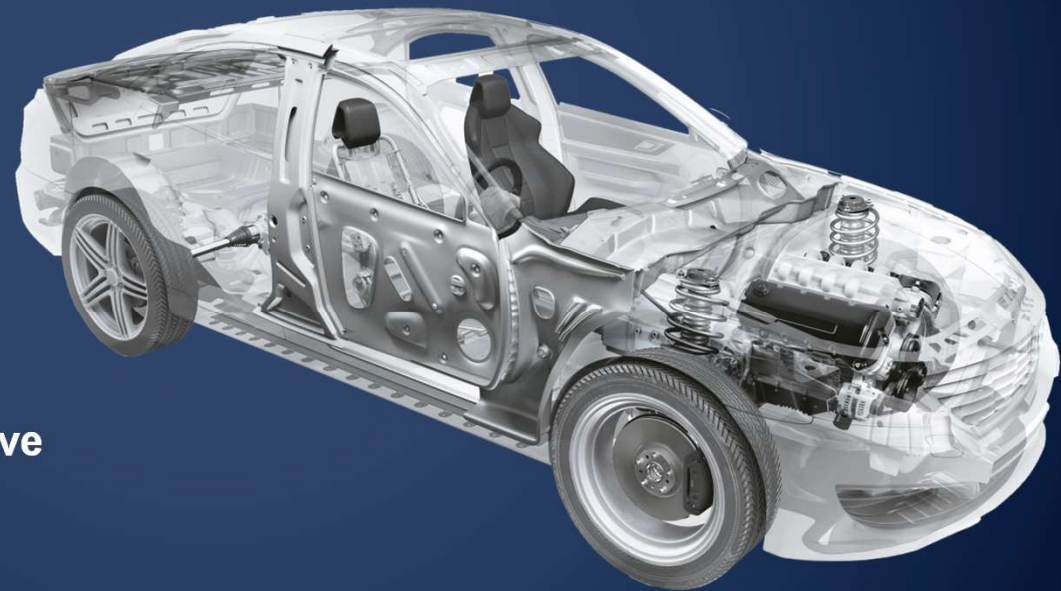


# ELECTRIC VEHICLES MADE BY LASERS

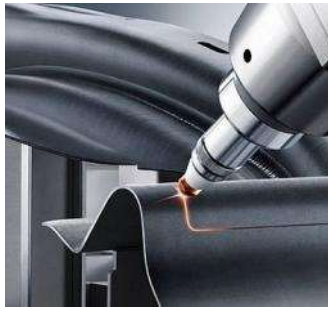


**Dr. Günter Ambrosy**  
**Industry Management Automotive**  
**E-mobility**

**Ditzingen, 20.02.2019**

# Laser Applications

Broad spectrum: Applications with TRUMPF lasers



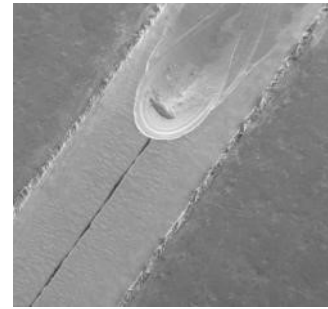
Cutting



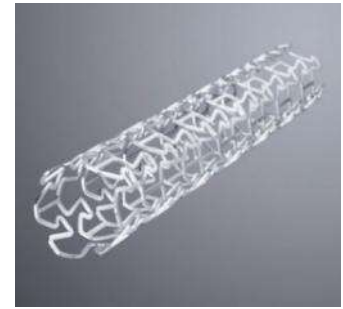
Welding



Brazing



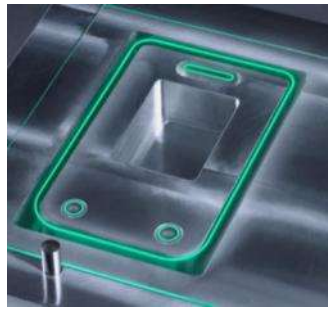
Drilling / Ablation



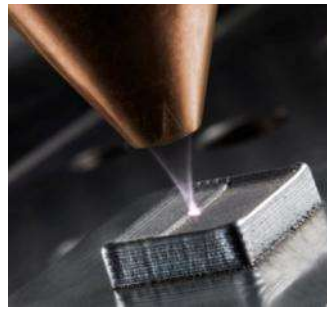
Micro-processing



Marking / Engraving



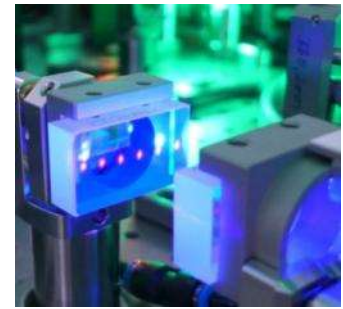
Plastics and glass processing



3D printing



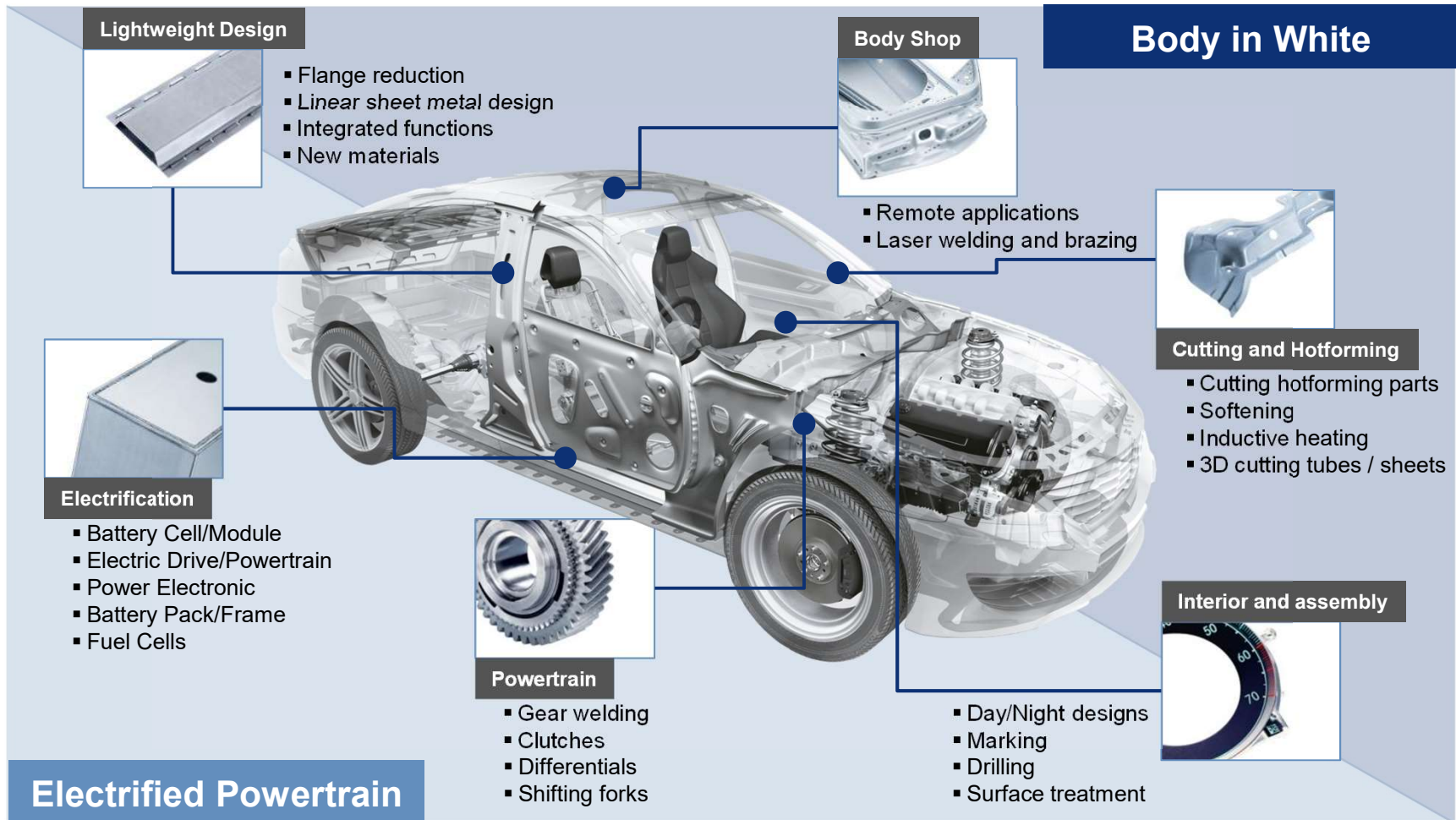
EUV Lithography



Scientific Applications

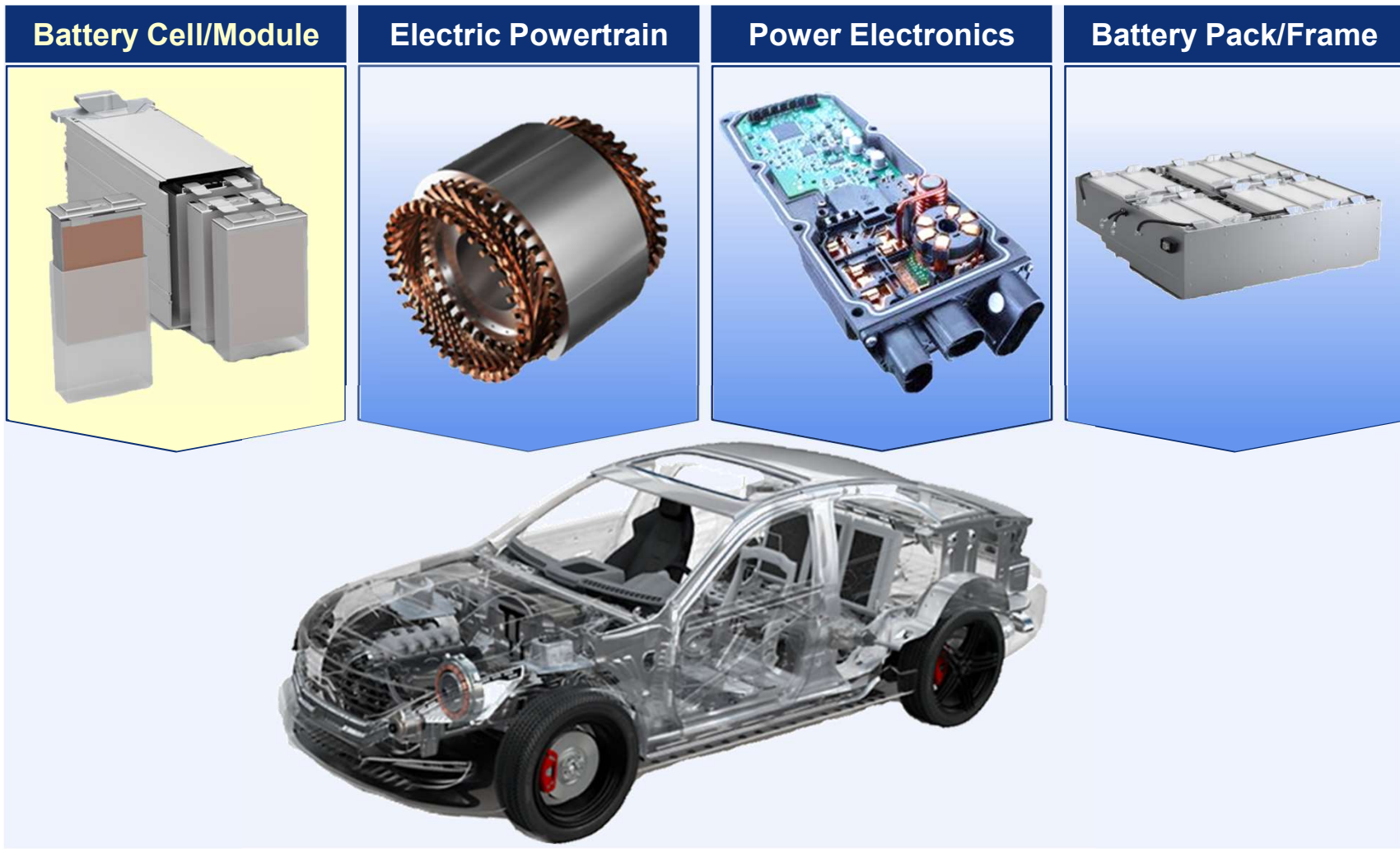
# CARS – made by laser

In the Automotive production process there are many established laser applications with increasing numbers in electrification



# Application fields for lasers in E-mobility

The laser offers numerous industrial solutions in manufacturing fields of EV



## Battery Cell: Cutting of electrode foil

Electrode shaping by cutting double sided coated foils (coated Al/Cu)

### Description:

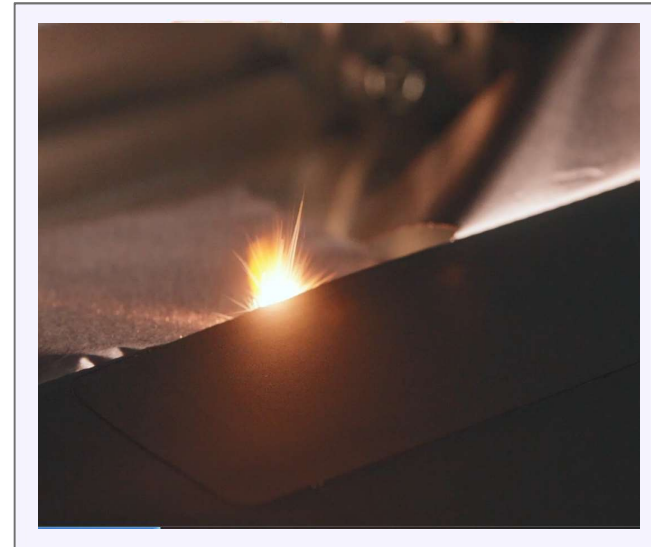
Contour cut of single electrode sheets by mechanical punching process (0.2 s) or laser cut (>1000mm/s)

### Requirements:

- Stable geometry of the cutting edges
- Big scanning field, cutting speed (> 1.000mm/s)
- Burr <5um, no particles on the surface
- HAZ 50-200µm (loss of active surface)

### Recommendation:

- 200W ns pulsed IR laser (TruMark7050, SPI,..)
- TruFiber2000 as cw solution and/or TruMicro5000 (fs/ps) possible.



## Battery Cell: Foil stack / tab welding

superior electric conductivity (lowest electric resistance) by laser joining

### Description:

Contacting of electrode foil stacks



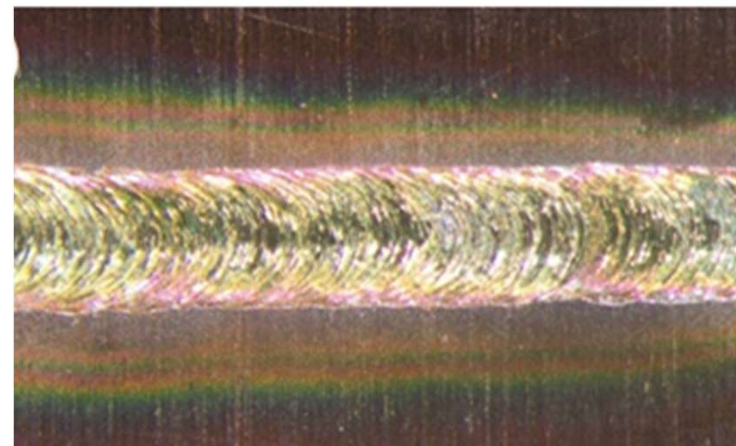
Depth: 305  $\mu\text{m}$

### Requirements:

- Perfect contacting of foils (low electrical resistance)
- Low mechanical and thermal stress during welding
- No spatters
- Limited accessibility and speed

### Recommendation:

- TruDisk1020 (515nm, 1kW, cw)  
at high welding speed up to 20 m/min



## Battery Cell: Welding of prismatic battery housing

Media tight sealing with TruDisk



## Battery cell: Busbar welding

Superior electric conductivity (lowest electric resistance) by laser joining

### Description:

Welding of busbar connections < 3mm thickness

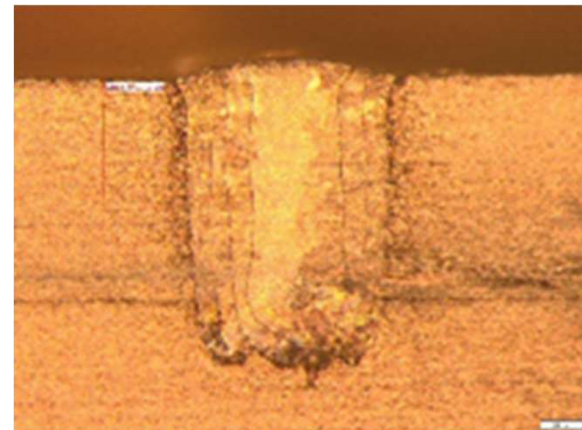
**Material:** Al ; Cu ; Al/Cu  
TruFiber2000. Cu-Cu

### Requirements

- Electrical contact, mechanical strength
- No spatters
- Low HAZ

### Recommendation:

- TruFiber2000 + PFO20
- Welding speed approx. 25 mm/s
- Wobbling





## Battery cell: Bus bar welding

Welding of thick (> 3mm) Aluminum/Cu Busbars

### Description:

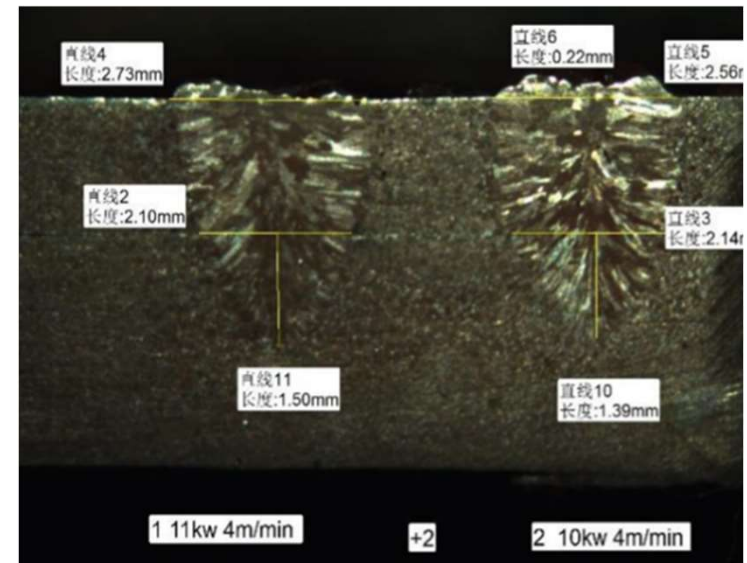
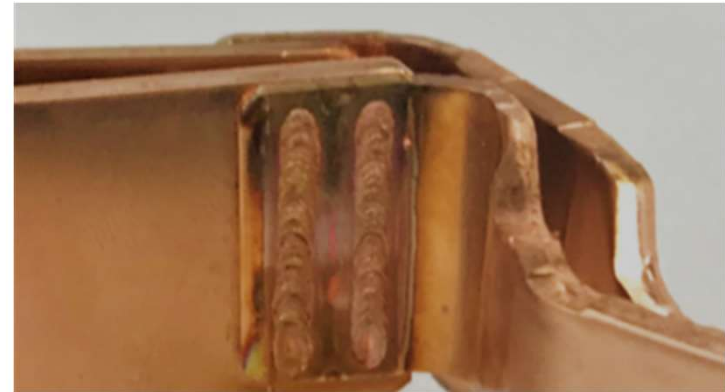
Welding of thick Al and Cu (PHC and ETB) busbars.

### Requirements:

- Peel-off-force > 5kN
- Welding depth about 3.3mm
- No spatters

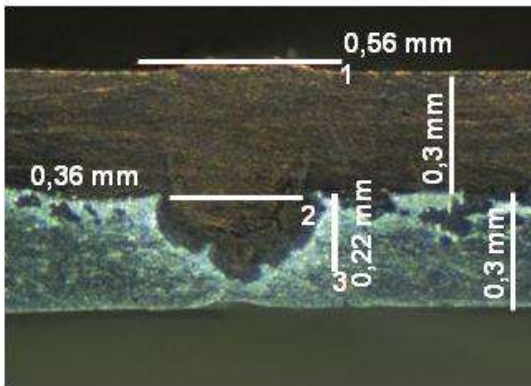
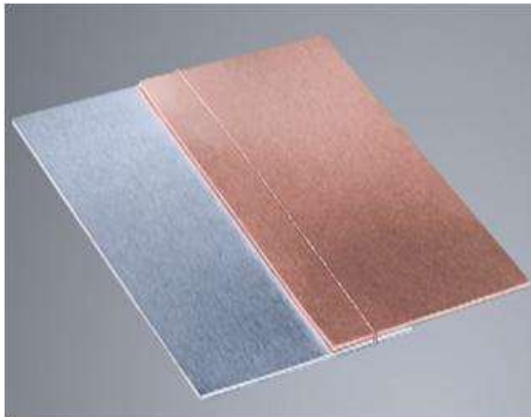
### Recommendation:

- Laser cleaning of surface prior welding is highly recommended TruMark xx.
- Welding with TruDisk10000/11000 + D70 + LLK200um
- Welding speed up to 4m/min
- Peak temperatures < 140°C achievable.
- Cu-PHC welding surface is more smooth



## Battery Cell: Welding of dissimilar contact tabs

Joining of electrical connection of thin dissimilar materials



### Material

- Cu / Al, approx. 0,3 mm

### Requirements

- joining of dissimilar material
- electrical contact
- mechanical strength
- partial penetration

### Laser

- TruDisk

### Optics

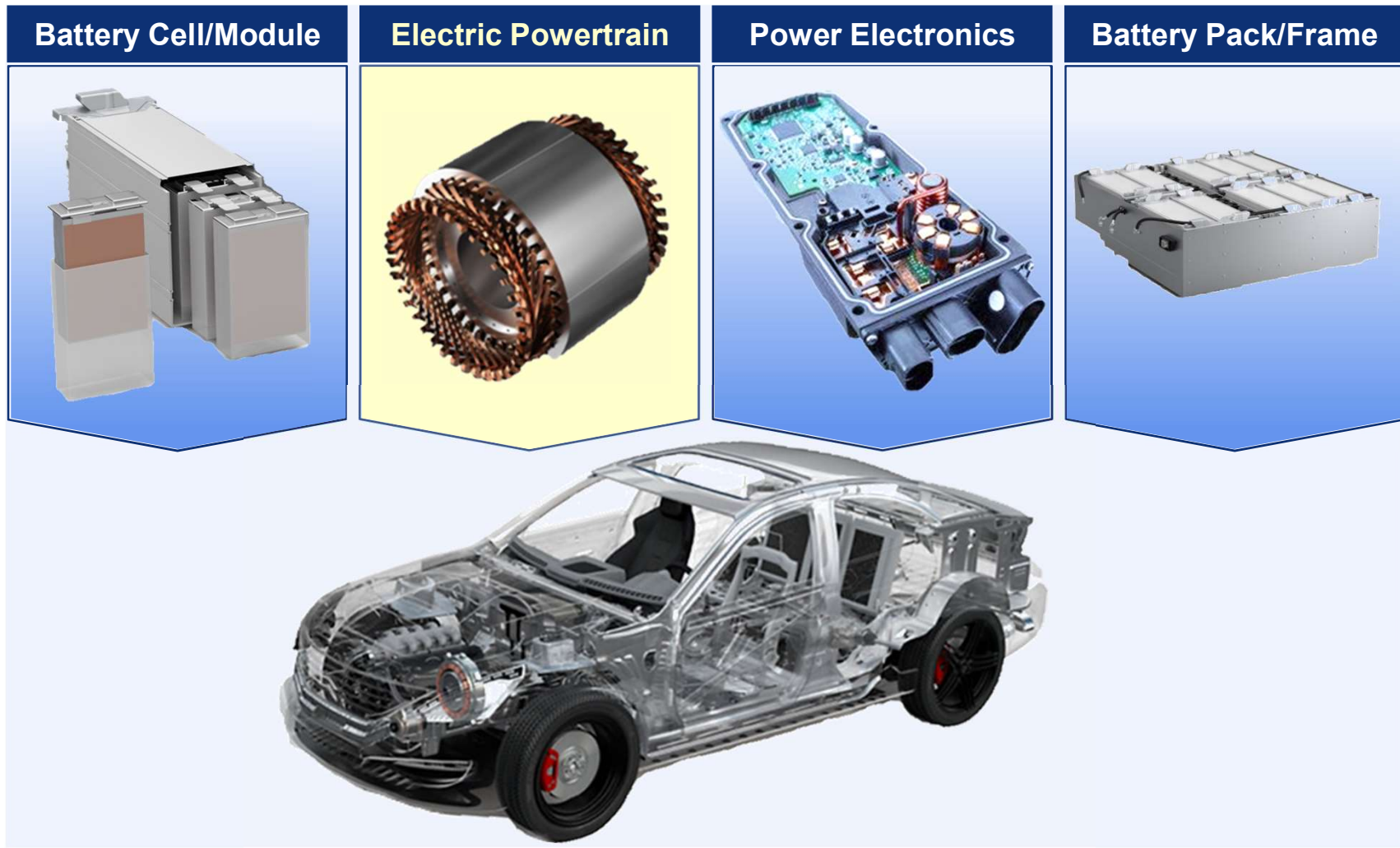
- PFO
- BEO

### Customer Value

- flexibility in welding geometry
- no porosity, no cracks
- clean working process
- little space requirements
- no mechanical stress

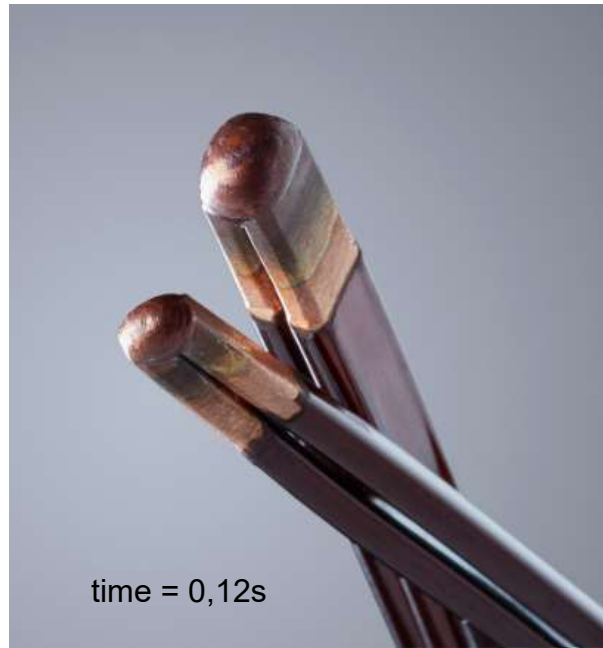
# Application fields for lasers in E-mobility

The laser offers numerous industrial solutions in manufacturing fields of EV



## Electrified Powertrain: Welding of hair pins:

Hairpin designed e-drives are often used in electrified drivetrains



### Material

- Cu-Cu; 2x4mm to 6x6mm

### Requirements

- electrical contact
- defined welding bead
- full automation, no scrap

### Laser

- TruDisk + PFO33 and VisionLine smart sensor

### Customer Value

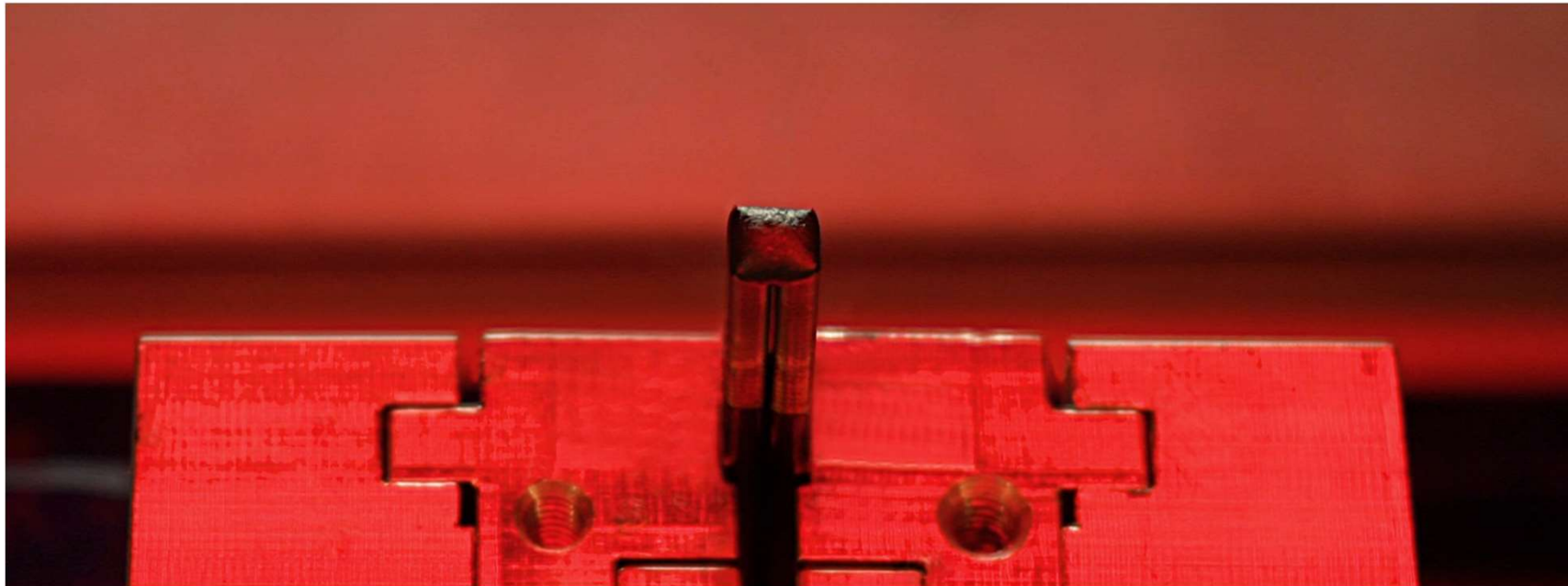
- perfect connection
- no spatter
- VisionLine → fully automated



# Laser Welding of Hairpins

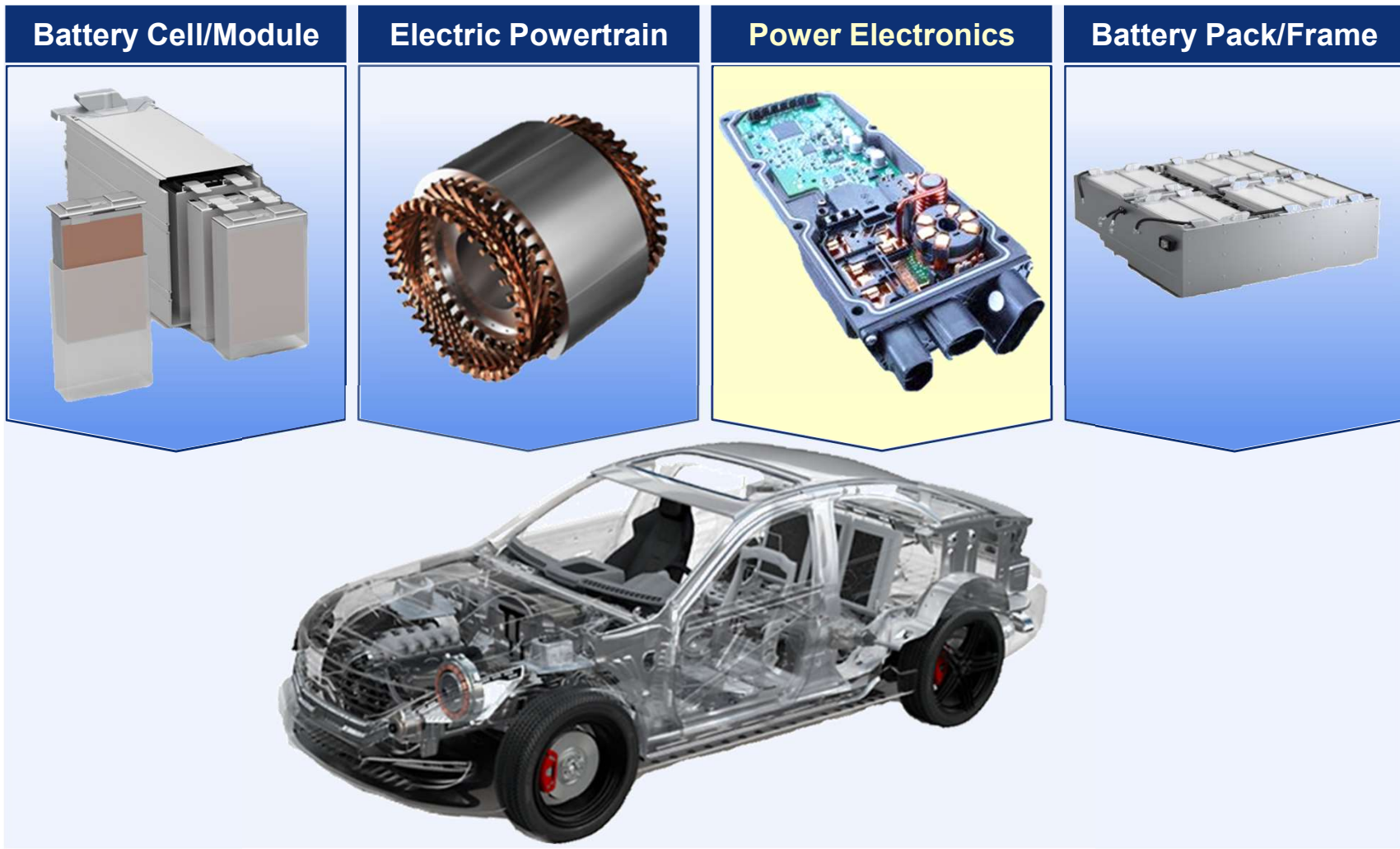


Paint stripping and welding of hairpins  
With the TruLaser Cell 3000 and image processing VisionLine



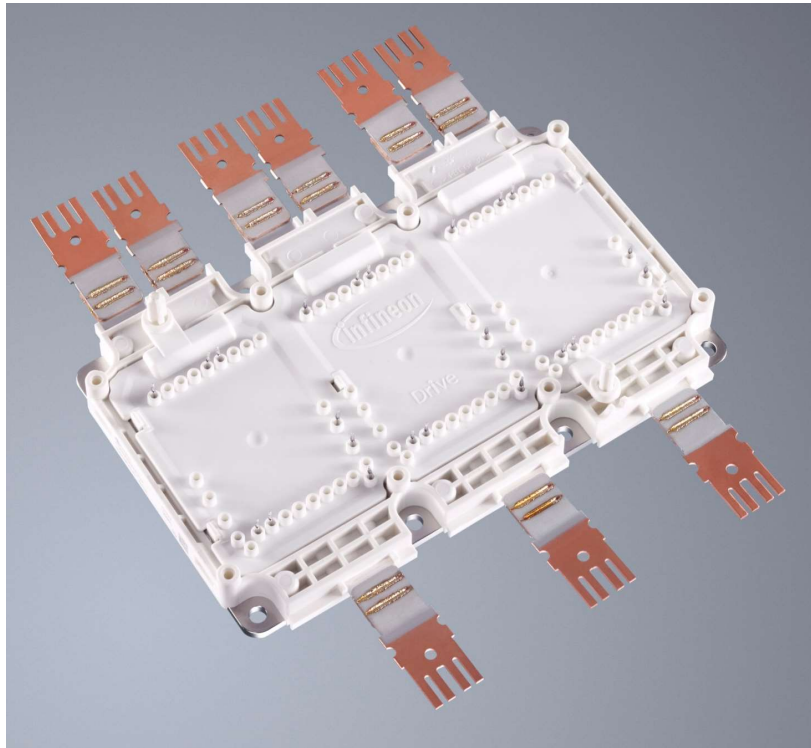
# Application fields for lasers in E-mobility

The laser offers numerous industrial solutions in manufacturing fields of EV



# Power Electronics: Copper welding with BrightLine Weld

Fast welding with reduced spatter formation with high power IR Lasers



Cu-Sn galvanized 2-8 $\mu$ m

Penetration depth: 1,63mm  
 $P_{av} = 5,7$  kW

- TruDisk 6001 with PFO33 + BLW
- Speed: 10m/min
- No pores, almost spatter free

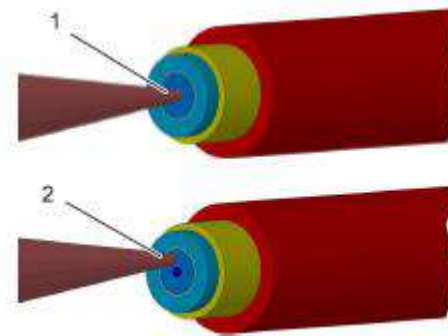
**BrightLine Weld for thick materials, large welded areas, ....**

## Excursus: BrightLine Weld – Functional Principle

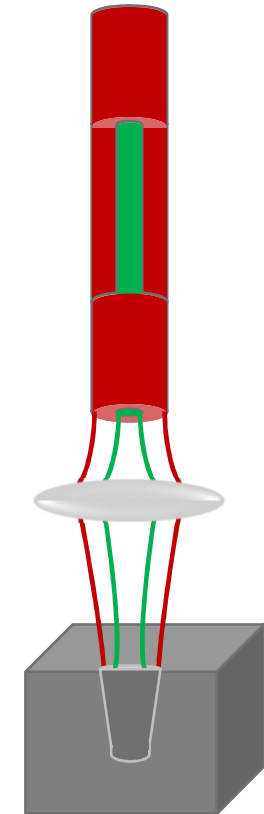
Flexible power distribution for optimal application results

- Patented waveguide layout of **TRUMPF *2in1*-fiber**
- Flexible distribution of laser power into inner and outer fiber core out of one single laser source
- Superposition of two beam into the process zone

→ Adjustment to application specific optimum



- 1: laser beam coupled into an inner fiber core  
 2: laser beam coupled into coaxial outer fiber core





## Excursus: BrightLine Weld

Beneficial in steel, aluminum & copper

Standard Setup: Cu; feet rate 10 m/min



New: ***BrightLine Weld***



- High speed, high quality laser welding
- Almost spatter free

## Power Electronics: copper contacts

97% less spatters by welding with green laser compared to IR.

### Description:

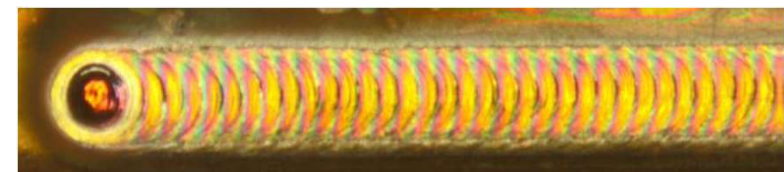
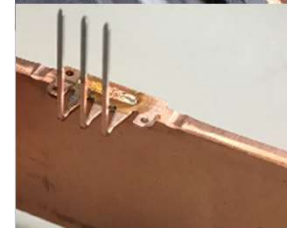
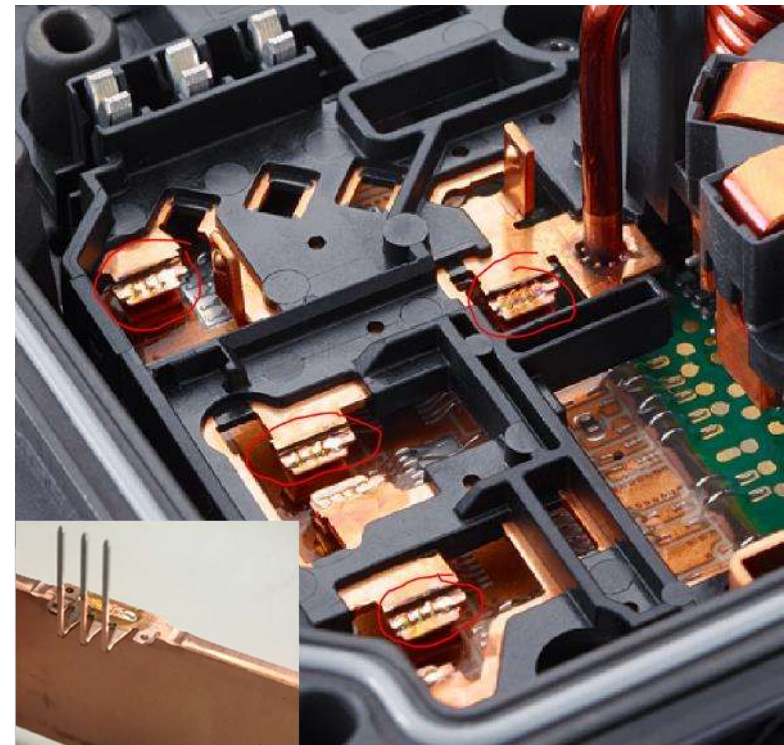
Welding of copper contacts Cu-ETP  
less than 0.8 mm welding depth.

### Requirements

- Less short circuit faults
- Less pores/spatters
- Less contamination of optics and fixtures
- Less subsequent process control steps.

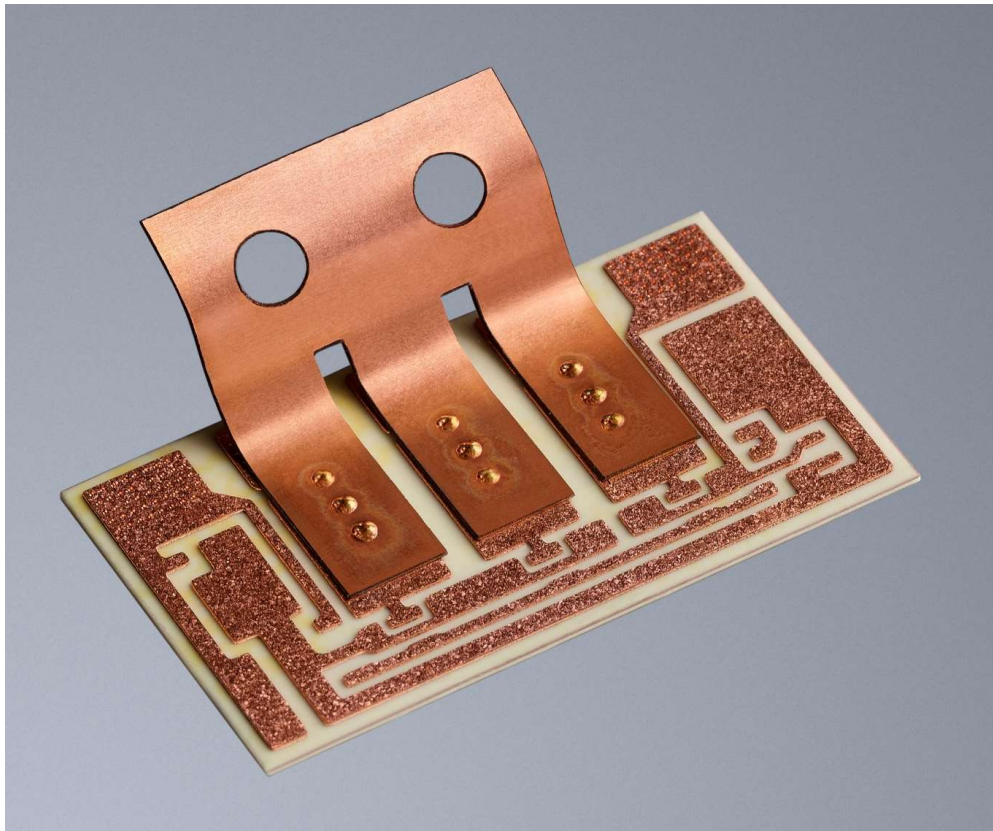
### Recommendation:

- TruDisk Pulse 421 + PFO20-2/D70  
+ VisionLine-Detection



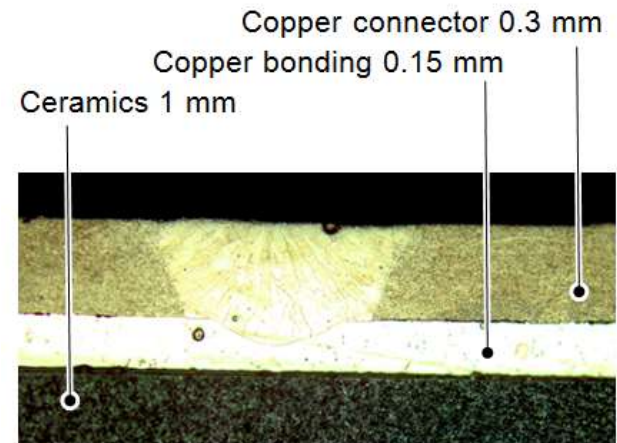
## Contacting of Copper on Ceramic PCB Boards

DCB Spot welding with pulsed green laser – 1 pulse ~ 5 – 10ms



### Precise spot welding:

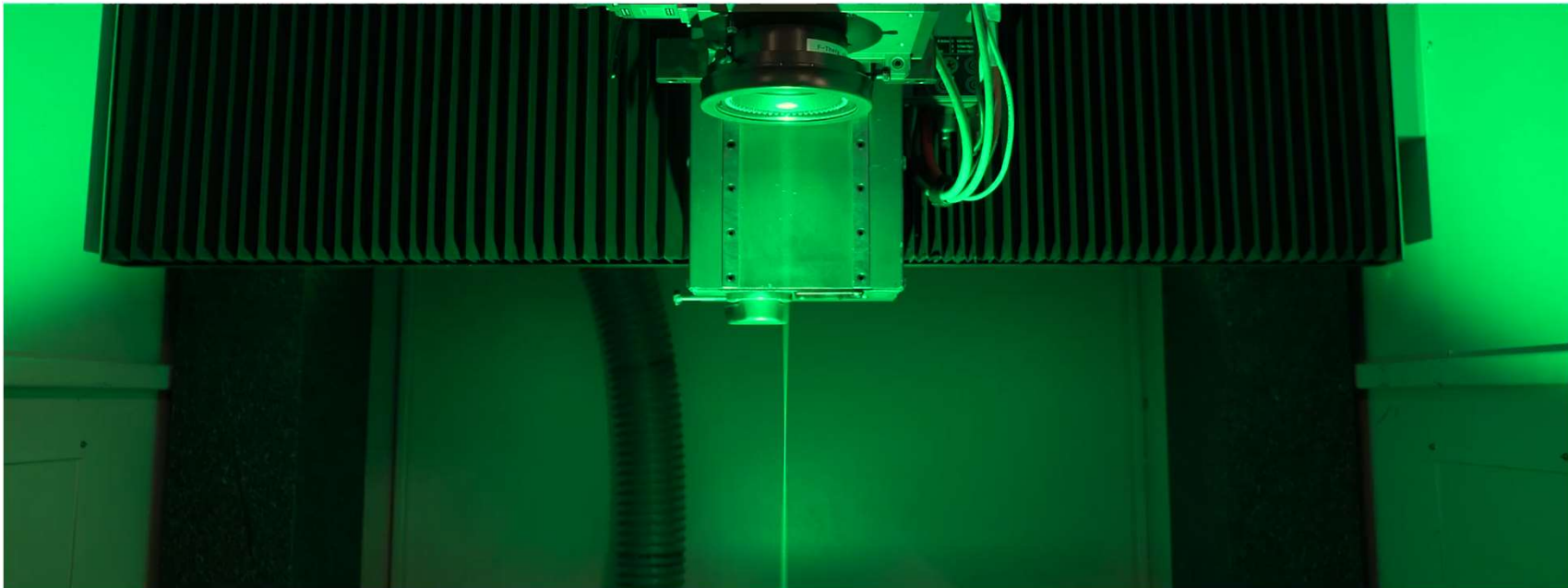
- reproducible penetration depth
- Long pulse welding (50ms) for short lines possible



# Copper welding with cw green laser

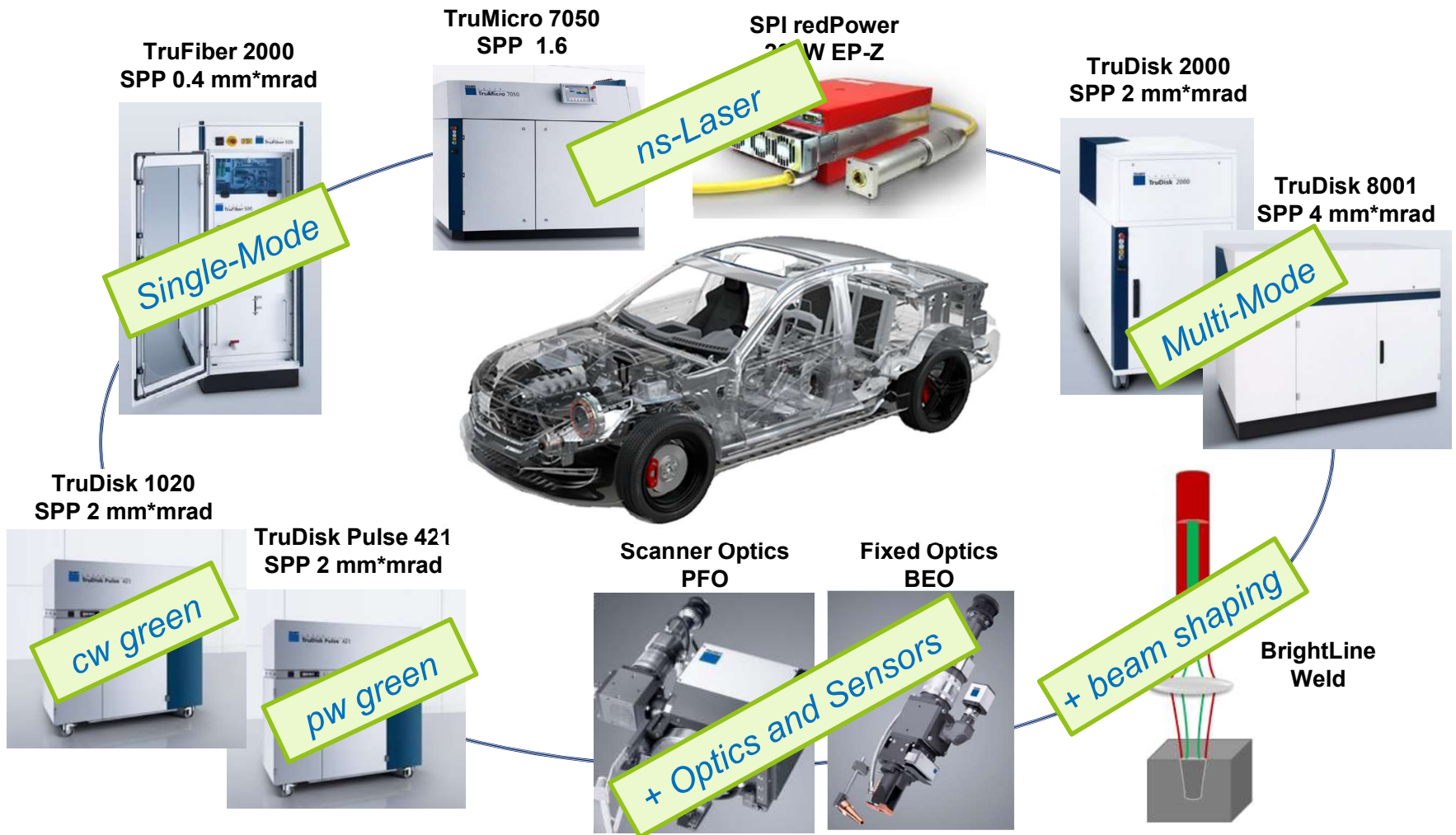


TruDisk 1020  
Copper welding with green wavelength



# Lasers and tools for E-Mobility & Electronics

Power of Choice! - Many tools with the same customer benefit?



## Summary

### E-Mobility made with TRUMPF Laser

- Industrial solutions for manufacturing of electrified vehicles xEV
- Reliable joining and sealing processes in battery cell assembly
- Highest electrical conductivity and mechanical strength of busbar connections, and hairpin welding
- Spatter free joining of copper





# Thank You

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