PI (Poly-Imid, Kapton)
- PEI (Poly-Ester-Imid)
- Mixed Systems (PEEK over PAI)

All mentioned coating types work with the TRUMPF laser decoating process at comparable cycle times.
E-drives: Laserdecoating of Hairpins
State of the Art Welding Preparation using High Peak Power ns pulsed Lasers

Insufficient Decoating
Remains of coating- or bonding materials lead to burnings and bad welding quality.

Mechanical Decoating
Security Removal of Copper

Laser decoating
No loss of copper material, Selective processing
No remains of coating/bonding materials
Cycle times <0.5 s
Proposed Optical Setup for Hairpin Decoating
Scalable to single or multi-wire specifications through flexible beam management

Most versatile solution

- Fastest processing times
- Works with all coating types (comparable processing times)
- For large wire cross sections

Tailored solutions

- Small Wire cross sections
  or long Cycle times
- Medium Wire cross sections
  or moderate Cycle times

Key feature: high pulse energy enables high fill factor & spot size resulting in high speeds
CONTACTING TECHNOLOGY
HAIRPIN DECOATING & WELDING

HAIRPIN WELDING
Solution Bundle for Hairpin Laser welding
State of the Art Process Control

TruDisk Bright Line Weld Laser
LLK 100/400μm
LLK 50/200μm
Typical Laserpower 6kW

Positioning data

Measurement data

Welding time per weld
25 to 200ms
(depending on geometry)

Welding time as function of weld volume

- Closed Loop Real Time processing based upon 100% position measurement
- Freely programmable (weld shape)
- Ready to run, Easy to integrate
- Beam Management allows to use one lasersource for multiple workstations/optics

https://www.youtube.com/watch?v=xwtLkxYei4
CONTACTING TECHNOLOGY
HAIRPIN DECOATING & WELDING

INTEGRATED SENSOR TECHNOLOGY FOR HAIRPIN WELDING
An important use case is position correction

- **High process reliability** → Visualization of welding points and correction of eventual error displacement.
- **Intuitive operation** → Intuitive user interface and predefined pattern library. Easy to integrate.
- **Tailor-made solutions (VisionLine Project)** → VisionLine can also be easily enhanced for complex image processing tasks.
CONTACTING TECHNOLOGY
HAIRPIN DECOATING & WELDING

HAIRPIN WELDING, Bright Line Weld Multi-Spot welding
Bright Line Weld - solution for spatter reduction using IR for copper welding

BrightLine Weld is based on the TRUMPF technology of the 2in1-fiber.

Attributes:

- **Patented** waveguide lay-out of TRUMPF 2in1-fiber
- Full flexible superposition of two beams into the process zone ➔ Optimum applicable to the welding task
- Basic principle optical wedge 2in1-fiber:
- Optical wedge Bright Line Weld

Comparison: SingleSpot

New welding parameter: Power distribution

Definition of power distribution

\[ m_{Pav} = \text{Core} : \text{Ring} [%] \]
Bright Line Weld Technologies for Hairpin Welding

TruDisk and option BrightLine Weld

Optics: BEO, PFO

2in1-fiber

Fiber diameters

Typical Power for Hairpin Welding

50µm/200µm

3kW, 4kW, 5kW, 6kW

100µm/400µm

4kW, 5kW, 6kW, 8kW

50µm Lasers available from 1 to 6kW
100µm Lasers available from 1 to 8kW
Quality Monitoring – Example 4D Weldwatcher

- Integration of the sensor into the laser source via Trumpf adapter
- Installation in less than 30 min
- Monitoring of all optical paths
- Quick trials/tests possible
Hairpin Welding – References
Hairpin Welding – Remaining Insulating Coating-Bonding
TruDisk with Green Wavelength (cw) Processing on the green side of light
Hairpin Welding – Remaining Insulating Coating-Bonding

- Ideal tool for heat conduction welding of copper
- Foil or sheet thickness of up to about 2 mm
- Stable and reproducible process
- No spatter formation
- Highest weld seam quality
- High productivity due to high feed rates
- No beam oscillation required
- Constant weld depth

https://www.youtube.com/watch?v=aUsWFSOf95Y
Trumpf at a glance: E-cars made by Laser

Worldwide service
Optics
Trainings
Lasers
Monitoring systems
Quality systems
Products innovation
Integrated solutions
Partner for your solution
Consulting
Application supports
Machine tools
Software
Etienne Caracciolo
Sales
Etienne.Caracciolo@trumpf.com
Phone: +39 348 2570039