



# LASER TECHNOLOGY IN SURFACE TREATMENT

## The Next Industrial Level

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Sales Engineer Laser Technology

Scherpenzeel, 1-11-2017

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- 2. Introduction laser technology**
- 3. Applications**
  - Layer Ablation
  - Roughening / polishing
  - Laser Metal Deposition (LMD)
- 4. New developments**
- 5. Summary**



## ABOUT TRUMPF

# TRUMPF: independant family owned company

## Our management



Dr. rer. pol.  
Lars Grünert

Dr.-Ing. Heinz-  
Jürgen Prokop

Dr.-Ing. E.h.  
Peter Leibinger

Dr. phil. Nicola  
Leibinger-Kammüller

Dr.-Ing. Mathias  
Kammüller

Dr.-Ing. Christian  
Schmitz

Chairman of the Supervisory Board: Dr. Jürgen Hambrecht [not in the picture]

# Worldwide presence – Business Field Laser Technology

Our locations close to our customers





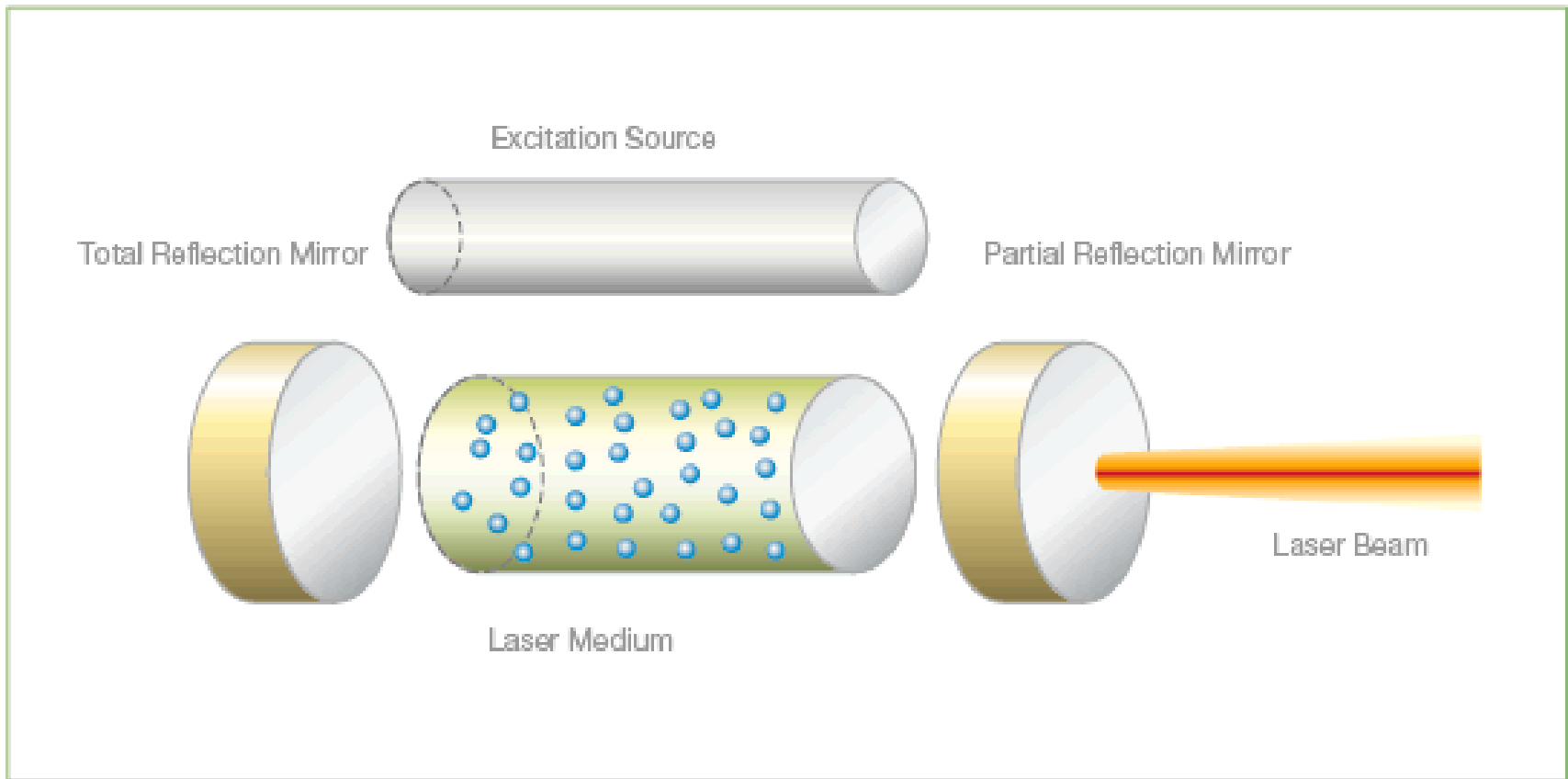




## INTRODUCTION LASER TECHNOLOGY

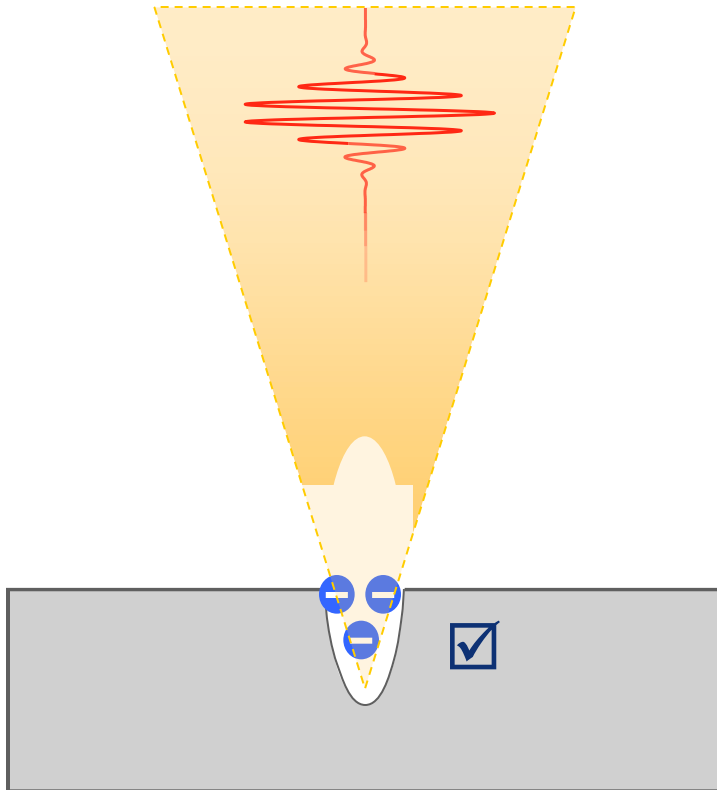
# Principle of laser

Every laser consists of four elements: active medium, resonator, pump source and cooling system





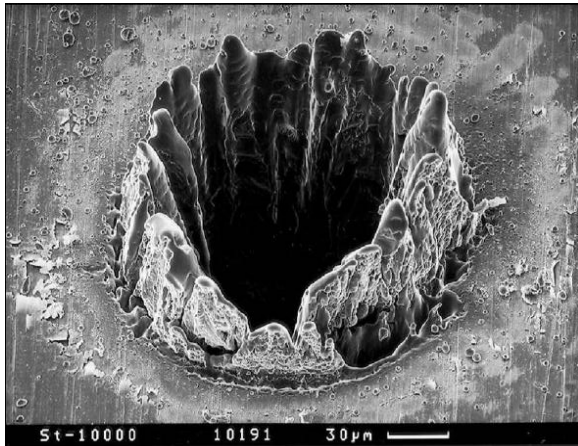
# Ultrafast Micromachining: Cold Processing



- Laser Pulse Hits Workpiece
- Electrons Absorb Pulse Energy
- Electrons Transfer Energy to Atoms  
⇒ *Localized* Heating
- Material Sublimates Before  
Heating the Surrounding Material
- Minimum Heat Affected Zone!

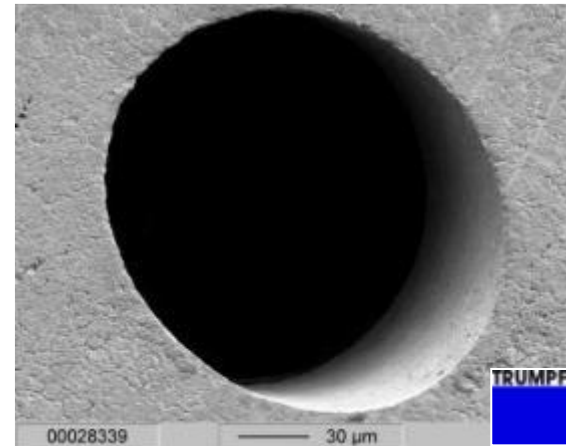
# Why shorter than short?

ns pulses



- Melt, burr, HAZ
- Limited accuracy
- High throughput

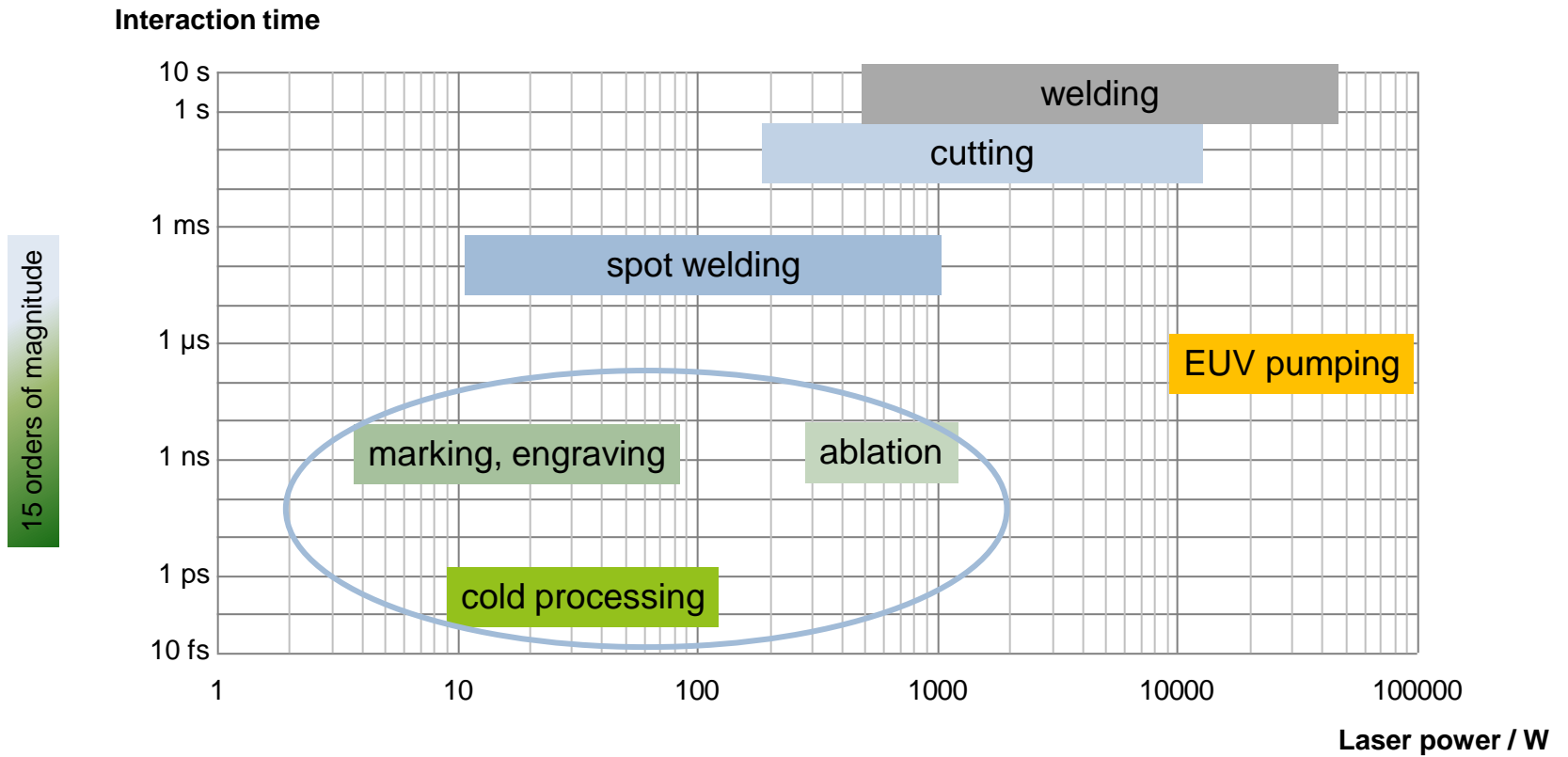
ps pulses



- Perfect quality
- High accuracy

C. Momma, B.N. Chichkov, S. Nolte, F. von Alvensleben, A. Tünnermann, H. Welling, B. Wellegehausen, "Short-pulse laser ablation of solid targets", *Opt. Commun.* **129**, 134 (1996)

# Laser Process Map





## APPLICATIONS

- Layer Ablation
- Roughening / polishing
- Laser Metal Deposition (LMD)

# Ablation of thin films

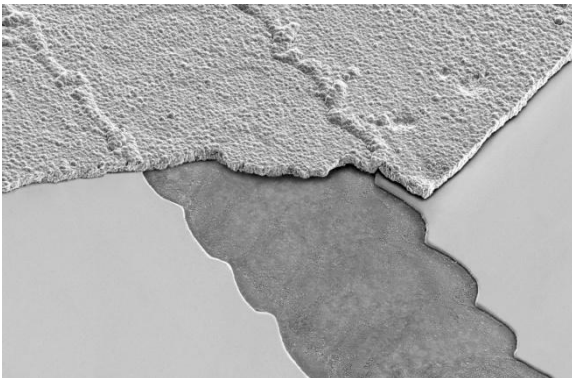
## Thin Films

- Metals
  - Au, Ag, Cu, Mo
- Semiconductors
  - Si, CdTe, Cl(G)S, IGZO
- TCOs
  - ITO, ZnO, SnO<sub>2</sub>
- Dielectrics
  - SiO<sub>2</sub>, SiN



## Substrate materials

- Glass
- Sapphire
- Metals
- Semiconductors
- Ceramics (Al<sub>2</sub>O<sub>3</sub>, ALN)
- PET



## Ablating / Cleaning with the LASER - Why?

- Cleaning: Preparation / Improvement of downstream operations
- Edge deletion: Easy disposal of ablated material (remove the suction filter vs. sand-blasting)
- High level of automation
- No additional processing materials / chemicals required.
- No tool wear
- Economical remote ablation
- Requirement: High area ablation rate

# Laser cleaning (movie)

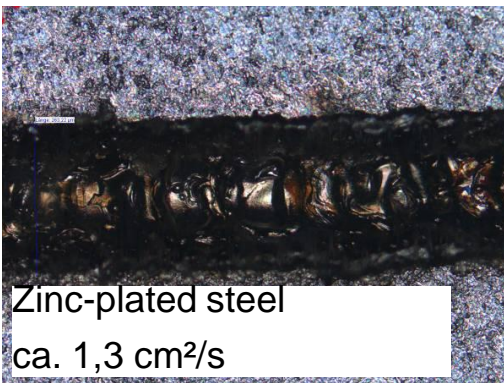
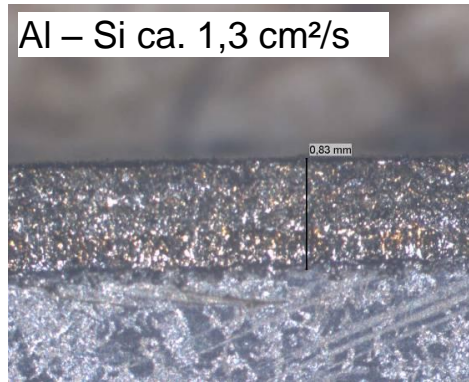
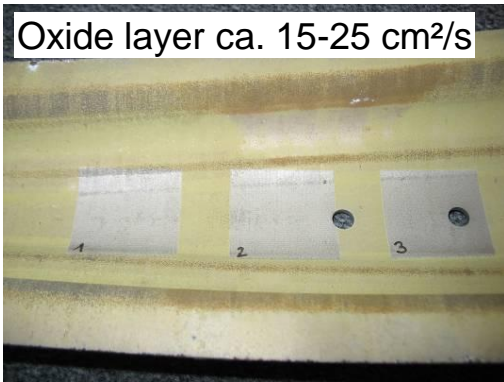


TruMicro 7050: Laser cleaning





# Application: Ablating / Cleaning metal sheets



TruMicro 7050

- $f_p = 10 \text{ kHz}$
- $P = 500 \text{ W}$
- $t_p < 500 \text{ ns}$

LLK04 – round / square

PFO20

- $F = 90 - 135 \text{ } \mu\text{m}$

Spot = 400 - 600  $\mu\text{m}$

# Paint Ablation From Cast Aluminum

## Requirement:

- Ablate paint from cast aluminum
- Minimum heat impact to aluminum

## Solution:

- TruMicro 7050
- Square fiber
- SFO scanner



## Result:

- Ablation rate: 2 cm<sup>2</sup>/s
- Minimum melting of aluminum



## Customer showcase



LR SYSTEMS  
LARGE ROBOTIC SOLUTIONS

### **Laser Coating Removal Robot:**

- 20 kW CO2 laser that can handle all paint colors and both metal and composite surfaces
- The system will be available in 4 sizes
- The system is fully autonomous and will be controlled by a single operator
- Compliant with all safety requirements for labor and aircraft
- 50% less processing time
- 90% reduction in labour





## APPLICATIONS

- Layer Ablation
- Roughening / polishing
- Laser Metal Deposition (LMD)

# Improvement tribology surface

## Requirement:

- Tailored friction bearing

## Solution:

- TruMicro 2000/5000 (IR) – ps/fs
- SFO scanner

## Result:

- Structure depth  $\sim 10\mu\text{m}$
- Minimum HAZ





# Surface roughening for plastic – metal joining

## Requirement:

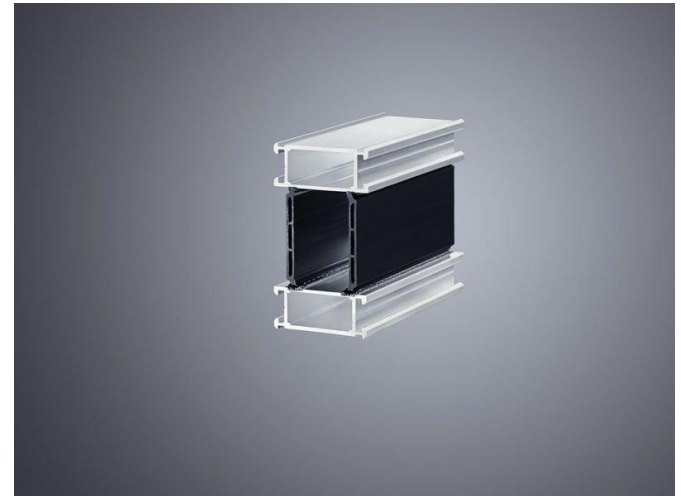
- Open metal structure to allow for molten plastic to flow / interconnect

## Solution:

- TruMicro 7000 (IR) – ns
- SFO scanner

## Result:

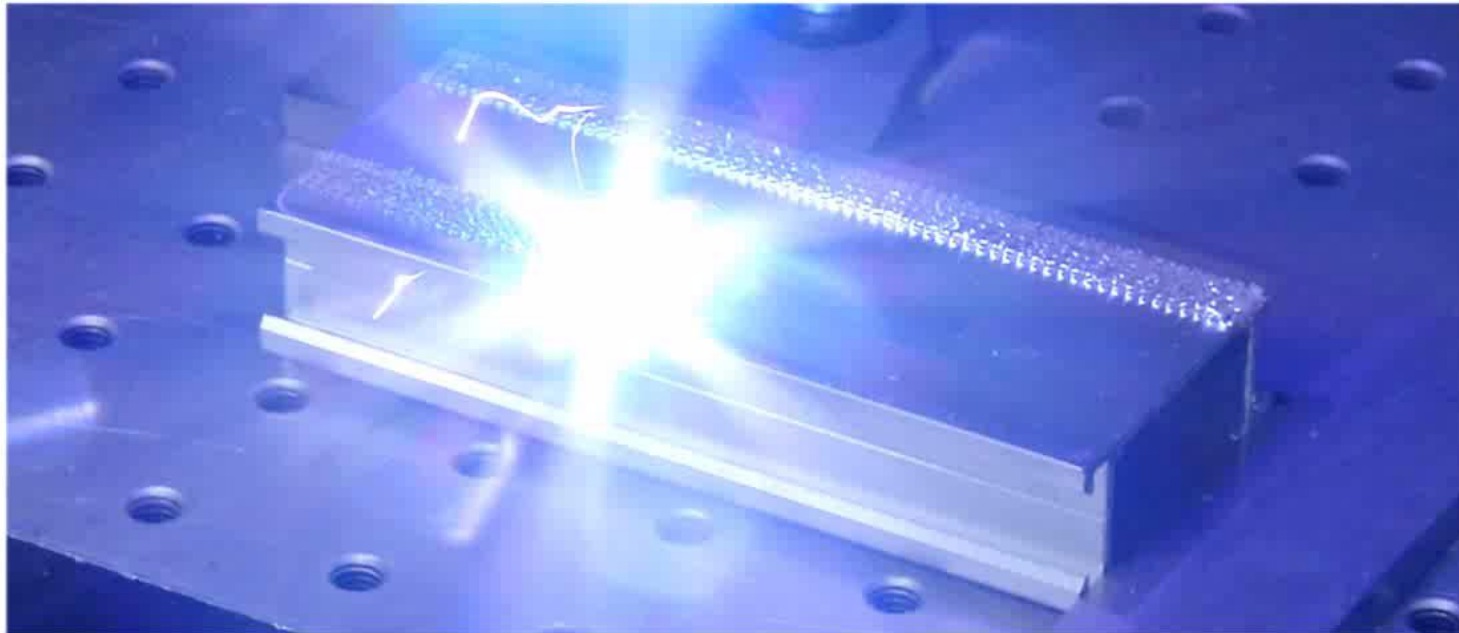
- Clean and sustainable alternative for glueing
- Already in research in automotive and window frame industry



# Laser structuring (movie)



TruMicro: Metal surface roughening





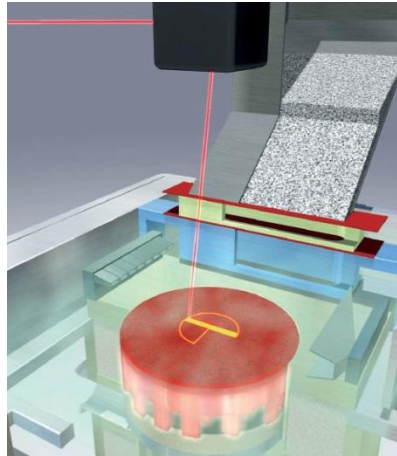


## APPLICATIONS

- Layer Ablation
- Roughening / polishing
- Laser Metal Deposition (LMD)

# Laser additive manufacturing (3D printing): LMF and LMD

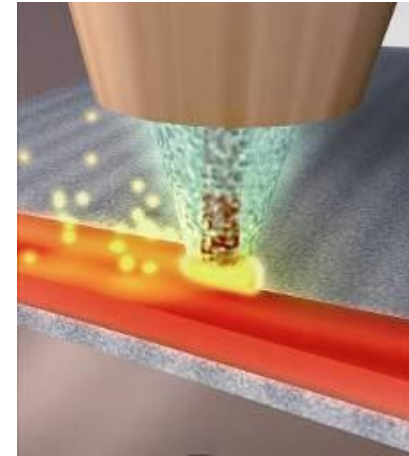
## LMF: Laser Metal Fusion



Powder bed process



## LMD: Laser Metal Deposition

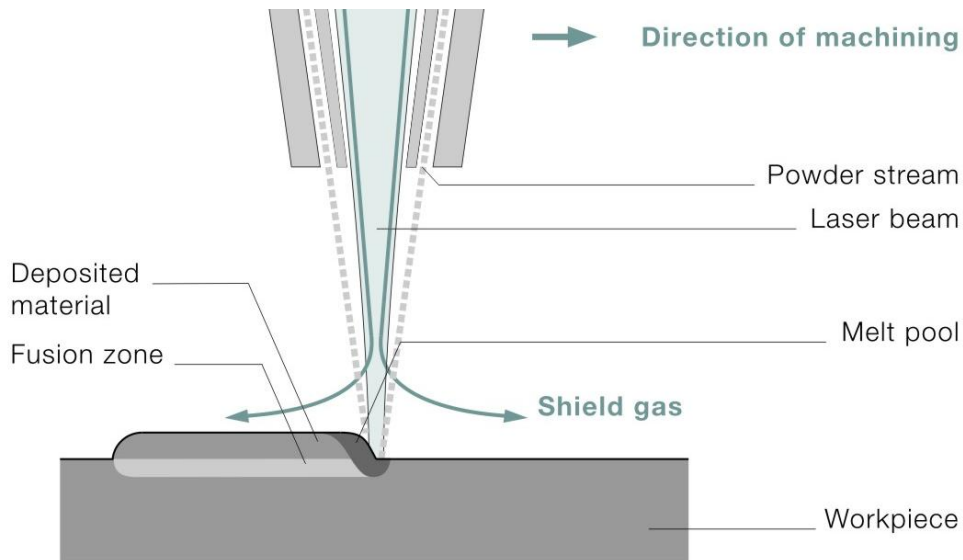
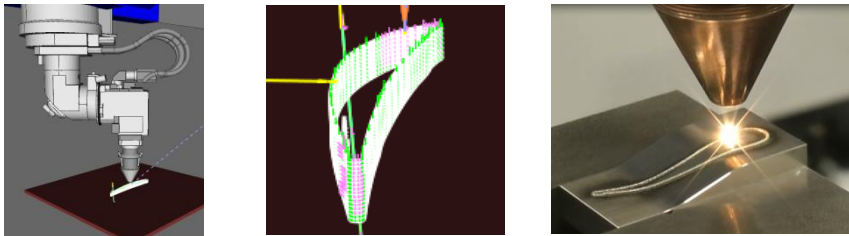


Powder delivery nozzle  
process

# Laser Metal Deposition (abbr. LMD)

## Principle of the process and advantages

### Laser Metal Deposition



#### Principle of the process:

- Melt pool is produced on surface of a component
- Powder particles of material to be deposited are injected in the melt pool



#### Advantages:

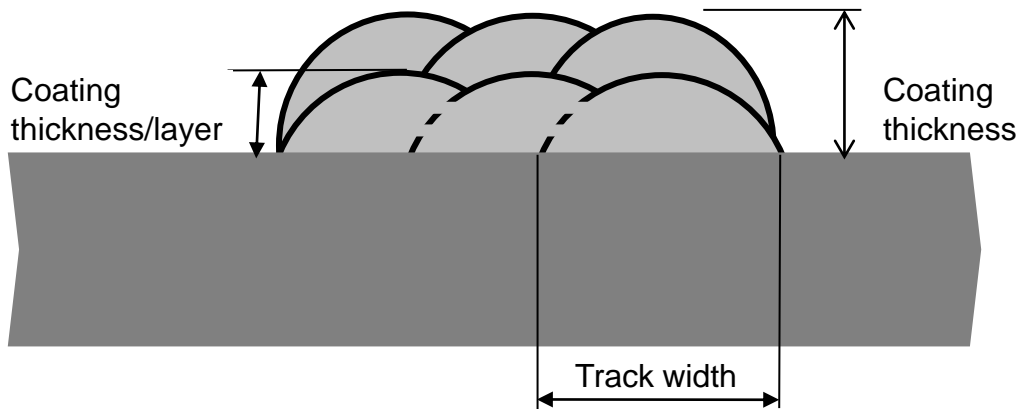
- Production of coatings and volumina on 3D surfaces
- High deposition rates (>300cm<sup>3</sup>/h) possible
- Combination of materials

# Deposited tracks

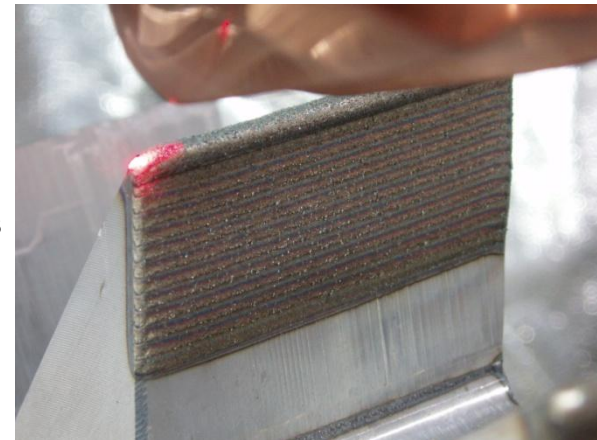
## Geometrical characteristics

Property	Min.*	Max.*
Track width	ca. 0,4 mm	ca. 7 mm
Coating thickness/layer	ca. 0,5 mm	ca. 1,5 mm

\*Depending on material and process parameters



Coated saw tooth



## Common deposit materials

### Materials for protection against corrosion:

- Iron base alloys: austenitic steels
- Nickel alloys: NiCr, NiCrMo

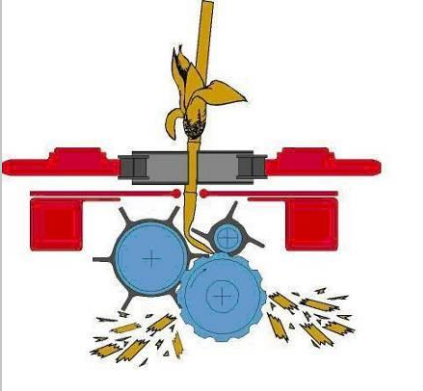
### Materials for protection against wear:

- Iron base alloys: martensitic steels
- Nickel base alloys: NiCrBSi
- Cobalt base alloys: Stellite<sup>®</sup>
- Carbide particles embedded in metallic matrices: WC, TiC


# Application fields of Laser Metal Deposition

Coating production, repair and additive manufacturing

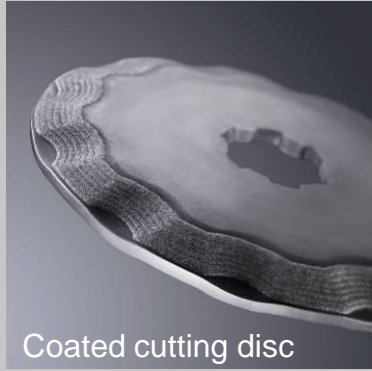
## Coating



By courtesy of MWS Schneidwerkzeuge (Germany)


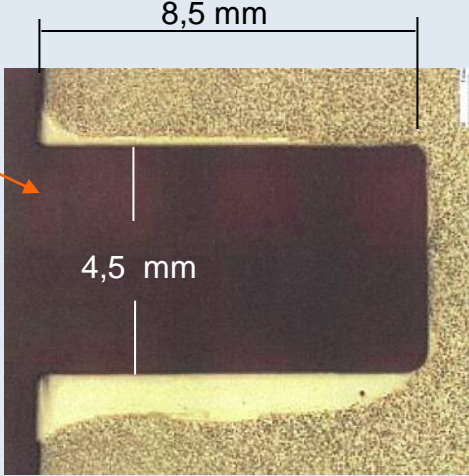


Coated blade



Coated cutting disc

## Repair

8,5 mm

4,5 mm

By courtesy of: Gall & Seitz Systems, Germany

## Additive Manufacturing

# Harvesting machines





# Applications in agricultural devices

Increased life time of blades, cutting discs and shear bars

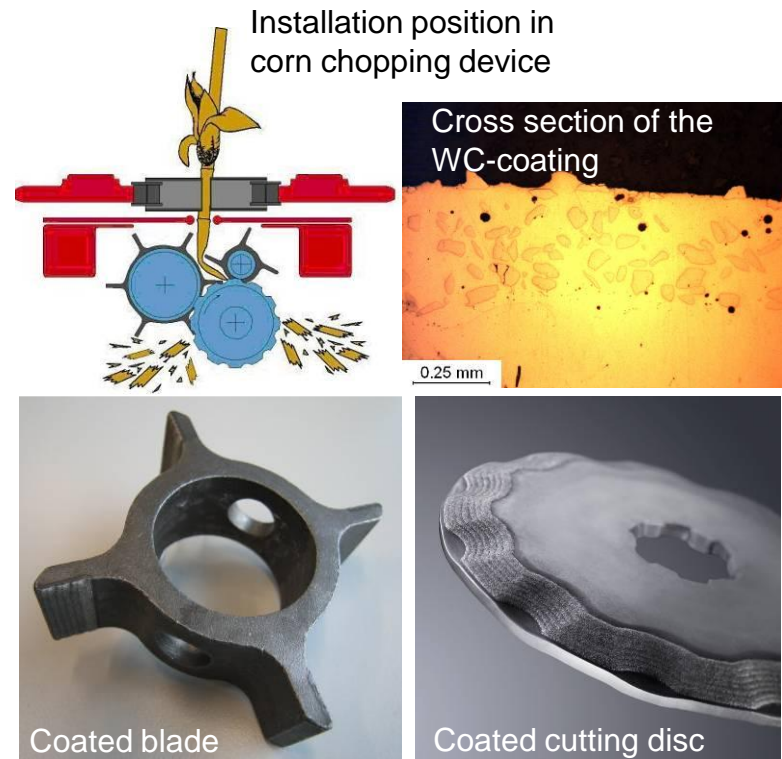
Coating system: WC in Ni-Cr matrix

Increase of operating life approx. 100%

Previous technology:

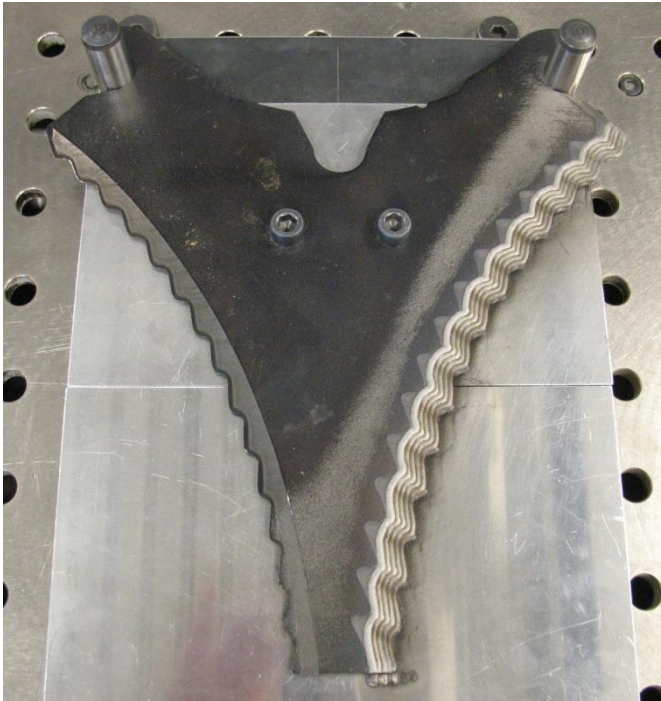
- Flame spray
- Melting afterwards (self-melting alloy)

By courtesy of MWS  
Schneidwerkzeuge (Germany)



# Agricultural parts

Additional examples



# Knife blades

## Retractable knives and cooking knives

- Blades for retractable utility knife (Stanley Tools, United Kingdom) / cooking knives (Evercut, France)

<http://www.stanleytools.com/carbide/index.html>



By courtesy of Evercut, GDD (France)



# Petrochemical Industries: wear and corrosion resistance

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# Coating of pillars



Iron Alloy: 42C

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Advantage LMD:  
High repeatability of process

Previous process:  
- preheating  
- thermal spray  
- inductive melting afterwards

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# TRUMPF Laser Metal Deposition

## Main components



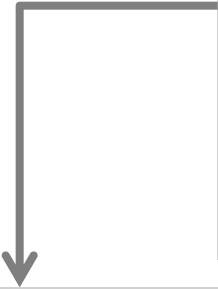
Laser source



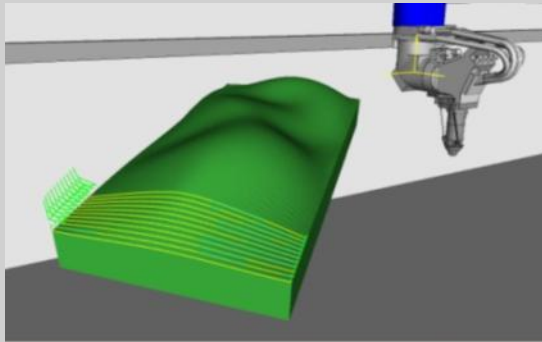
Powder feeder



Laser head



Manipulation system



Off-line programming system



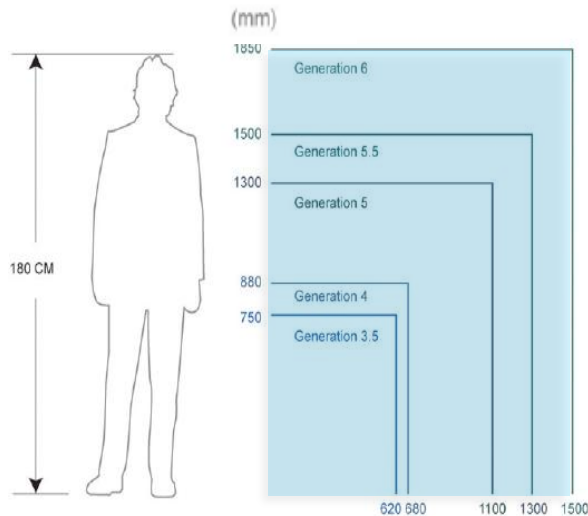
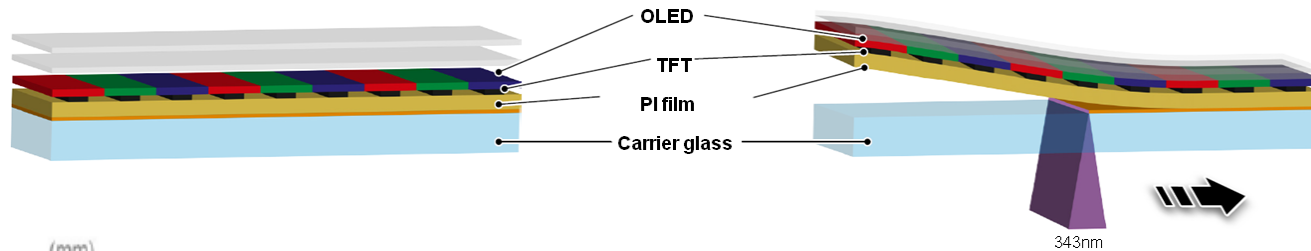
## NEW DEVELOPMENTS



# Laser lift off

## Process information

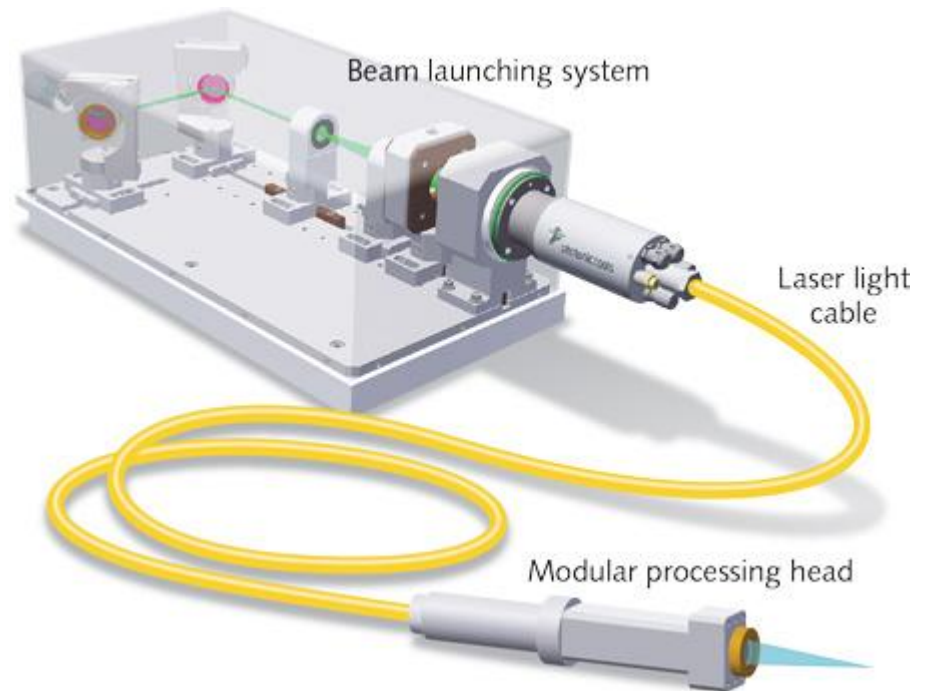
- Destruction of bonding between carrier glass and PI film with TruMicro 7370
- Scan over glass substrate by means of a line beam optics



Gen6 (1800 mm \* 1500 mm) is state of the art glass substrate for mobile OLED devices

# Hollow core fiber

- Beam delivery of ultrafast pulses with high peak power
- TRUMPF innovation displayed on Laser World of Photonics 2017
- Will open up whole new range of applications in combination with new 2kW TruMicro ns-laser (expected 2018 / 2019)



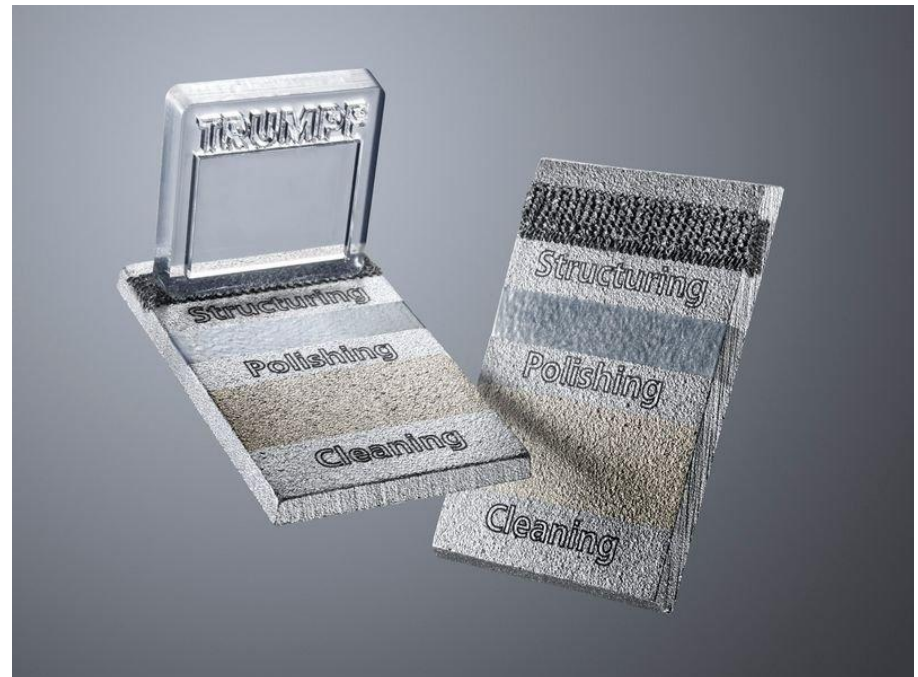


## SUMMARY

# Summary

## Laser surface processing - unlimited possibilities

- Short pulses enable „cold“ micromachining
- High powered CO2 laser state of the art for high volume paint stripping
- Combination of high powered solid state laser and accurate systems support industrial LMD applications
- Short pulse lasers are now available in industrial grade for a variety of different processes:
  - Thin layer ablation
  - Surface structuring
  - Surface polishing
  - Surface cleaning





# YOUR CONTACT

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**TRUMPF**

