# TruMicro Laser Portfolio

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Cold Processing of WLCSP with ultrafast lasers

Michael Lang
Industry Management Microtechnology
## Company figures

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<tr>
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<th>Fiscal Year 2014/15</th>
<th>Change in %</th>
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<tr>
<td>Sales (in mil. €)</td>
<td>2,717.0</td>
<td>+ 5.0</td>
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<tr>
<td>– Adjusted comparison*</td>
<td></td>
<td>+12.6</td>
</tr>
<tr>
<td>Income before taxes (in mil. €)</td>
<td>357.1</td>
<td>+ 43.8</td>
</tr>
<tr>
<td>Investments (in mil. €)</td>
<td>129.4</td>
<td>+ 3.7</td>
</tr>
<tr>
<td>Expenditure for R+D (in mil. €)</td>
<td>265.1</td>
<td>+ 8.9</td>
</tr>
<tr>
<td>Employees (as of 06/30/2015)</td>
<td>10,873</td>
<td>- 0.4</td>
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<td>– Adjusted comparison*</td>
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<td>+ 6.8</td>
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<td>Sales (in bil. €)</td>
<td>2.8</td>
<td>+ 3.0</td>
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* Adjusted comparison that includes the effects due to the discontinuation of the Medical Technology business division

** Preliminary figures for the fiscal year 2015/16.
Worldwide presence – Business Field Laser Technology

Our locations close to our customers
## Our business divisions

### Share of sales in 2014/15

<table>
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<tr>
<th>Machine tools for flexible sheet metal processing</th>
<th>Laser technology / Electronics</th>
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<tr>
<td>Sales 2014/15</td>
<td>2,360 mill. €</td>
</tr>
<tr>
<td>Share of sales</td>
<td>70.7 %</td>
</tr>
<tr>
<td>Sales 2014/15</td>
<td>966 mill. €</td>
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<td>Share of sales</td>
<td>28.8 %</td>
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# The Power of Choice

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<th>CO$_2$-Laser</th>
<th>Disk Laser</th>
<th>Diode Laser</th>
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<td>TruFlow &amp; TruCoax</td>
<td>TruDisk</td>
<td>TruDiode</td>
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- **CO$_2$-Laser**: TruFlow & TruCoax
- **Disk Laser**: TruDisk
- **Diode Laser**: TruDiode

- **Fiber Laser**: TruFiber
- **Pulsed YAG**: TruPulse
- **USP Laser**: TruMicro
- **Marking Laser**: TruMark

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*The Power of Choice*
What our laser technology is typically used for…

...Industrial material processing

- Cutting
- Welding
- Cladding
- Ablating
- Marking
CE Products and their Components e.g: Tablet
COLD PROCESSING OF WLCSP WITH ULTRAFAST LASERS

TRUMPF in Semicon Industry
EUV requires fundamental innovations...

...in and around the lithography system

- Where is TRUMPF?
TRUMPF technology in EUV system

Upper level: cleanroom / chip manufacturing
Lower level: CO₂ laser pulse generation

TRUMPF FFA focusing optics

Scanner

EUV light generation

Final focusing assembly

Beam transport system

TRUMPF CO₂ laser system: Drive Laser and Seed module

Quelle: ASML/Cymer

Quelle: ASML
Drive Laser

Seed laser module and power amplifiers

- 50,000 CO₂ laser pulses per second
- 10.6 μm wavelength
- Several MW pulse peak power
- > 25 kW average power
- <1.4 beam quality factor M²
TRUMPF Lasersystems for Semiconductor Manufacturing GmbH

Founded November 01, 2014. 100% dedicated to EUV.
Ultrafast pulses as a tool
Ultrafast Pulses

Pico- \((10^{-12})\) or Femto \((10^{-15})\) Second pulse durations

Light travels 1.3 seconds between the moon and earth – in one femto second it only covers half a human hair.
Properties of Ultrafast pulses

Ultrafast pulses enable extreme power densities

Surface of the sun:
ca. 1 Mio. = $10^6$ W/cm²

Ultrashort-Laser:
$>10^{16}$ W/cm²
Materials processing with ultrafast laser pulses

Cold ablation of a wide range of materials

**ns Pulse**


**ps Pulse**

Cold ablation on a match stick
**Injection nozzle drilling – development**

1999  Drilling with TRUMPF Vanadat short pulse laser (ns)

2000  R&D project Primus (ps-Laser)

2002  BoR: Laser for finest material processing
      (Cooperation partner: BOSCH)

2003  1. Concept laser (Quattro)

2004  R&D project Promptus

2006  Kickoff: TruMicro 5000 (Gen I)

2008  BoR: TruMicro 5000 (Gen II)
      B. Leibinger award for BOSCH: „Introduction of USP
      micro processing in industrial production”

2009  Release TruMicro 5000 (Gen II)

2011  TruMicro 5000 highpower (IR + green)

2013  German Future Price awarded to BOSCH, Fraunhofer
      IOF / University Jena, TRUMPF
THIN FILM ABLATION
Ablation of thin films

**Thin Films**
- Metals → Au, Ag, Cu, Mo, In
- Semiconductors → Si, CdTe, Cl(G)S, IGZO
- TCOs → ITO, ZnO, SnO₂
- Dielectrics → SiO₂, SiN

**Substrate materials**
- Glass
- Sapphire
- Metals
- Semiconductors
- Ceramics (Al₂O₃, AN)
- PET, PI, PC
Ablation of Dielectrics

Target:
- Single Spot Ablation of SiN, SiO₂
- Substrate Silicon
- No thermal influence on Si

Solution:
- TruMicro 5000
- Ultrashort pulses
- Scanner solution
- Focus diameter ~30 µm
- Low damage to substrate
- Speed > 5 m/s
Ablation of Metal Coatings

Target:
- Ablation of Molybdenum from Glass

Solution:
- TruMicro 5050
- 20 µm min. track width
- Low average power necessary
- Speed > 2 m/s
- Low damage to substrate
Ablation of Metal Coatings

- Ablation of various coatings (Ag, Au, Cu) from alumina ceramic and PET substrates

Solution:
- TruMicro 5250
- 20 µm min. track width
- Low average power necessary
- 100 mm/s
- Low damage to substrate
Ablation of Metal Coatings

Target:
- Silver layer ablation
- 20 µm lines
- Ag: 8 µm thick
- PET substrate: 120 µm

Laser:
- TruMicro 2020
- Up to 1600 mm/s
Ablation of Metal Coatings

Application:
- Copper ablation
- Cu: 25 µm
- PI: 75 µm

Laser:
- TruMicro 5250
CERAMICS
Drilling of Ceramics

Target:
- Cylindrical holes in AlN ceramics
- Thickness 0.5 mm
- 60 µm diameter
- 500µm thickness

Solution:
- TruMicro 5050 / 5070

Result:
- Almost straight walls
- > 20 holes / s
- No burr
Ceramics
Ceramic Engraving

Request:
- General test engraving of ceramic (Al$_2$O$_3$) with TruMicro 2020

Equipment:
- TruMicro 2020 (IR)
- Optics f = 100 mm
- Burstmode (1,2,…,8)

Result:
- Volume ablation rate up to 3 mm$^3$/min; 100 µm depth
- No engraving possible without Burstmode; Taper ~25°; No burr
PI / ORGANICS / MIXED STACKS
Cutting of thin PI Film (cover layer)

Request:
• Cutting of a thin PI (Kapton) Foil on paper
• No burning

Solution:
• TruMicro 5250
• Multipass cutting

Result:
• Effective cutting speed: 140 mm/s
• No burning or bulging
Flexboards – Cutting of Polyimide film

Request:
- Cutting PI film
- Thickness 100 µm

Solution:
- TruMicro 5250
- Cutting speed up to 100 mm/s
- Low HAZ
Wearables

A MUCH More Diversified Market Than Investors Realize

Source: Company Website, iFlowreader, Credit Suisse Estimates,

Produced by: John Pitzer
Slide 6
SiP Singulation

Low Taper, high cut speed
No heat affected Zone (HAZ)
TRANSPARENT MATERIALS
Sapphire cutting
Flat Panel Displays: Cover glass and displays

Displays for mobile devices

- Cutting of chemically strengthened cover glass and display glass
- Picosecond lasers with special optics enable high speed cutting up to 1 m/s

⇒ Picosecond lasers
Selective laser etching

The modification of glass medium USP lasers enables targeted, selective etching of almost any geometry

Ø 200 micron holes

Ø 500 micron holes
COLD PROCESSING OF WLCSP WITH ULTRAFAST LASERS

www.trumpf.com
www.Laser-Community.com
YOUR CONTACT

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