

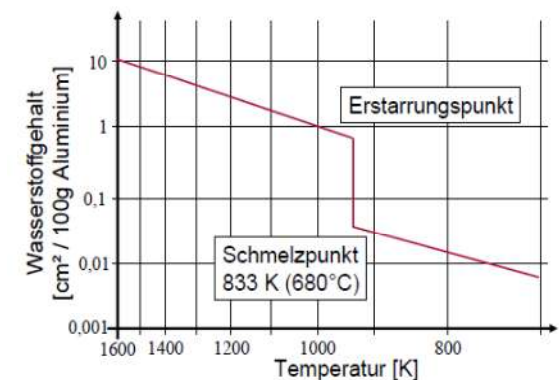
Laser Welding of Aluminum

- General Subjects
- Examples @ TIR1
- Examples in Automotive Industry
- Remote welding of Aluminum

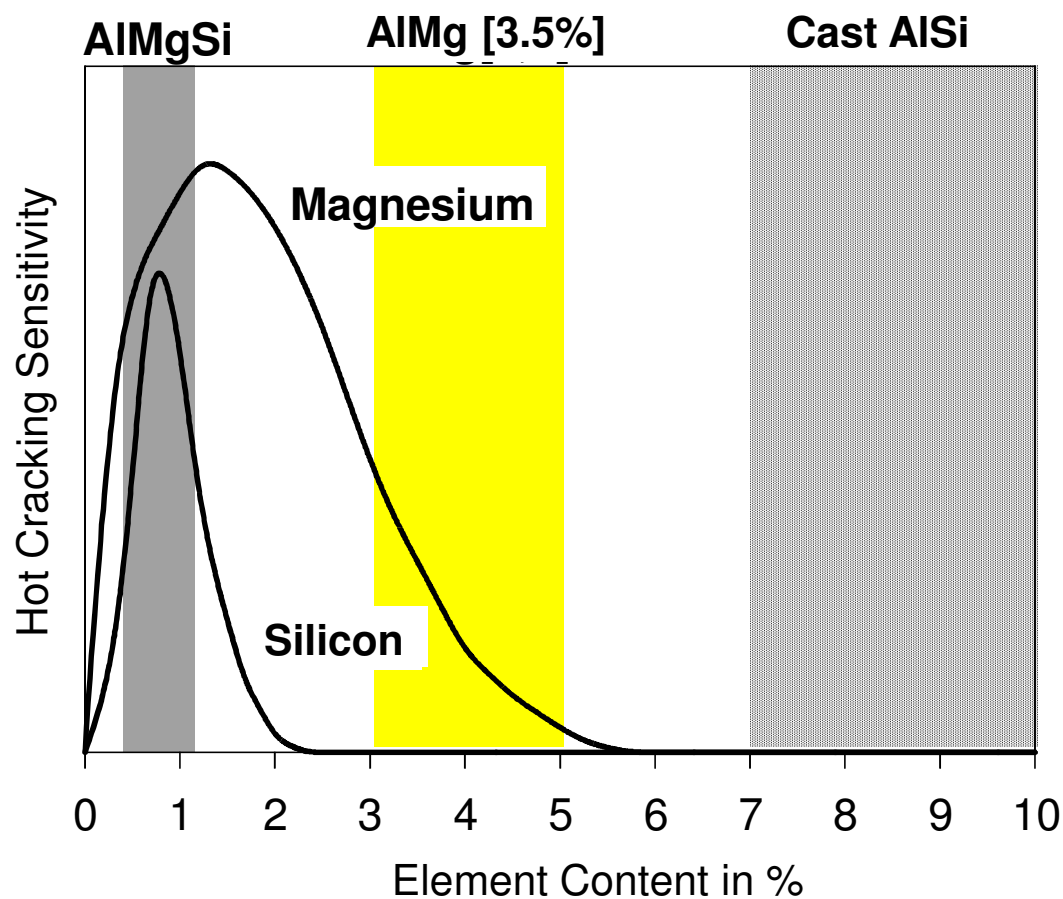
Properties of aluminum



- Low melting point (660.32 ° C)
- Very high thermal conductivity 235 W / (mK), (Fe: 80 W / (mK))
- Large thermal expansion coefficient of $23.8 \cdot 10^{-6} / \text{K}$ (Fe $12.1 \cdot 10^{-6} / \text{K}$)
- Strong affinity to oxygen
- High melting point of the natural oxide layer (2050 ° C)
- Porous, moisture and contaminants binding surface layer. Softening in the weld and HAZ
- Jump of the hydrogen solubility between liquid and solid by a factor 10

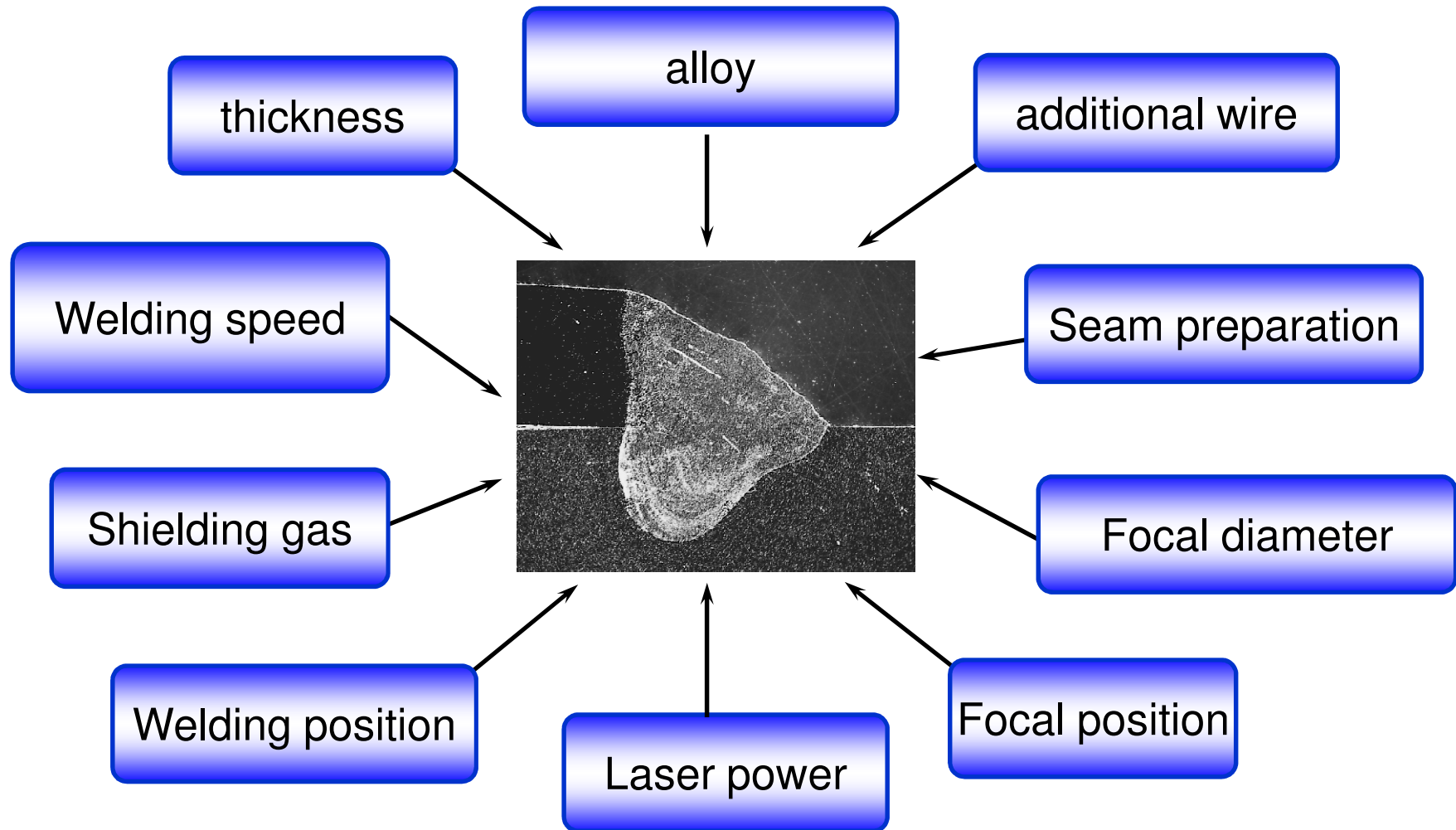


Weldability and Hot Cracking Sensitivity of Alloys



Source: IFSW

Effects on seam quality



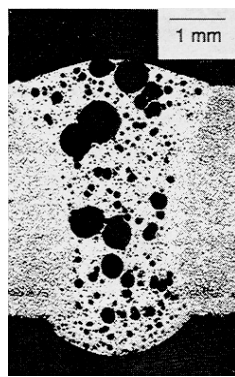
Laser Welding of Aluminum

Welding Defects occurring in Laser Welding of Aluminum

● Hydrogen Pores



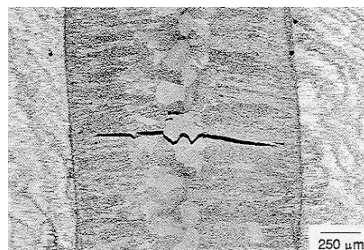
**Seam Preparation,
Material Selection**



● Hot Cracks

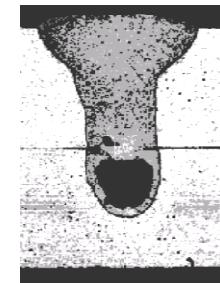


**Selection of Material,
Material Combination,
Filler Wire**

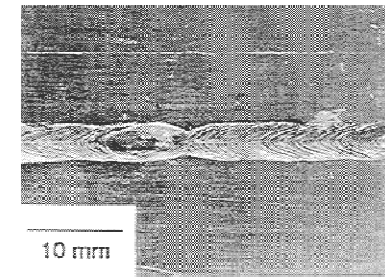


according to: IFSW - Universität Stuttgart

● Process Pores



● Melt Pool Ejection



**Higher Laser power,
Higher Beam Quality,
Beam Shaping
Material Selection
Kind of Shield Gas and its Guiding**

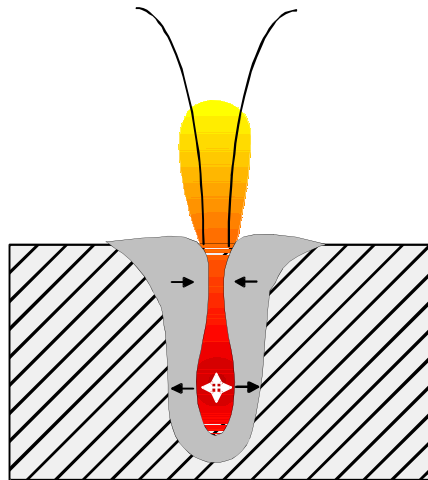
Laser Welding of Aluminum

Model of Seam-Defect Generation in Aluminum Welding

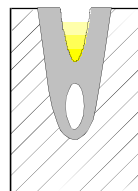
Cause

Constriction of the capillary

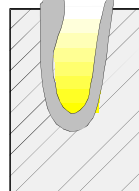
↓
Blow up of the capillary



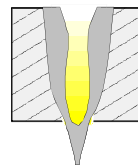
Effect



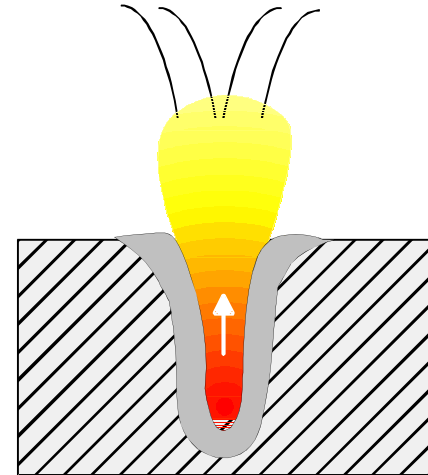
Pore



Blow hole



Serrated root



Solution

Widening of the capillary diameter
→ unhindered evaporation

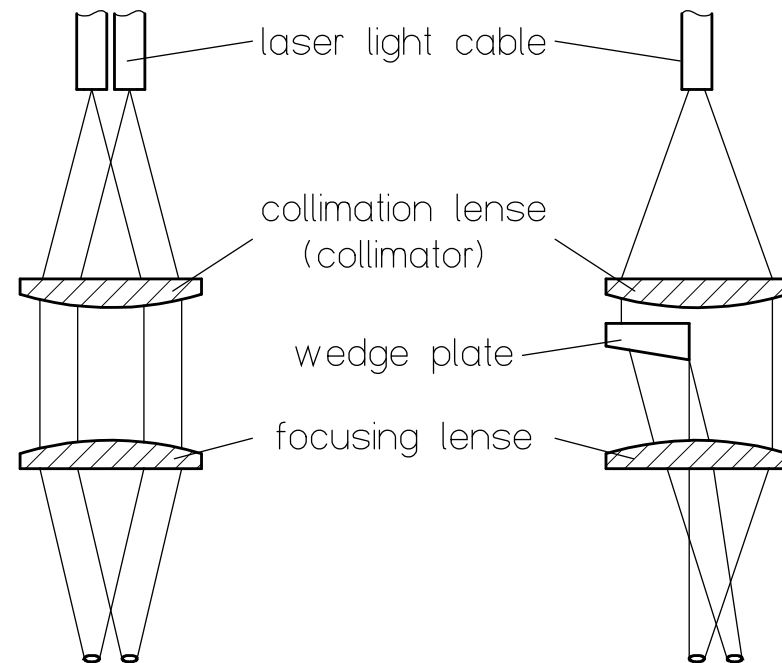
→ **Process stability**

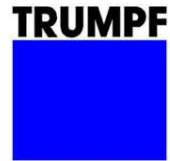
TWISTLAS® Beam Technology

Principle: Welding with two focused laser beams generated by one or two lasers

Objectives:

- Increased welding quality and process stability in aluminum welding
- Higher positioning and gap tolerance in butt joints
- Increased laser power by adding several lasers





Crack tendency of different alloy components

	Welding depth at penetration (mm) free of blow-out	Additional material	Shielding gas	TWISTLAS
1000er e.g. Al 99%	>1	Not necessary	Not necessary- better surface with: Helium Monomix 70	
5000er e.g. AlMg 3	3	AlSi 12 (good surface) AlMg 5 (same alloy)	Helium Monomix 70	Low blow-out and better intermixture
6000er e.g. AlMgSi1	4	AlSi 12 AlSi 5 (better seam elevation)	Not necessary- better surface with: Helium and Monomix 70	Decrease of speed ~ 30-60%
Casting alloys	>2,5	Crack-free without wire, few blow-out with AlSi 12	Not necessary- better surface with: Helium and Monomix 70	



Alu-Examples @ TIR1

Laser welding of

- Steering columns of aluminum
- Fuel Filter Box
- Wheel

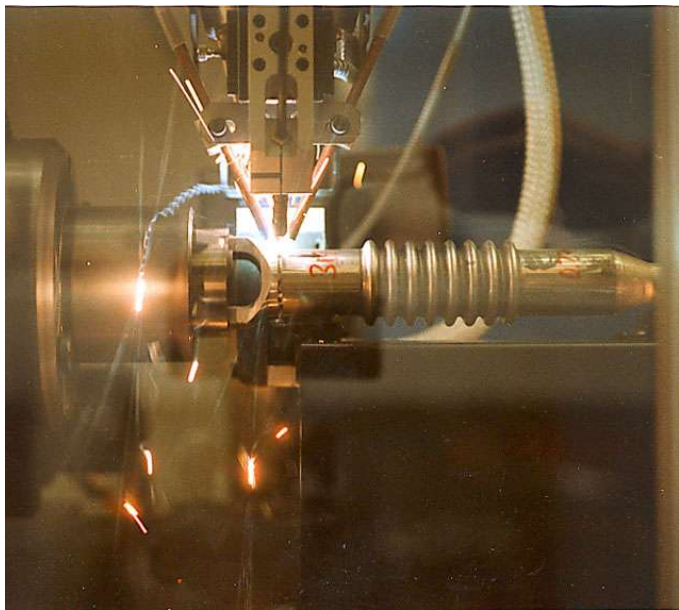
Laser Welding of Aluminum



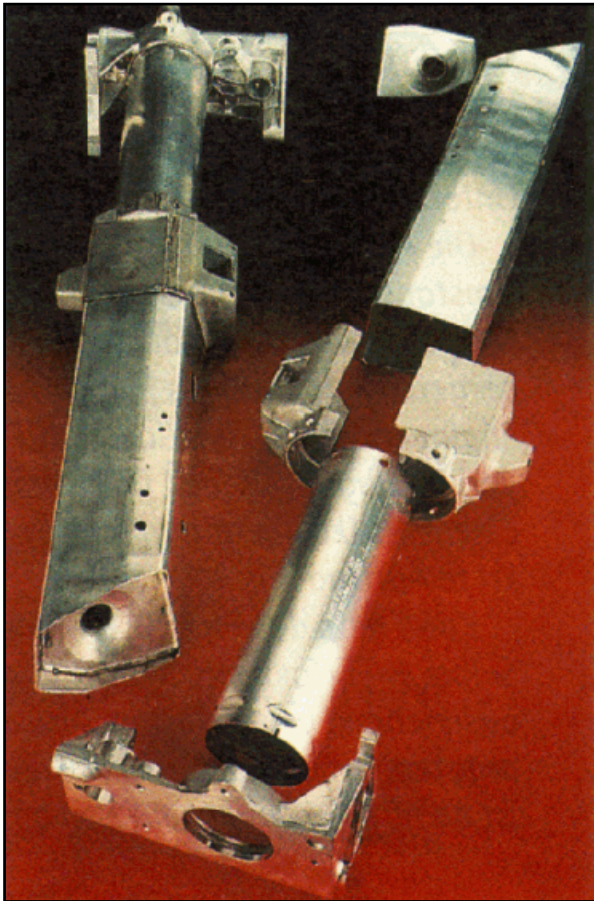
Fa. Elbe: Laser beam welding of steering columns of aluminum

Characteristics and benefits

- high strength
- low distortion
- high welding speed
- cost reduction



Laser Welding of Aluminum



Joining of
Aluminum Tube +
Die-Cast Parts



Fuel Filter Box

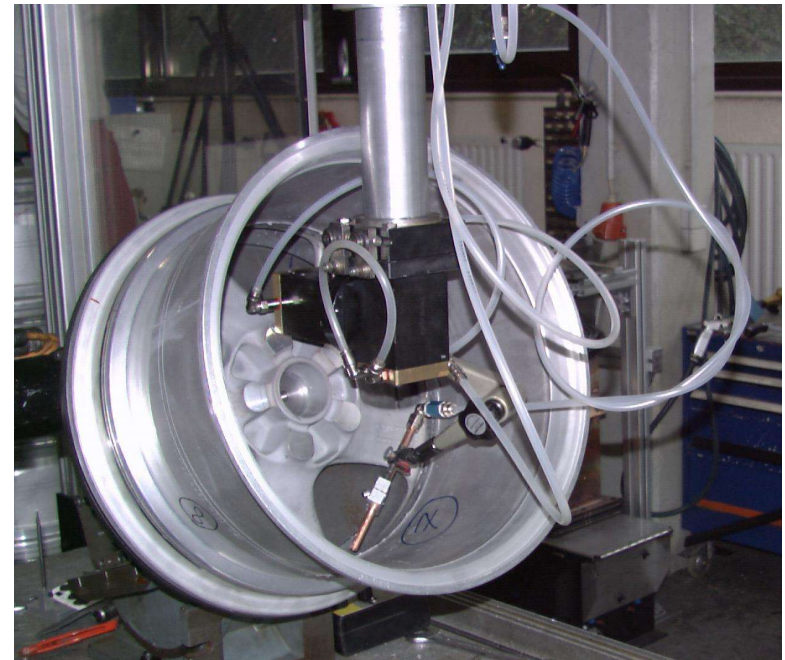
Aluminium wheel



Experimental set up

- Laser Welding of hollow spoke aluminum wheel

External welding



Internal welding

Alu-Examples in Automotive Industry



Laser welding of

- Daimler- Maybach door (film)
- VW Phäton door
- Audi A2 space frame
- Audi A8 roof
- Daimler S-Class integral carrier, doors, fender
- BMW 7er door
- Hybrid Welding

TRUMPF



Daimler- Maybach door
1x HL 4006 D



Since 2002



Laser Welding of Aluminium

TLD_2011



VW Phaeton door

7 MIG Welds 380 mm

11 Laserwelds 1030 mm

48 Hybrid Welds 3570 mm



2002–2007

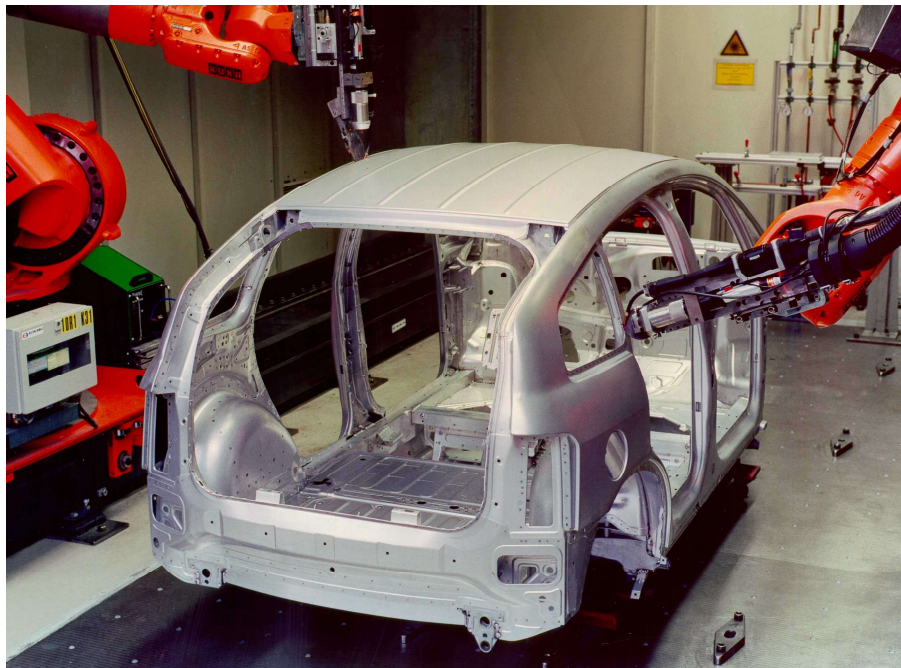


The door of the Phaeton is a mixture of Aluminum cast sheet and extruded Profile.

→ High side impact protection

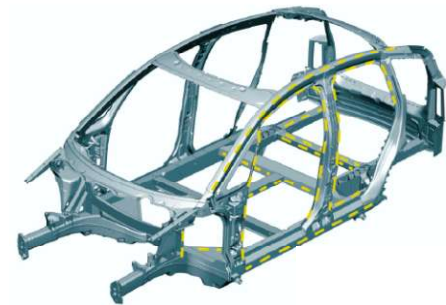
IS, VW

Audi A2: Laser Welding of Aluminium



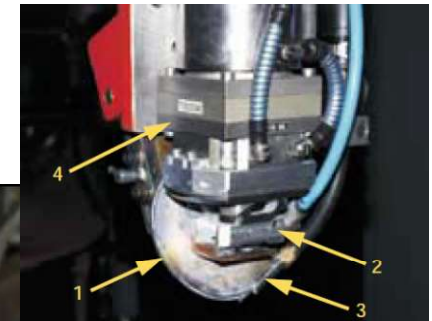
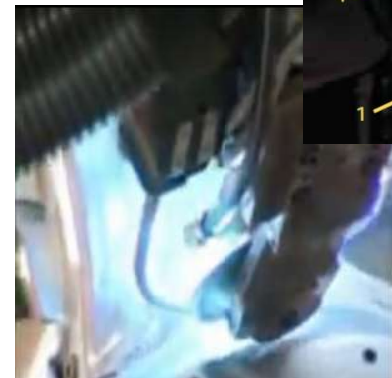
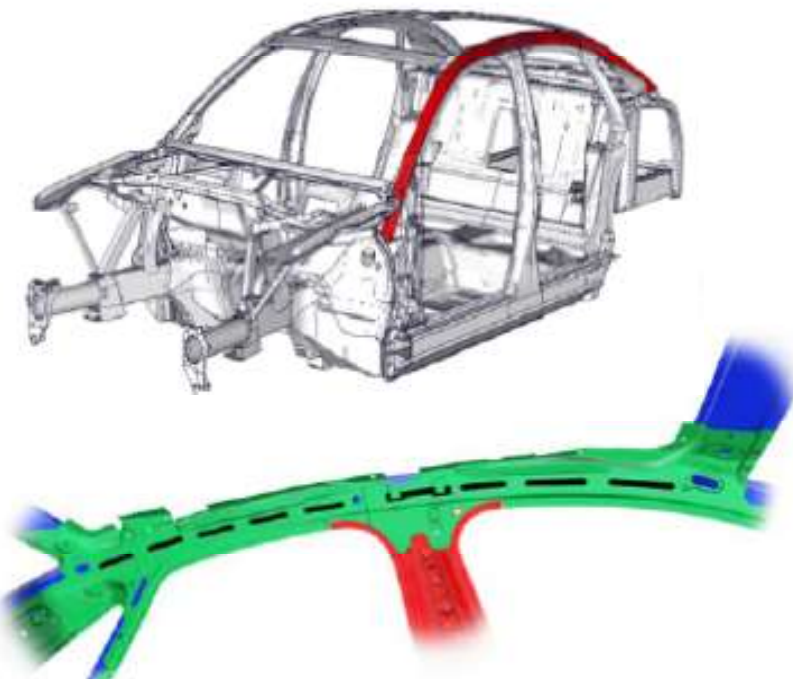
1999 - 2005

- 30 m Laserweld
- 8x 3 kW YAG
- additional wire
- $v \leq 6 \text{ m/min}$





Audi A8 (20 m Laser Seam)



additional
roller head

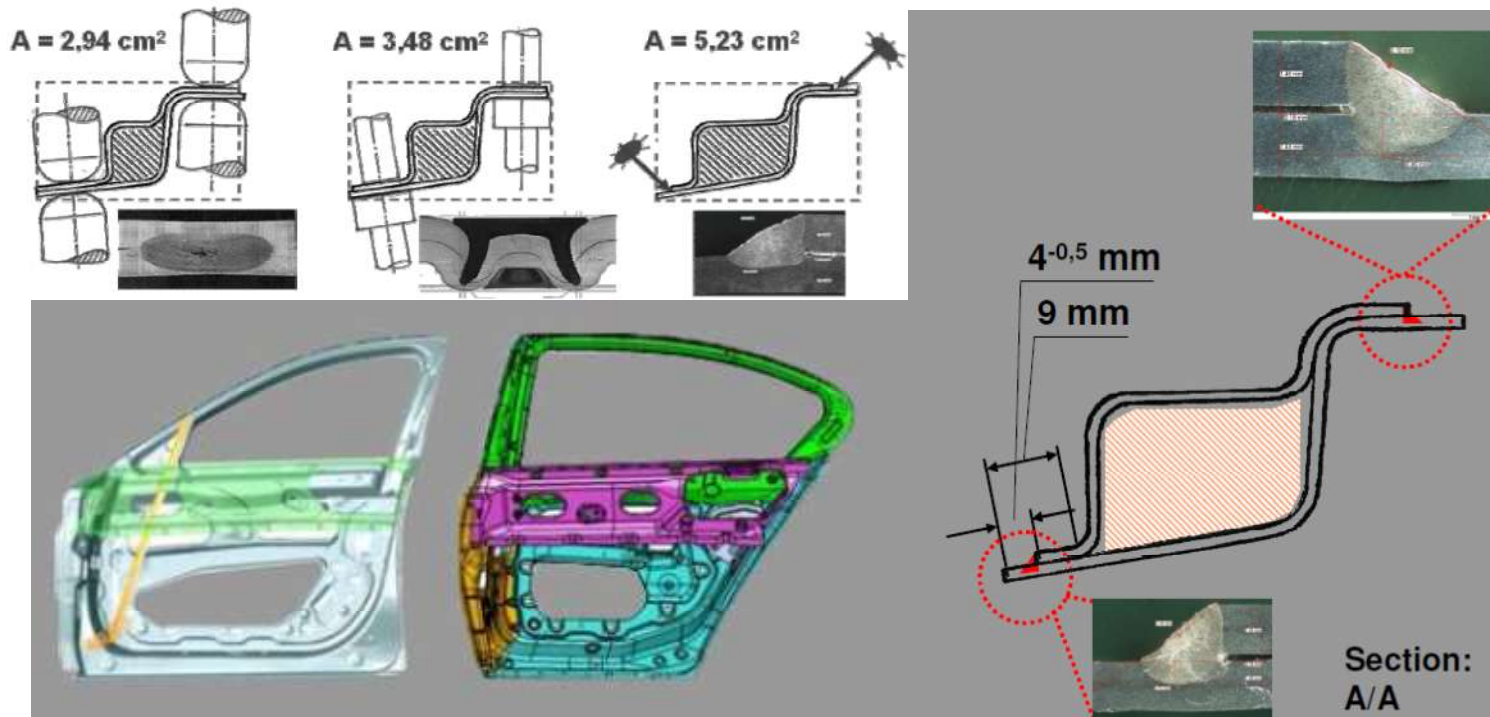
2007–2010



MIG Hybrid



BMW 7-Serie - Aluminium Door



Material: AlMg4,5Mn (1,5 mm and 1,2 mm)
 Seam length: 15,4m (16,2m@long version)
 Laser: TruDisk 4002
 Optik: Scansonic with additional wire

Since 2008

TRUMPF



BMW 7-series - Aluminium doors with wire

Laserschweißen von Aluminiumtüren im Automobilbau

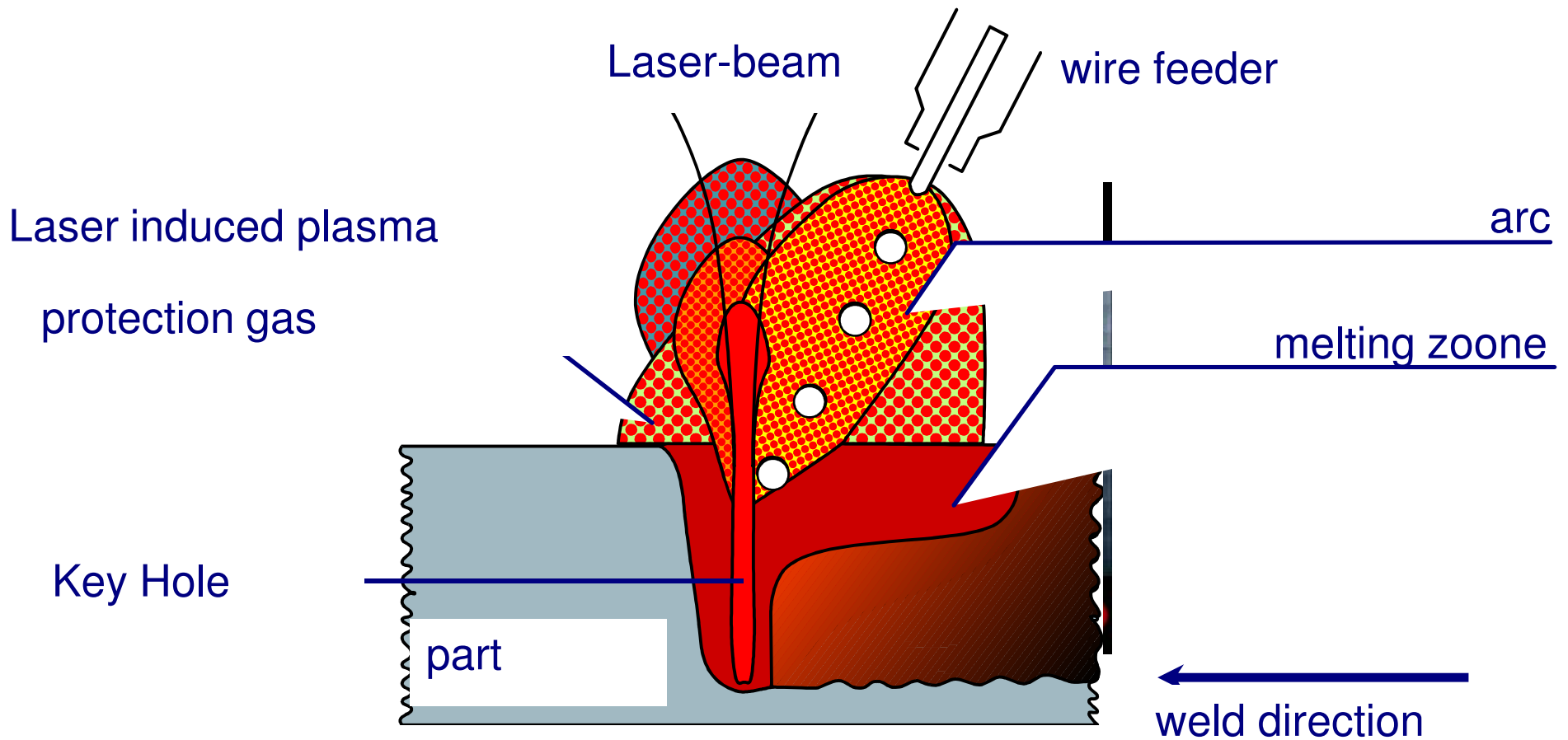


Laser Welding of Aluminium

TLD_2011



Laser Hybrid welding of Aluminum



Source: Fronius

Laser Hybrid welding of Aluminum

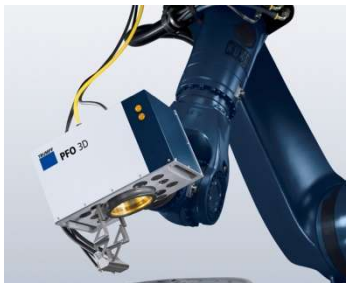
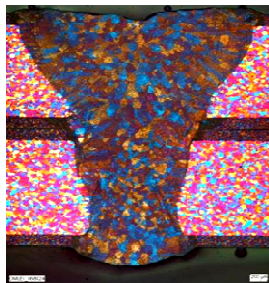
- Combination of Laser and MIG to have better quality, gap behavior
- **up to 3 x times higher speed compared with MIG only**
- **higher quality**
- **reduction of number of machines**
→ Reduction of invest

source DAIMLER- axle carrier



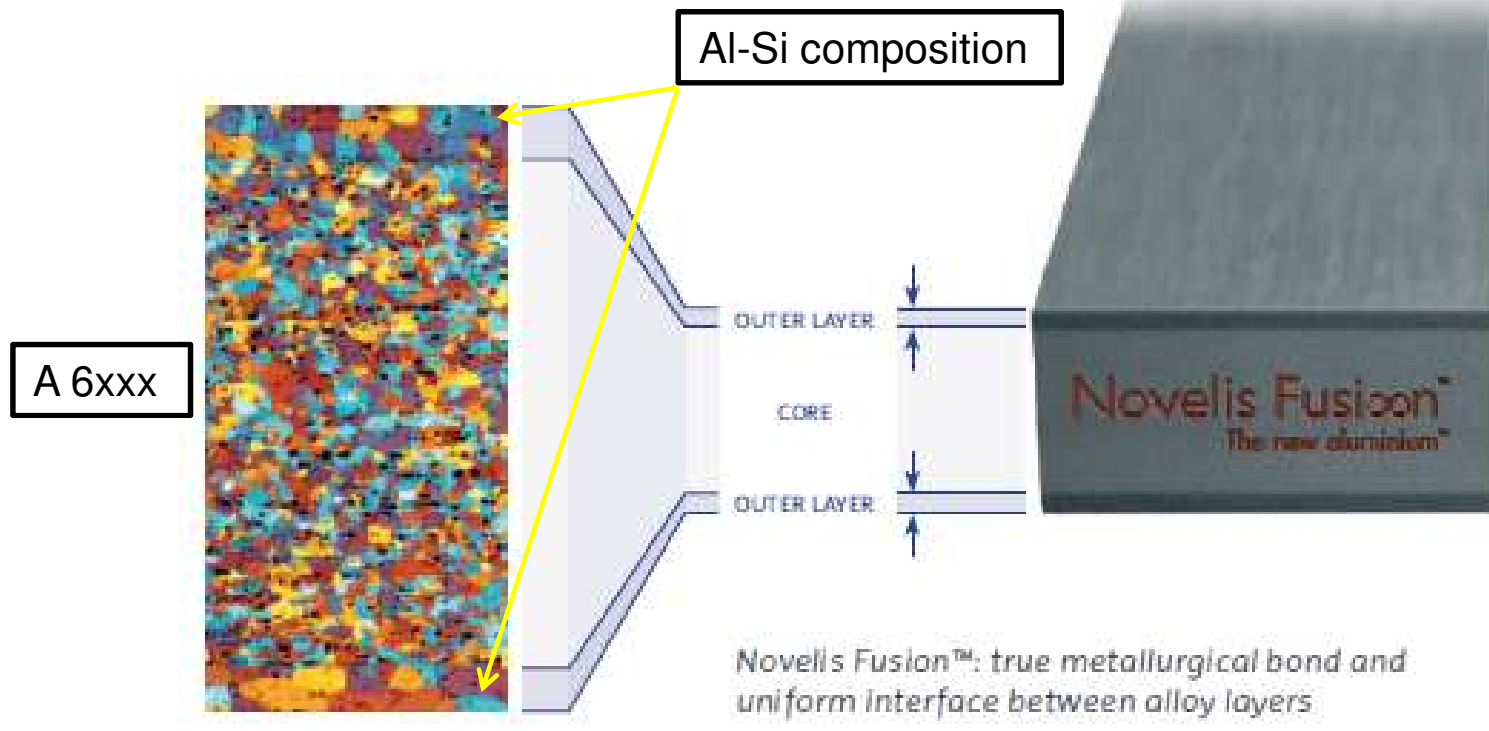


Laser (Remote) Welding of Aluminum Alloy without additional filler material





Novelis Fusion



Source. Novelis
Homepage