3D-Micromac AG

Symposium on Smart Integrated Systems in Chemnitz

Laser Micromachining for Industrial Applications and R&D

microDICE™ system

TLS-Dicing™ for separation of SiC wafers

Current situation by using dicing saws

Cost
- High costs for saw blades
- Reduced uptime

Quality
- Delamination of back-side metal
- Defects by chipping

Speed
- 2-10 mm/s
- Limited throughput

Our solution – TLS-Dicing™ with microDICE™ System

For excellent cleaving results and higher throughput

Your advantages using TLS-Dicing™ technology

Cost reduction

- Minimal CoO due to contactless processing
- Increased yield by zero kerf

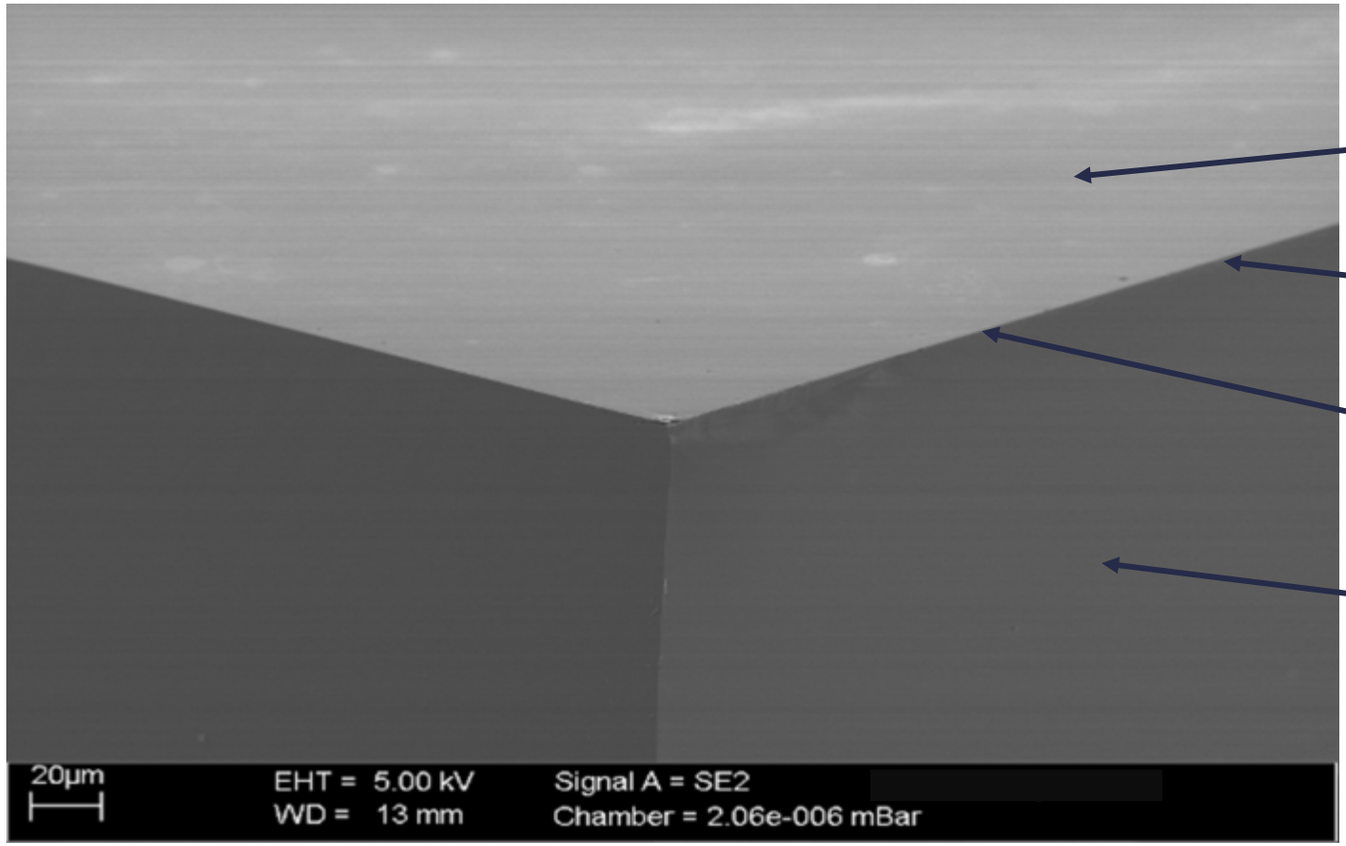
Function

- Back-side metal can be separated without delamination
- Several wafer editable

Speed

- Dicing speed up to 300 mm/s
- Higher throughput due the higher process speed

Advantages at a glance



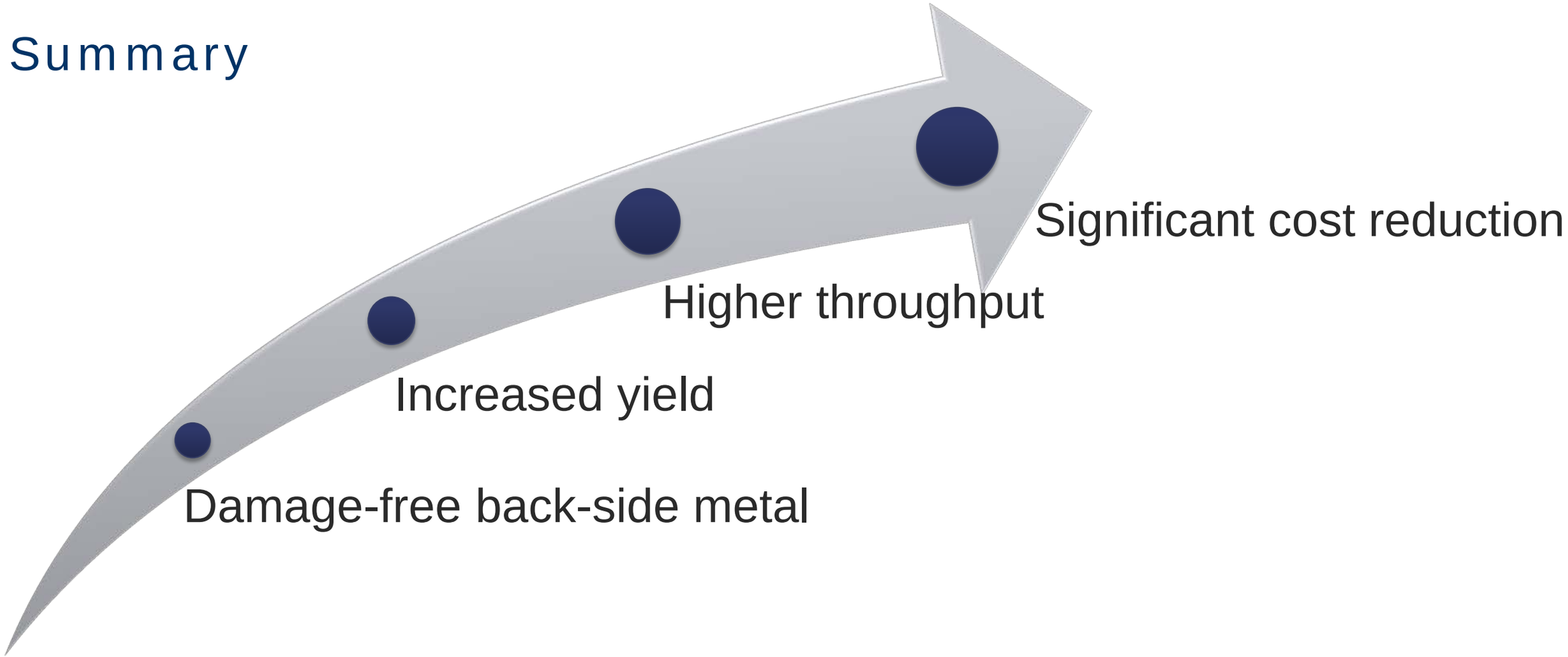
- Free of residues
- Free of chipping
- Zero kerf
- Perfect sidewalls

microDICE™ system

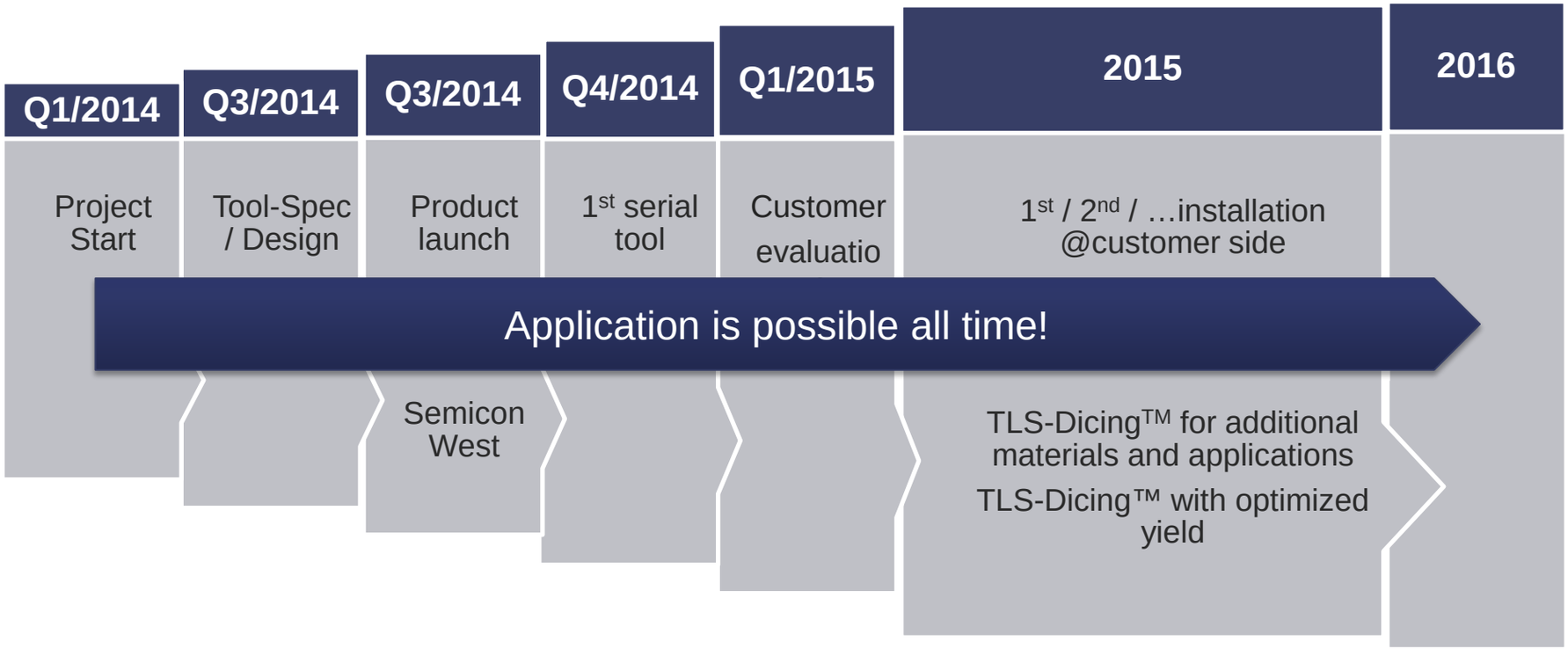
- Up to 300 mm (12”) wafer size
- Integrated laser sources with long lifetime
- Integrated patented micro stretching function
- Automated wafer handling
- SECS / GEM interface
- Compatible with common SEMI standards
- Consumables: only DI-water

microDICE™

Summary



Product roadmap TLS-Dicing 2014



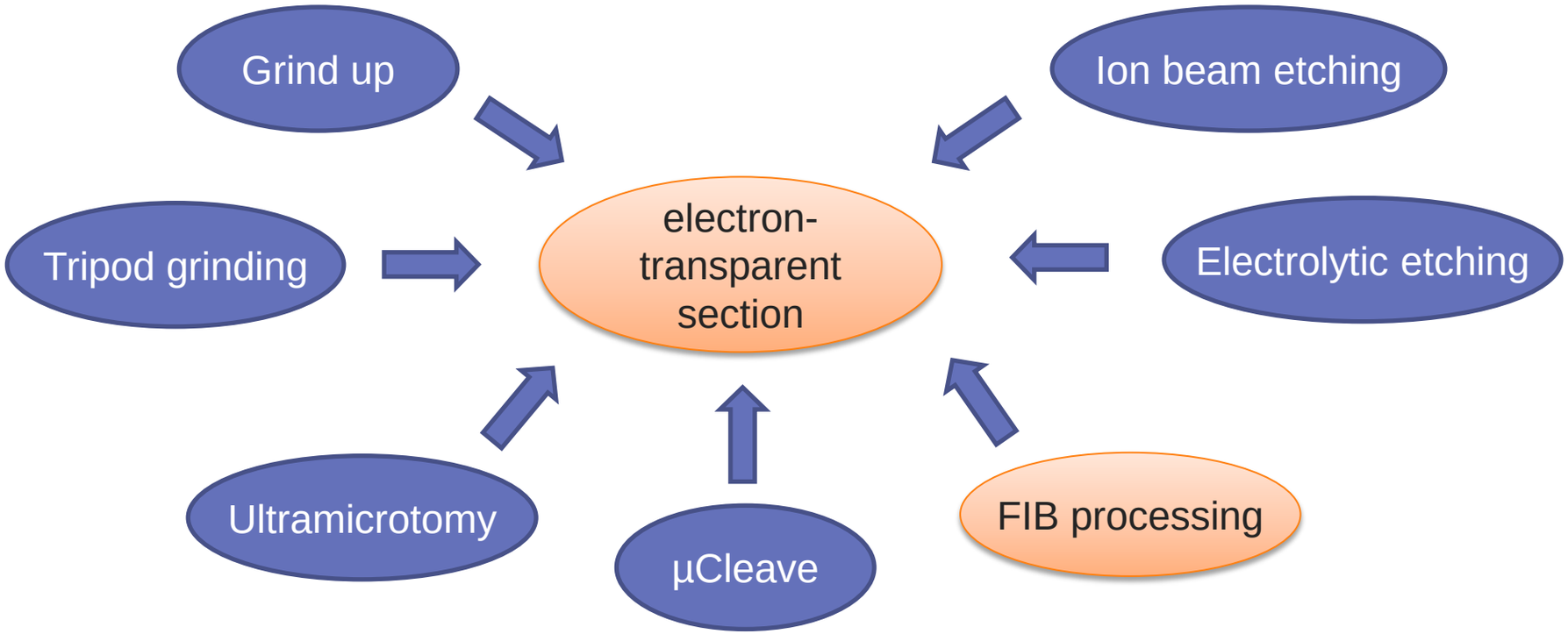
Laser Micromachining for Industrial Applications and R&D

microPREP™

New vistas for targeted and high-throughput microstructure diagnostics

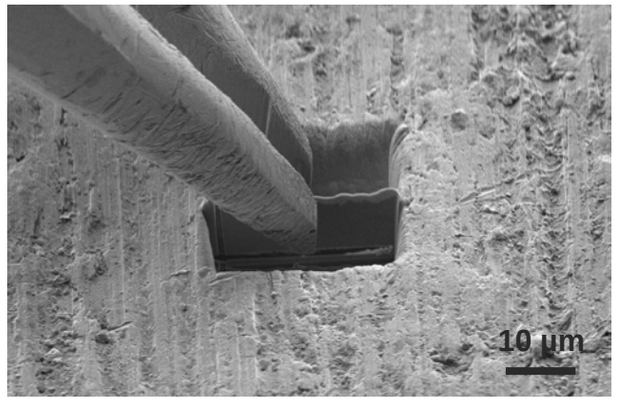
Transmission Electron Microscopy (TEM) – Classical ways

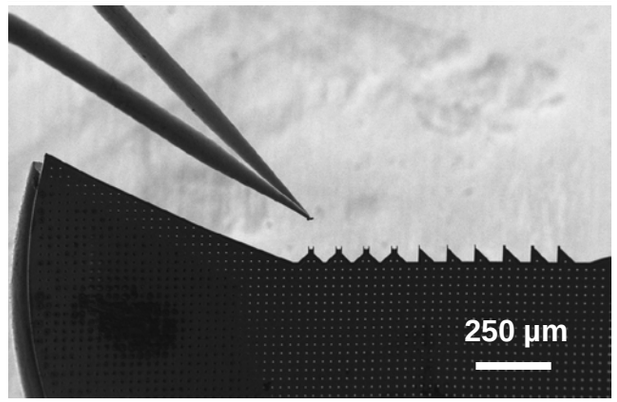
- Many ways to achieve electron transparency



One common way to achieve electron transparency - FIB

- Lamella preparation with a focused ion beam (FIB)

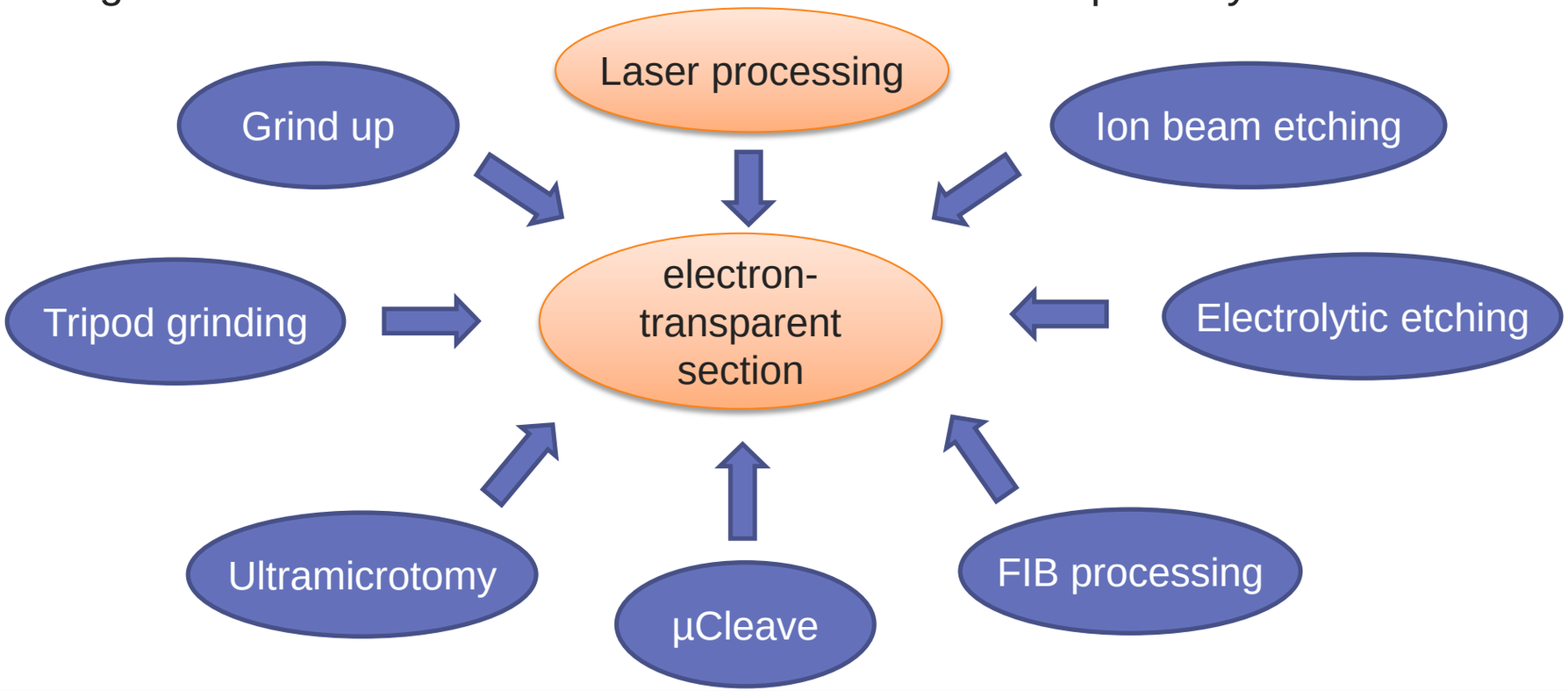




- FIB is a proven method, but the process is very complex

Expanding the opportunities by using laser

- Laser processing as a all-new instrument to achieve electron transparency



Laser – Properties

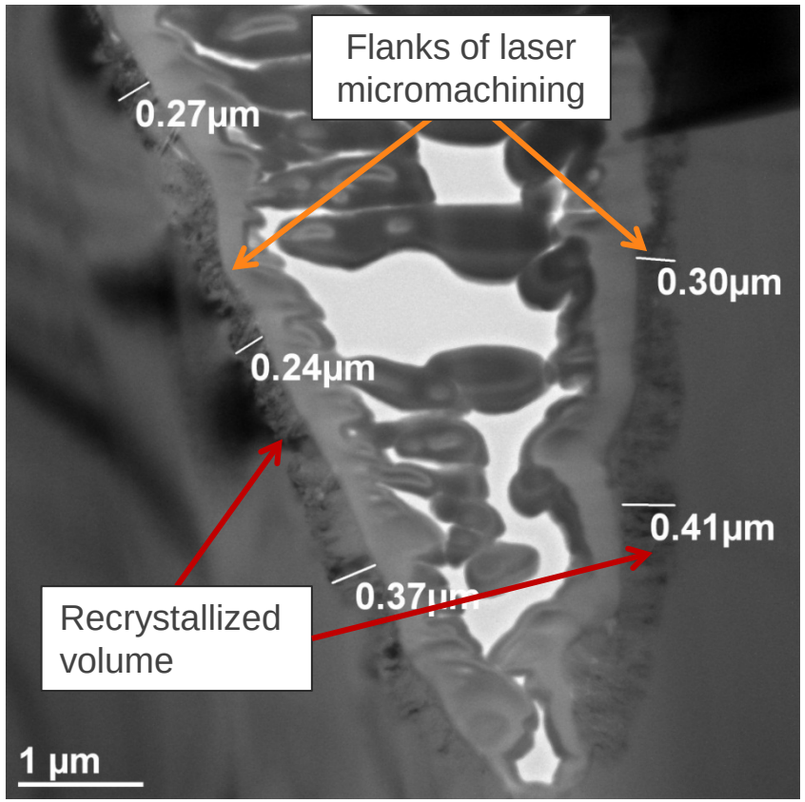
- High power densities → Materials ablation
- Precise local delivery and focusing
- Just photons → clean in terms of contamination
- Low running costs
- High fluences → non-linear optics:
  Multi-photon absorption
  → Machining of transparent-at-the-wavelength materials feasible

Source: Scanlab

Is structural damage an issue?

Laser – Induced Structural Damage? → Controllable!

- Silicon, laser machined with ultrashort pulses
- Recrystallization along flanks to a depth of 150 nm to 450 nm
- No significant changes to the bulk material beyond this depth detected (e.g., no dislocations, stacking faults etc.)
- Depth of the laser kerf > 15 µm



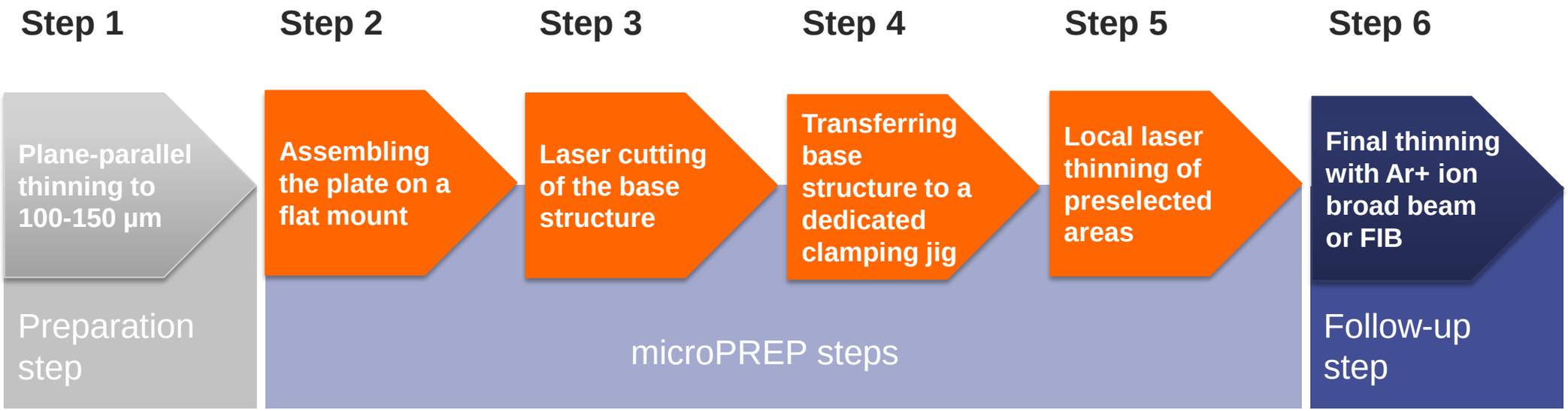
Motivation using laser for TEM

- Very high ablation rates using FIB-technology not achievable

Method	FIB (Ga^+)	High-Current FIB	FIB plus GIS	Plasma FIB (Xe^+)	355-nm DPSS Laser
Milling rate of silicon [$\mu m^3/s$]	2,7	30	250	2 000	1 000 000
Time needed to remove 0.3 mm^3	3.5 years	116 days	14 days	1.7 days	5 min
Spot diameter (theory)	ca. 20 nm (@ 100 pA)			ca. 200 nm (@ 100 pA)	500 nm
Structural-damage depth [nm]	2-20 nm			2-20 nm	< 2 … 4 µm

In Parts after: Martens *et al*., EuroSimE, 2010.

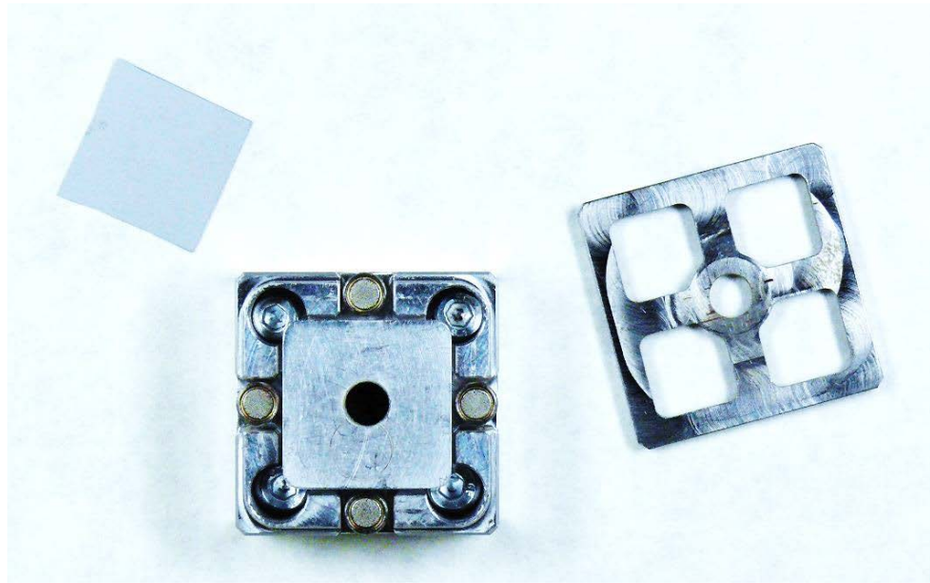
microPREP™ – Process Flow



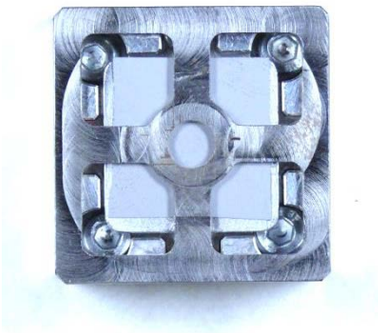
microPREP™ – Process Flow

Step1 | Step 2 | Step 3 | Step 4 | Step 5 | Step 6

- Steps 1 & 2 – Providing a plane-parallel plate and firmly fixing it to a jig



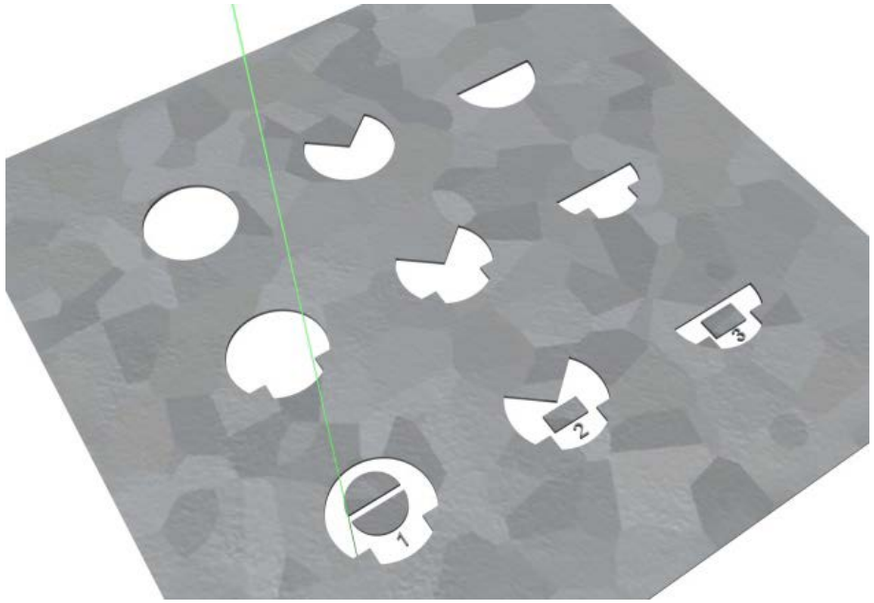
Parts of the jig



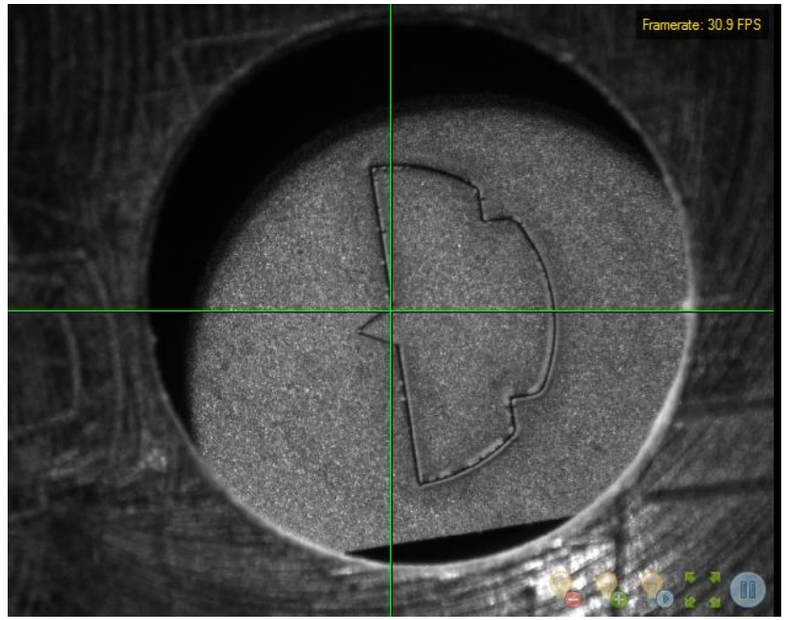
microPREP™ – Process Flow

Step1 | Step 2 | Step 3 | Step 4 | Step 5 | Step 6

- Step 3 – Laser cutting of the supporting base structure



Examples of base structures

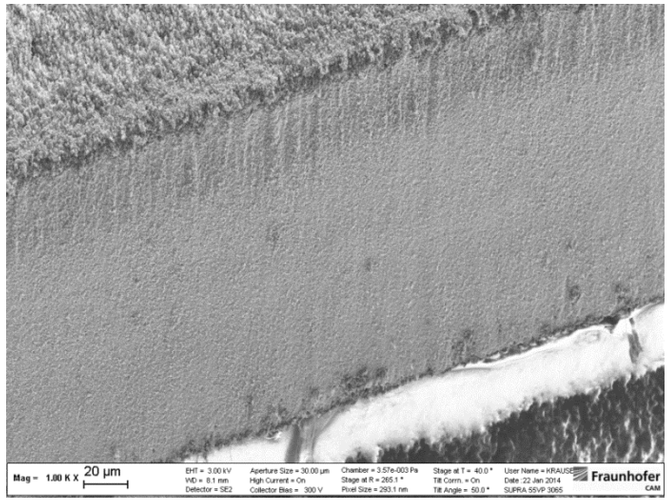


Cutted base structure

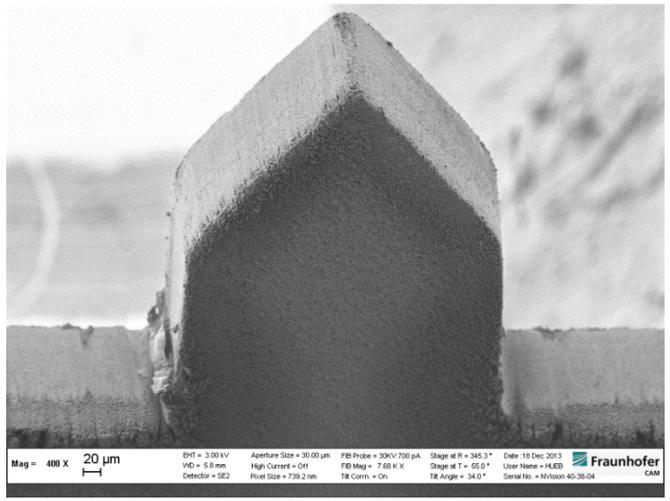
microPREP™ – Process Flow

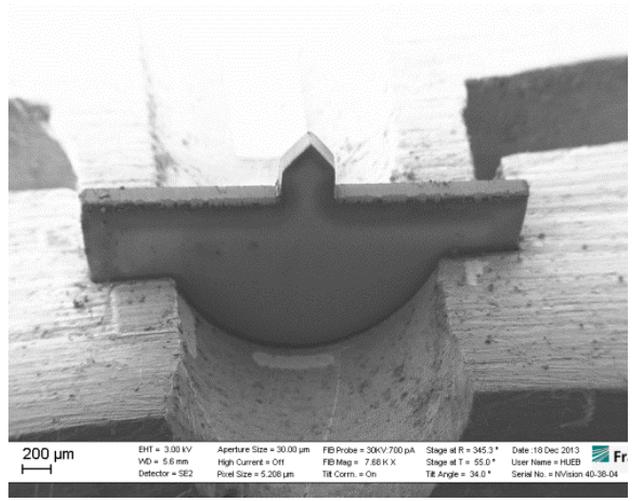
Step1 | Step 2 | Step 3 | Step 4 | Step 5 | Step 6

- Step 3 – Laser cutting of the supporting base structure



As-cut flank in silicon



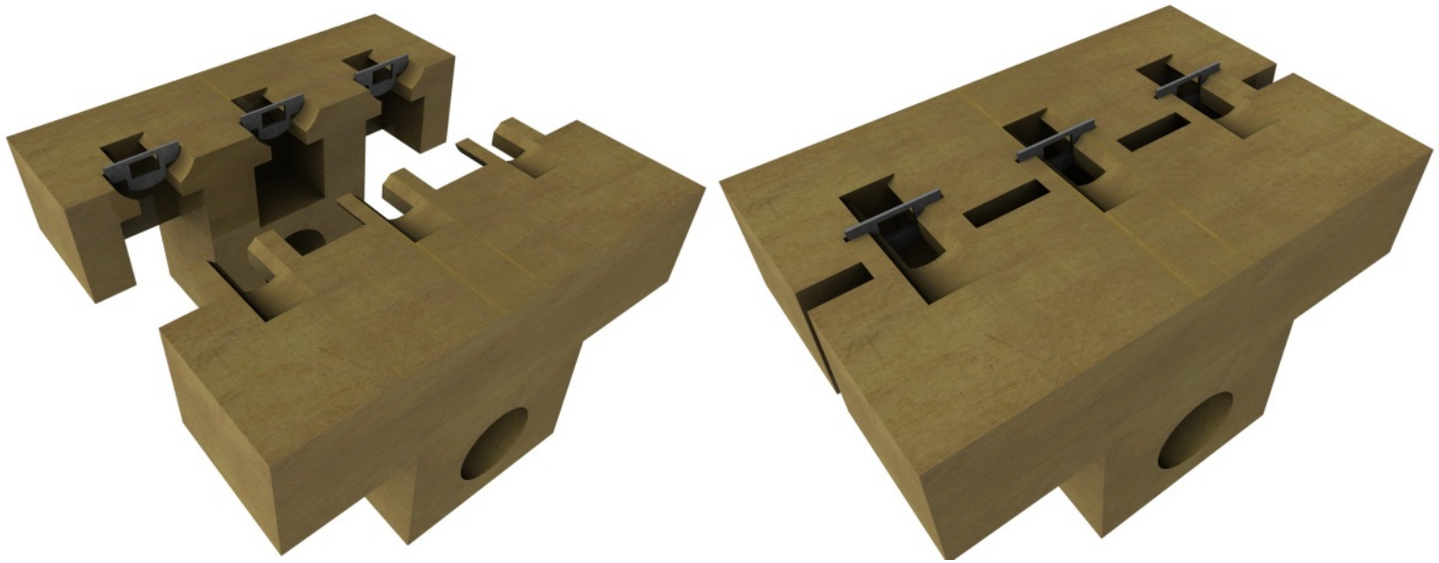


Tomographic basic structure laser-machined into silicon

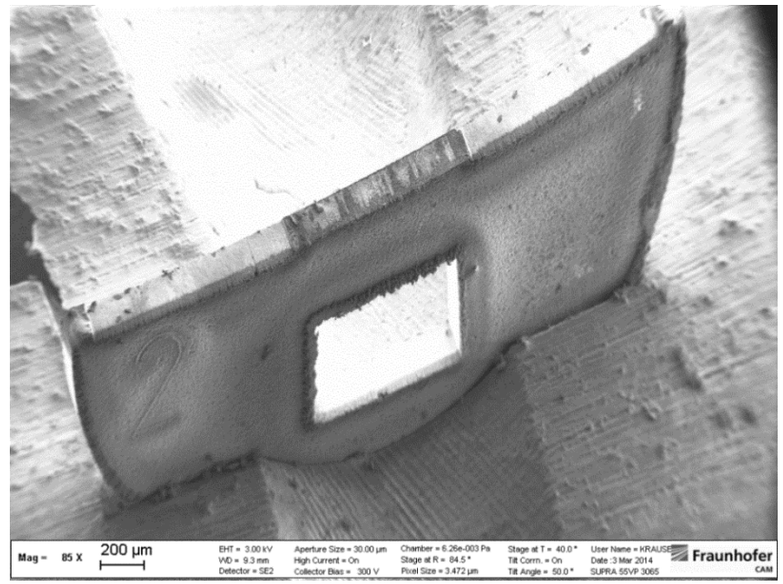
microPREP™ – Process Flow

Step1 | Step 2 | Step 3 | Step 4 | Step 5 | Step 6

- Step 4 – Transferring the supporting base structure to a dedicated clamping jig



Clamping jig

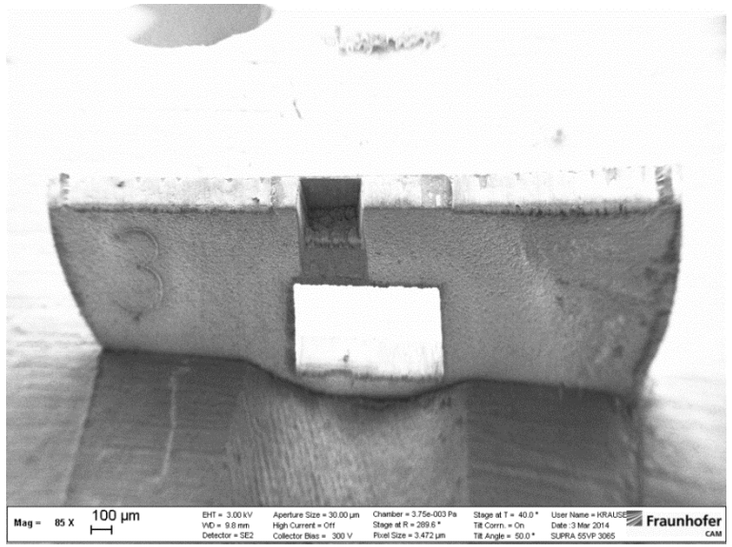


Basic structure fixed by the jig

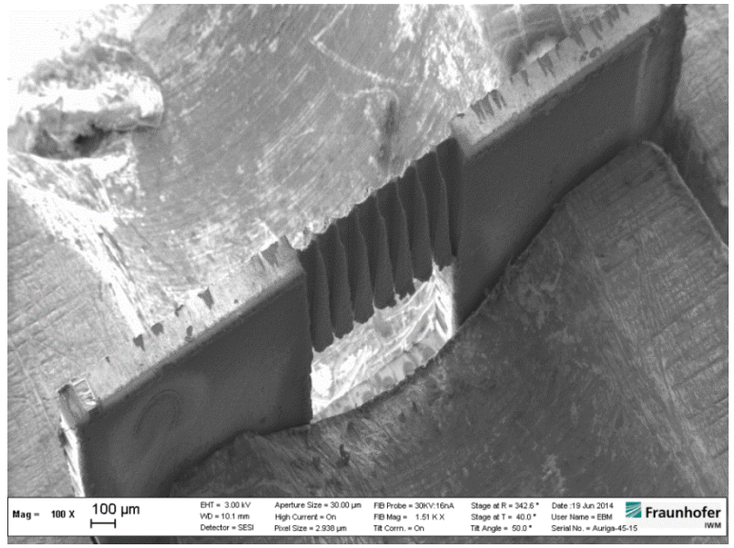
microPREP™ – Process Flow

Step1 | Step 2 | Step 3 | Step 4 | **Step 5** | Step 6

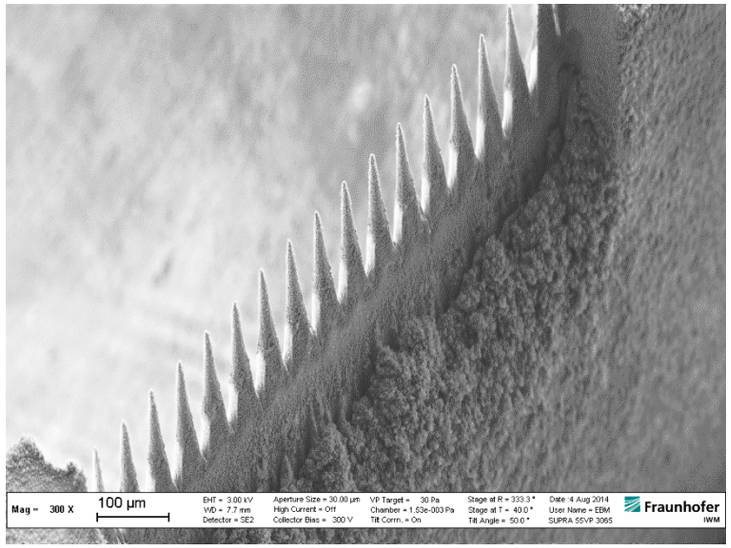
- Step 5 – Local laser thinning of preselected areas (high-throughput screening)



Local thinning in a box-like manner



Local thinning of multiple probing positions



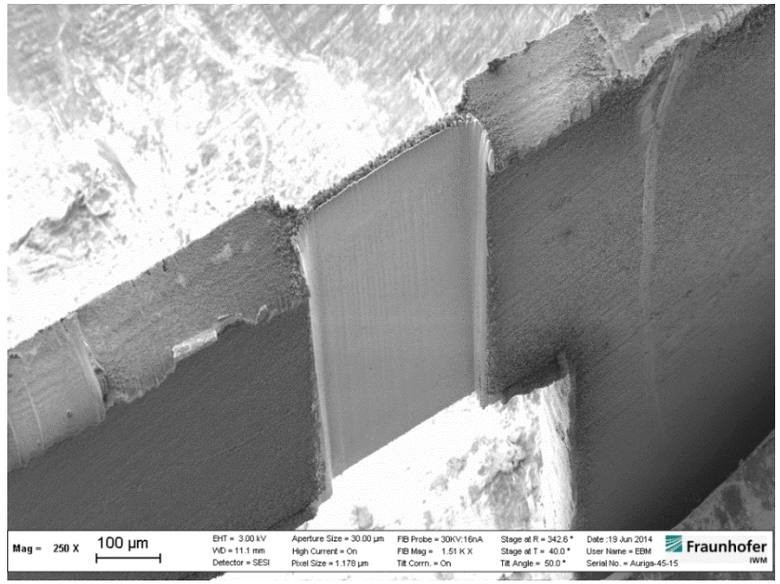
Automated preparation of a pillar array

microPREP™ – Process Flow

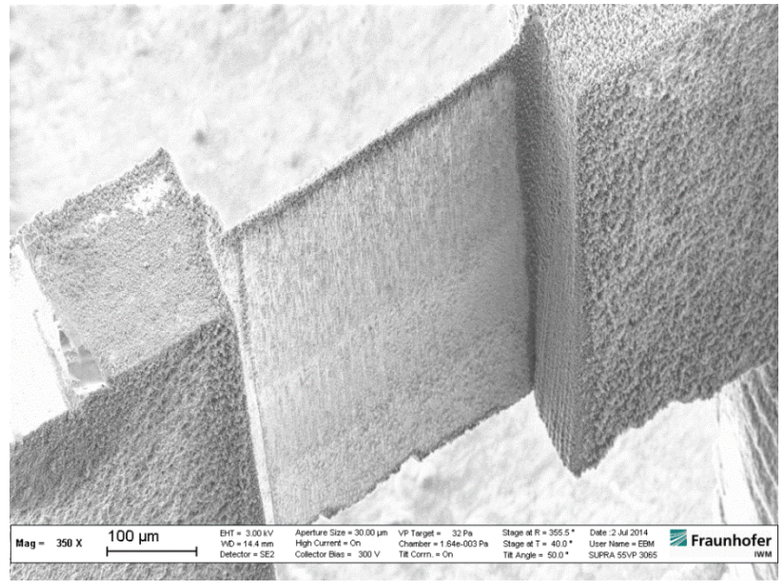
Step1 | Step 2 | Step 3 | Step 4 | **Step 5** | Step 6

- Step 5 – Local laser thinning of preselected areas (high-throughput screening)

- Smooth flanks



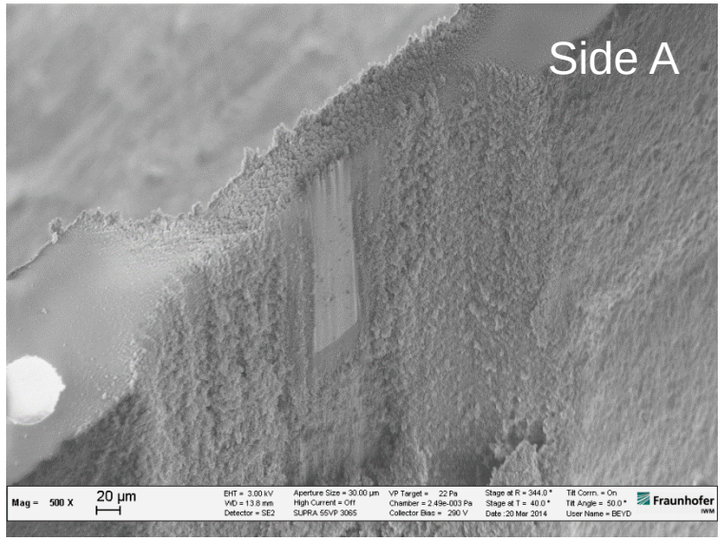
Local thinning in an open-box manner in copper

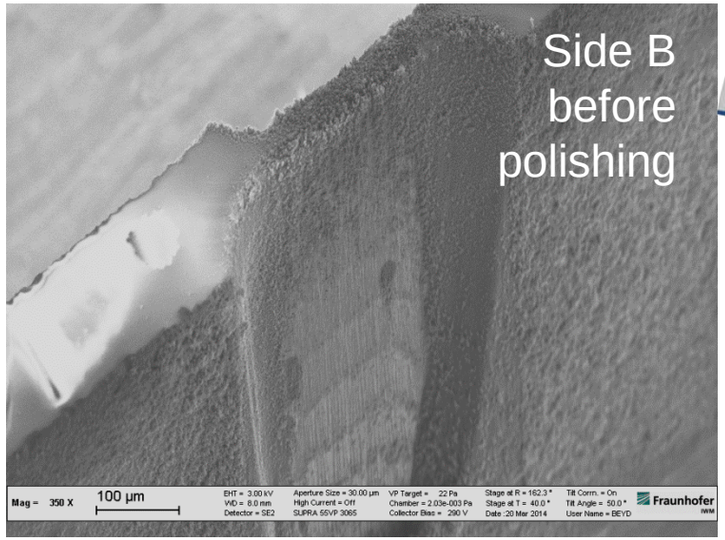


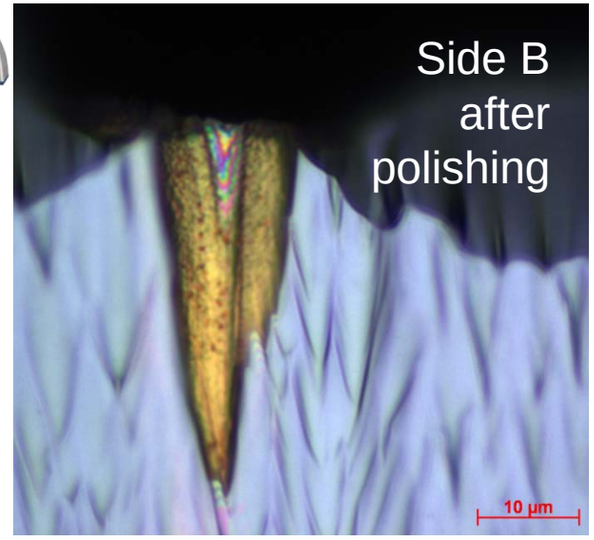
Local thinning in an open-box manner in silicon

microPREP™ – Process Flow

- Step 6 – Final thinning with Ar^+ broad beam or FIB (TSV's)



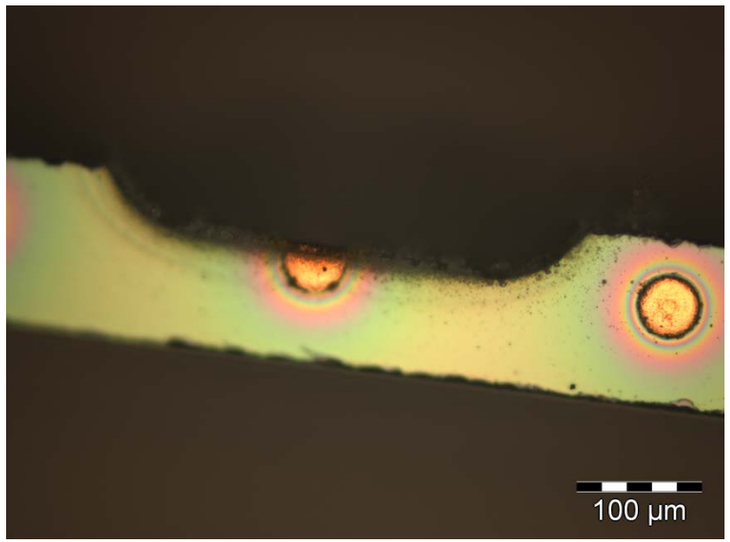


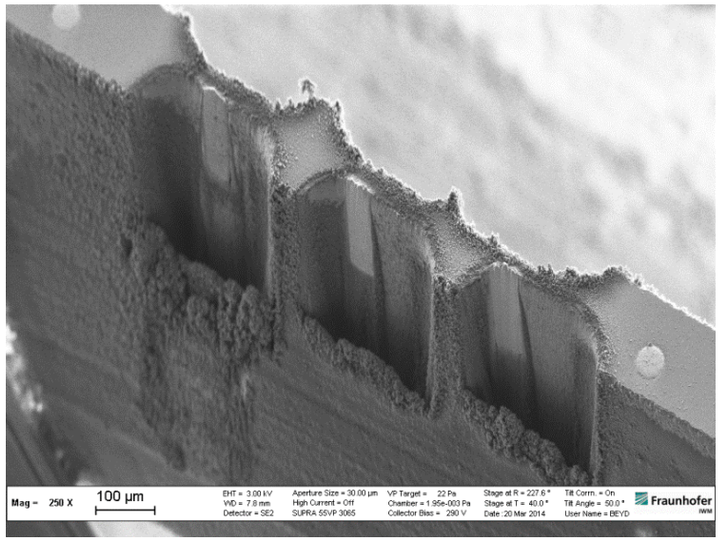


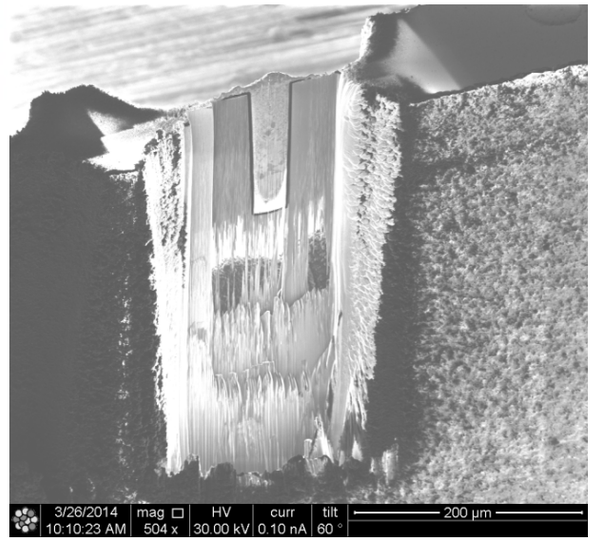
microPREP™ – Process Flow

Step1 | Step 2 | Step 3 | Step 4 | Step 5 | Step 6

- Application for 3D-integrated Structures (TSV's)







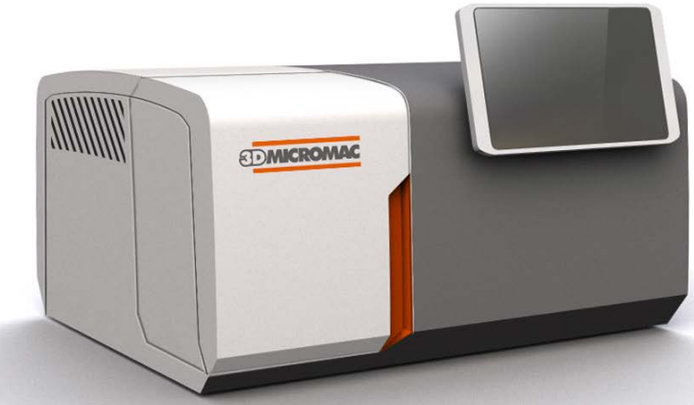
Key features – microPREP™

- Machine:
  - Use of ultra-short pulse laser
  - High target position accuracy (± 3 µm)
  - User friendly control software including recipes
- Process:
  - No sample drift due to charging
  - Rugged support structure allows easy sample handling
  - Suited for metals, semiconductors, ceramics, and compounds
  - Multiple probing positions

microPREP™ - Stand-alone version

Summary – microPREP™

- Low manpower requirement
- Risk minimation of sample lost
- Preparation quality less dependent on user skills
- Simple (machine-guided) usage
- High utilization of (TEM) analysing tool
- Reduces FIB capacity requirements



microPREP™ - Desktop-version

High preparation quality in a fast time for lower cost per sample!

microPREP™ - A machine for more than one application

TEM

Source: FEI

TKD

Source: Bruker

X-CT

Source: Zeiss

LEAP

Source: Cameca

µ-mechanics

Source: Keysight

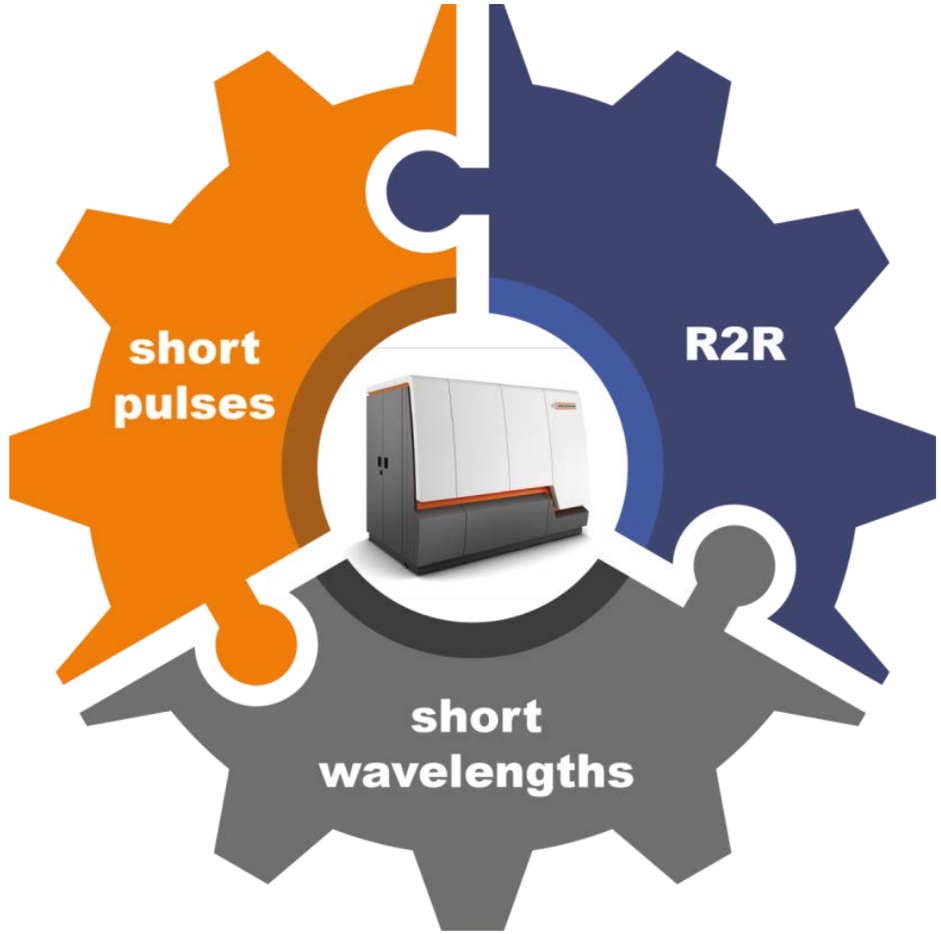
Laser Micromachining for Industrial Applications and R&D

3D-Micromac AG

First Choice in microMachining

3D-Micromac - At a Glance

- Manufacturer and service provider of
  - Laser micromachining systems and
  - Equipment for printing and coating technologies
- Design of complete machining systems as stand alone devices, integrated modules and entire production lines
- Evaluation of processes, feasibility studies, development of technologies and machine solution on customer‘s demand
- Founded in 2002



Company Headquarter

3D-Micromac AG

Chemnitz, Germany

- Production area: 3 production halls with 4450 m^2

3D-Micromac‘s Portfolio

Laser micromachining systems for R&D purposes

Laser systems for machining of large panels

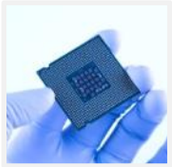
Production equipment for laser machining tasks

Roll to roll system for machining of flexible substrates

Branch Solutions – Example Systems

Ophthalmic marking systems

- Laser systems for engraving of eye glasses or contact lenses
- Digital printing machines for non-permanent marking of eye glasses



Equipment for SEMI/MEMS

- Fab equipment
- Manufacturing of inkjet nozzles
- Lab equipment
- TLS-Dicing
- Sample preparation for microstructure diagnostics

Fab equipment PV

- On-the-fly laser processing of silicon solar cells, e.g. PERC solar cells, selective-emitter, LFC, MWT, and EWT cells

Medical device technology

- Manufacturing systems for welding of implants
- Machining in highly purified environment incl. process monitoring

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