VW Golf V
Laser Processing
Concept and Production Implementation

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VW Golf V: Concept and Implementation in Production

Outline

- History of laser applications in Body in White at Volkswagen.
- Laser applications in Body in White of the Volkswagen Golf V
  - Data of the Body in White production line
  - Laser applications
    - Laser Brazing
    - Laser Cutting
    - Laser Welding
- Conclusions based on ½ year production
- Outlook
History of Laser Applications in Body in White at VW

- **Start 1993**
- **1996**: Roof joint
- **1997**: Roof joint, Trunk lid
- **1998**: Roof joint, Trunk lid, UB-Side panel, Rocker panel, Side panel, B-pillar
- **1999**: Roof joint, Trunk lid, UB-Side panel, Rocker panel, Side panel, B-pillar
- **2000**: Roof joint, Trunk lid, UB-Side panel, Side panel, B-Pillar, Front module
- **2001**: Roof joint, Trunk lid, UB-Side panel, Side panel, B-Pillar, Underbody, Hood
- **2002**: Roof joint, Trunk lid, UB-Side panel, Side panel, B-Pillar, Underbody, Hood
- **2003**: Roof joint, Trunk lid, UB-Side panel, Side panel, B-Pillar, Underbody, Hood

Images of different models of VW cars are shown at intervals corresponding to the years of application of laser applications.
History of Laser Applications in Body in White at VW

VW laser Installed Base

- Lasers
- Units


Installed base 580 units in 2005.
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- Outlook
~ 56 m Total Length of Laser Based Joints
## Distribution of the Various Joining Technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Distance/Spots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laser Weld/Braze</td>
<td>~56,000 mm</td>
</tr>
<tr>
<td>Adhesive</td>
<td>~25,000 mm</td>
</tr>
<tr>
<td>MIG/MAG-Welding</td>
<td>~6,000 mm</td>
</tr>
<tr>
<td>Resistant Spot Welds</td>
<td>~2,600 spots</td>
</tr>
</tbody>
</table>
# Laser Technology

**Laser application:** Laser Welding (with and without filler material)  
Laser Brazing  
Laser Cutting

**Locations:** Wolfsburg, Mosel, Brüssel

<table>
<thead>
<tr>
<th>Location</th>
<th>Wolfsburg</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laser technology:</td>
<td>150 4kW Nd:YAG Laser (TRUMPF HL4006D)</td>
<td>250 1kW Nd:YAG Laser (TRUMPF HL1003D)</td>
</tr>
<tr>
<td></td>
<td>250 Laser welding heads</td>
<td>3 Laser cutting heads</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>9</td>
</tr>
</tbody>
</table>

**Infrastructure:**  
24 MW Electrical consumption (Laser)  
23 MW Cooling capacity (Laser)

**Capacity:**  
2,000 Cars/day  
140Km Laser joint length/day

>3,000  >210Km
Joining Strategy

L rail front right  | Underbody front  | Firewall  | Wheelhouse front L/R
Underbody T | UB I Auss. | Underbody II | UB II Auss.

Mainline

Sided panel right

Inner front Side panel  | Inner back side panel

Wheelhouse L/R  | Back panel | Framing station | Welding I | Welding II | Welding III | Assembly Anbaut.

L Rail front left  | Underbody back compl. | Wheelhouse back L/R | Back panel | Framing station | Welding I | Welding II | Welding III | Assembly Anbaut.

Sided panel left

Inner front Side panel  | Inner back Side panel

Wheelhouse L/R  | Back panel |

Roof/SAD

Fender li/re  | Doors front/back/left/right | Closure front and back

Laser Systems

www.autosteel.org
Body Side Lines

Goal: Cycle time 30 Seconds

Solution: Headstock & Tailstock positioner

Advantage: High utilization of the laser resonator
Flexibility (Products)
Floor space reduction
Body Side Lines

Laser Brazing on Body Side

Process Parameters:
- Braze Wire: CuSi3; 1.6 mm
- Laser Power: 3,500 W
- Fiber Diameter: 0.6 mm
- Travel Speed: 2.1 m/min
- Joint Gap: 0...0.5 mm
Framing-Station: Components
Framing-Station: Roof Joint

Reduction in Manufacturing Time: Example Roof Joint.

Body in White: Framing & Welding
Paint: Sealer
Assembly: Roof ditch cover installation

Laser Brazing
Framing-Station

Example: Framing-Station

Basic data:
14 Laser HL4006D
3,400mm Laser brazing
5,340mm Laser welding
68 s Cycle time
40% Floor space reduction

The system is designed to cover all Volkswagen PKW products:
Lupo to Touareg.

Lasers can be used in a second parallel weld station during
loading/fíxturing/unloading in the framing station.

Manufacturer:
Vorrichtungs- und Werkzeugbau,
Wolfsburg
Framing-Station: Simulation
Laser Welding Heads with Integrated Fixturing
Flexible Laser Welding Cell:

Eliminates the use of any product specific fixturing. Possible by the use of universal optics with integrated universal fixturing.

Universal fixturing: Wheel
          Double Wheel
          Splitter Wheel
          Single and double finger

Advantage:
• Created the possibility to run different products on the same line.
• Flexibility in terms of changes in demand for one product.
• Model changeover is possible in an efficient and timely manner.
Challenge:
A slight variation on the geometrical position of the mounting plate for the front end is based on tolerances throughout the manufacturing process of the auto body. In order to maintain the narrow gap tolerances of VW, it is necessary to reduce the slight variation.

Solution:
Optical measurement of the auto body. Cut to length of the front rail to the individual length. Joining of the mounting plate to the front rail at the designed relative location.
**Goal:**
To optimize the geometric position of the mounting plate for the body front to eliminate additional alignment during final assembly.

Optical measurement of each body.
Mounting Plate Front Module

Step 1: Optical measurement of each body.

Optical measurement system.
Correction of the robot program based on the individual measured data of the body.

Cut to length of the front rail to the X-Location.

Cutting optic and welding optic mounted on one robot.
Mounting Plate Front Module

One robot holds the mounting plate in place (Calculated Y and Z-location).

The safety critical laser weld is controlled by a process monitoring system.
Doors
Monitoring of the actual laser power at the workpiece after each cycle

- Optic
- Sensor head
- Graphical display
- Sensor Electronics
- Laser power above specified limit for the welding process
- Laser power is reaching lower limit
- Laser power below specified limit for the welding process
Customization of Cars After Paint

Right hand-Option

GPS-Antenna

Roof-Rail

TUSD280tm
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- Outlook
Stiffness Golf V v.s. Golf IV

- Static Torsion Stiffness: +80%
- Dynamical Torsion Stiffness: +15%
- Dynamical Bending Stiffness: +35%

Golf IV Golf V

www.autosteel.org
Conclusions Based on 1½ Years Production

Goals reached:

- Increased process speed (joining).
- Increased productivity
- Short cycle times (30 Seconds)
- Increased strength of the modules compared to most alternative joining methods
- Reduced heat distortion
- Narrow or no flange => Weight reduction
- High flexibility due to the possibility to direct the laser beam by the means of Laser Light Cables into different workcells.
- Reduced floorspace

<table>
<thead>
<tr>
<th></th>
<th>Golf IV</th>
<th>Golf V</th>
<th>(-50%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floorspace Side panel</td>
<td>2816 m²</td>
<td>1472 m²</td>
<td></td>
</tr>
<tr>
<td>Floorspace Underbody</td>
<td>480 m²</td>
<td>320 m²</td>
<td></td>
</tr>
<tr>
<td># of Spot Welds</td>
<td>4,608</td>
<td>2,600</td>
<td></td>
</tr>
<tr>
<td>Length of laser weld</td>
<td>3 m</td>
<td>70 m</td>
<td></td>
</tr>
</tbody>
</table>
Conclusions Based on 1½ Year Production

| Training Programs in all Areas:                  | Design dept. of the car |
|                                               | Planning dept. of the production lines |
|                                               | System manufacturer      |
|                                               | Production (plant)       |

| Additional Requirements - Plant Level:          | Laser technology         |
|                                               | Laser-beam-generator     |
|                                               | Laser application/process|
|                                               | Tooling/parts            |
|                                               | Optics and mechatronic   |
|                                               | IT-Network / control technology |

The workforce with the required training is not available on the present labor market

= Intensive education programs for the employees.
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Outlook

The implemented laser technology has shown to be robust and reliable.

Necessary improvements:

**Laser Resonator/Beam Delivery**
- Laser efficiency: 20%
- Beam quality: 6 mm*mrad
- Laser power: 6000W
- Length of light cables: 100m
- Up-Time: 99.9%
- Max. time to repair: 30 Min.

**Laser Processing Optics**
Robust optics, ready for production.

**Laser process**
Robust process, large process window
Self controlled/aligned process.
CO₂ Scanner Technology
YAG Scanner Implementation

- Galvanized Body Component
- Simple Robot Motion
- Complex Weld Shapes by Scanner
YAG Scanner Technology
CO$_2$ Scanner System Integration
The TRUMPF Laser Technology Division

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