Laser Based Manufacturing in the Automotive Industry

TRUMPF, Inc.
David Havrilla
Manager – Product & Applications
Agenda

Introduction

Trends in Laser Welding
> Remote welding
> Conventional laser welding
> Brazing

Trends in Laser Cutting
> Remote cutting
> High speed cutting

Conclusion
Laser applications - Automotive Industry

- Powertrain
  - Motor
  - Torque Converters
  - Clutches
  - Gearbox
  - Driveshafts
  - Differentials

- Body
  - B-Pillar
  - Tunnel
  - Roof
  - Roof rail
  - Trunk lid
  - A-Pillar
  - B-Pillar
  - Side Panel
  - Doors
  - Seat Rests, Tracks, Recliners
  - Differentials
  - Side member
  - Side member
  - Bumper
  - Bumper
  - Cross member
  - Door enforcements
  - Side member
  - Side member
  - IP Beam
  - Battery
  - Motor
  - Gearbox
  - Torque Converters
  - Clutches

Remote
Hotforming
Brazing
Powertrain
Laser applications - Automotive Industry

- Passenger-safety
- Interior
- Electronic
- Chassis/BIW
- Engine
- Components
- Exhaust systems
- Powertrain
- Suspension
Trend drivers

- **Manufacturing technology**
  - application incubators
  - decreased investment cost
  - green synergy
  - throughput requirements

- **End product requirements**
  - miniaturization
  - performance
  - weight reduction
  - cost reduction
Disk Laser technology

- Solid state
- Diode pumped
- Excellent beam quality
- Compact
- High WPE
- Fiber delivered
- Modular design
- > 1,000 sold

TLS Disk - Cavity
Principles of Programmable Focusing Optics

2D Scanner
- PFO 20
- PFO 33

3D Scanner
- PFO 3D
Remote welding – increased productivity

Conventional Laser Welding

- Process Start
  - approach
  - Welding 1
  - Positioning 1
  - Welding 2
  - Positioning 2
  - Welding 3
  - Positioning 3
  - Welding 4
  - Positioning 4
  - Welding 5
  - Positioning 5
  - Welding 6
  - Positioning 6
  - Welding 7
  - Positioning 7
  - Welding 8
  - Positioning 8
  - Home
- Process End
  - unproductive travelling times

Laser Scanner Welding

- Process Start
  - Approach
  - Welding 1
  - Welding 2
  - Welding 3
  - Welding 4
  - Welding 5
  - Welding 6
  - Welding 7
  - Welding 8
  - Home
- Process End

- Elimination of non-productive travelling times
- Maximization of beam-on share
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
Remote welding in body-in-white

Trunk Lid / Rear Panels

Picture: Daimler

Doors / Hang-on Parts

Picture: Daimler

Side Walls

B pillar
Scanner welding: Seating

- Recliners
- Seat Frames
- Seat Tracks
- Seat Panels
Scanner welding: IP beams

- Instrument Panel Carrier for automotive dashboards
**Spot weld - production**

34 ° + mech. shift code
4 robots, 5 welding guns
Welding time: 34.7s

**Laser remote weld - production**

34 ☐ + shift code
1 robot, 1 scanner optic
Welding time 13 s, ~9.5 s w/ 6 kW

Source: Volkswagen AG
Problem: Vaporization of Zn in between the panels causes weld spatter on the surface:

- Poor weld seam quality

Possible solutions to manage the problem:

- Spacers integrated in:
  - fixture
  - part design
- Adapted melt pool dynamics (twin-spot focus)
- Adapted coating (Zn-Mg)
- Gap created by dimples
Laser dimpling

- Constant dimple height (depending on zinc layer 0.1 - 0.2 mm (approximately))
- Dimple height adjustable via laser parameter
Laser dimpling process

- **Step 1:** Laser Dimpling
- **Step 2:** Placement of upper sheet
- **Step 3:** Laser Scanner Welding

Feed → BEO or PFO → Laser dimpling process

Feed → PFO → Laser Scanner Welding
5 laser dimples are covering the area of the later C-shaped weld seam.
Automotive Doors: Mercedes-Benz C and E class

welded parts:

welding station:

Source: Daimler AG
Remote welding success Mercedes-Benz

- 530 million remote welded seams by 2009 year end
- Sedans and wagons welded on the same RobScan line
- 35% floor space reduction
- 40% cost reduction
- Excellent part dimensional accuracy
- Higher vehicle structural stiffness at lower weight
AUDI Q5 requirements to the door concept

Maximum viewing angle, window & door opening as customer benefit.

**Consequence:**
Welding flange (< 6 mm).
No conventional spot welding technology possible.
Solution:

- Remote laser welding with PFO33
- 45 laser stitches (25 – 40mm each)
- Cycle time < 30 sec
Remote Welding of doors in high-volume production

Audi A4 / Q5
Conventional Laser weld with a Trumpf TruDisk 4002 and welding head with filler wire.
Conventional welding: BMW aluminum door

7 Series Sedan
• 15,4 meters of laser seam

7 Series Sedan Long
• 16,2 meters of laser seam
Laser welding of Aluminum doors BMW 7series sedan in production
Tailor welded blanks

Weight reduction
- Less material
- Less transportation weight

Higher stability
- Higher dynamic strength
- Higher crash performance

Reduced quantity of parts
- Less tooling cost
- Less forming cost
- Less logistics cost
Tailor welded blanks
Laser brazing – Roof Joint

Step 1
Overlap Joint
Resistance welding
Sealer
15mm molding

Step 2
Overlap Joint
Laser stitch welding
Sealer
8mm molding

Step 3
Edge Fillet
Laser welding
No Sealer
8mm molding

Step 4
Fillet Joint
Laser brazing
No Sealer
No roof ditch
No molding

y- / z-Compensation
Global Products customized to local markets with the help of laser technology.
Melt pressure cutting

- Melt ejection by melt pressure downwards
- Remote cutting on the fly with PFO (no cutting nozzle!)
- Good (burr free) cut quality, but oxidation layer
- Up to 4 mm sheet thickness
- Cutting speed < welding speed (approx. 50%)
- One tool for remote welding & cutting

\[ t = 1 \text{mm}; \ v = 8 \text{m/min}; \ P = 6 \text{kW} \]
\[ t = 3 \text{mm}; \ v = 3.5 \text{m/min}; \ P = 6 \text{kW} \]
\[ t = 2 \times 1 \text{mm}; \ v = \text{ca. 3 m/min}; \ P = 4 \text{kW}; \text{ kerf welded together} \]
Melt pressure cutting
Cutting with disk laser

- **Material:** 1.4301
- **Power:** 1000 W
- **Focus:** 100 µm
- **Thickness:** 0.8 mm
- **Speed:** 15 m/min
- **Gas:** N₂
- **Pressure:** 12 bar
TruLaser Cell 7000 series

TruFlow (CO₂)

TruDisk (FKL)
Faster cutting with SSL in thin sheets

Maximum production speed for mild steel and stainless steel

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<th>TruFlow 5000</th>
<th>TruDisk 3001</th>
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*3D processing speed depends on part geometry
Cutting of hot stamped material
Conclusion

- Innovative technologies can be trend drivers

- The beam quality & power of TRUMPF's disk laser has enabled several recent applications employed by automotive:
  - Remote welding
  - Remote welding of zinc coated steels w/ dimpling
  - High speed robotic cutting
  - Remote cutting
  - High speed 3D cutting

- The automotive industry has incorporated laser processing in virtually every sub-system of the automobile

- Ongoing laser innovations will continue to enable new trends in materials processing and will continue to make laser implementation more and more affordable
Thank you

TRUMPF Laser Technology Center
Plymouth, MI
(734) 454-7200