AGENDA

1. TRUMPF Introduction

2. Automotive Laser Applications
   - Powertrain
   - Light weight and e-mobility
   - Body in white incl. remote
   - Hotforming

3. Conclusion
TRUMPF Introduction
Worldwide Support

Our Sales-, Application and Production Locations LT

51 Worldwide Locations

<table>
<thead>
<tr>
<th>Region</th>
<th>Locations</th>
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<tbody>
<tr>
<td>Germany</td>
<td>10</td>
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<tr>
<td>Europa (w/o G)</td>
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<tr>
<td>America</td>
<td>7</td>
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<td>Asia/Pacific/Other</td>
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Production Location
Application Center
Sales- and Service location
Distribution Partner
Automotive Laser Applications
- Powertrain
- Light weight and e-mobility
- Body in white incl. remote
- Hotforming
TRUMPF Laser Applications in Automotive Industry

Powertrain
- Motor
- Torque Converters
- Clutches
- Gearbox

Motor
- IP Beam
- Battery
- E-Motor

HV Battery

Brazing
- Trunk lid
- B-Pillar
- Roof
- Roof rail

Remote
- Hotforming
- Powertrain
- E-Mobility

source: Uni Siegen
TRUMPF – Typical Laserapplicationen in Powertrain

Gearbox components

Engine components

source of pictures: BMW, Daimler AG, ZF, BoroWarner, Bosch, Mahle
Laser welding of Differential Gears with additional material „filler wire“

Housing: GJS600 cast material
Ring gear: case hardened steel e.g. 16MnCrS5
Filler wire (e.g. CrNi 19-9)
Typical laser power: approx. 4-5kW
Successful Laser Application: Weight savings, reduced production cost

Advantages of laser welding
- **Cost reduction** as screw fasteners are eliminated
- **Material savings** the diameter and thickness of the housing flange is reduced (t<T; d<D):
  - **Weight reduction** (approx. 1kg/diff)
  - **Smaller** part dimensions
- **Larger torques** can be transmitted
- **Reduced noise emission**

**Material**
- Housing: GJS 600
- Ring gear: 16MnCrS5
Laser welding of Differential Gears with additional material „filler wire“

1. Laser cleaning station for housing and ring gear

2. Laser welding station
   Weld speed: approx. 1.5 m/min
   Penetration: ~ 5 mm
   Cast material / case hardened steel
   With filler wire
Integrator Solution: New Automatic Transmission
8- and 9-speed automatic transmission

source: ZF

source: Felsomat

TRUMPF TruDisk / TruMark Lasers
Inflatable sheet metal structures

- From Design-Object to innovate lightweight design
  - DesignStool PLOPP
  - Lightweight bridge; Material thickness 1mm, mass 174kg, carrying capacity 1850kg

source: www.zieta.pl
Perforation of materials and CFRP cutting example

- Perforation of materials for:
  - Lightweight design
  - Noise reduction
  - Optical effects
  - Ventilation
  - ....

- Possible materials
  - Fiber reinforced plastics
  - Plastics
  - Leather
  - ....

- Characteristics
  - > 50 µm diameter
  - User-defined alignment of holes – even on 3D-parts
Metal-Plastic-Joining

- Undercut structures, macro- and microscopic size, on metal surface
- Welding of plastic material on structured metal surface
- „Welding“ of Parts
Welding of bus bar

**Application**
- welding of bus bar

**Material**
- Cu-Cu; 0,3 mm – 1 mm
- Al-Al; 0,3 mm – 1 mm

**Requirements**
- electrical contact
- mechanical strength

**Laser**
- TruDisk

**Scanner**
- PFO (Programmable Focus Optics)

**Customer Value**
- flexibility in cutting geometry
- no splittings
- no splatter
Laser Remote Welding as new design enabler

Remote Laser Welding advantages

Customized weld patterns allow for optimum strength of the joints and increased design flexibility due to:

- virtually any weld seam shapes
- virtually any orientation of weld seams
- user defined distribution of weld seams
- optimum flow of forces

- reduced flange width
- material, weight and cost savings
Laser Remote Welding as new design enabler

Remote Laser Welding of car doors

Door design

The design of the W204 door represents the best possible compromise between functionality, weight, cost, quality and production compatibility.

- **Lightweight steel design**
- Reduced visibility interference angle
- Enhanced frame and inherent rigidity
- Improved crash performance
- 100% of DC welding by Robscan

**Highlights:**
- Inserted window frame

**Table:**

<table>
<thead>
<tr>
<th>Function</th>
<th>Crash</th>
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<table>
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<th>Weight</th>
<th>-1 kg</th>
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<th>Cost</th>
<th>-15%</th>
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- Laser Dimpling
- Laser Welding (86 welds in 35 sec)
- Error rate: 0.003 % of welds
- Beam-on-time > 90%
- 30% less floor space than predecessor

Sources: Euro Car Body 2007, Mercedes Benz, The new C-Class
Data: Laserstammtisch, Bremen, Feb. 2008

Reinforced hinge
high-strength
(ZE340)

Side impact reinforcement
ultra-high-strength
(MSW1200)

Paneling up to beltline
Brazing process

3-metal welds panel roof/reinf roof side rail/panel body side outer in roof ditch

2-metal welds reinf roof side rail/panel body side outer in roof ditch; panel roof to panel body side laser brazed

no sealing needed + „class-a“ surface + waterproof

Quelle: FORD EALA 2008
Brazing history

- class-a surface
- high process speed
- waterproof
- no sealing needed

Quelle: Erlas
Process chain hotforming

Blanking

Edge ablation

TWB & Patchwork

Tool properties

Laser cutting

Partial Softening

Cutting blanks with laser

Ablation with TruMicro

TWB with TruDisk

Laser Metal deposition / LMD

3-D Cutting TruLaser Cell

Flange softening with induction or laser

Laser marking and welding
Process chain hotforming (video)

Laser applications in the process chain hot-stamping
Conclusion
Conclusion

- TRUMPF offers laser based solutions for high volume automotive production
- Laser technology makes joining of different materials and cutting of hotforming parts possible
- Laser technology is an enabler for light weight design and helps to reduce CO₂ emissions in production
- Global support from TRUMPF worldwide
THANK YOU!

Dr. Andrey Andreev, Industry Management Automotive- Remote Applications
Ditzingen, 11.12.2013