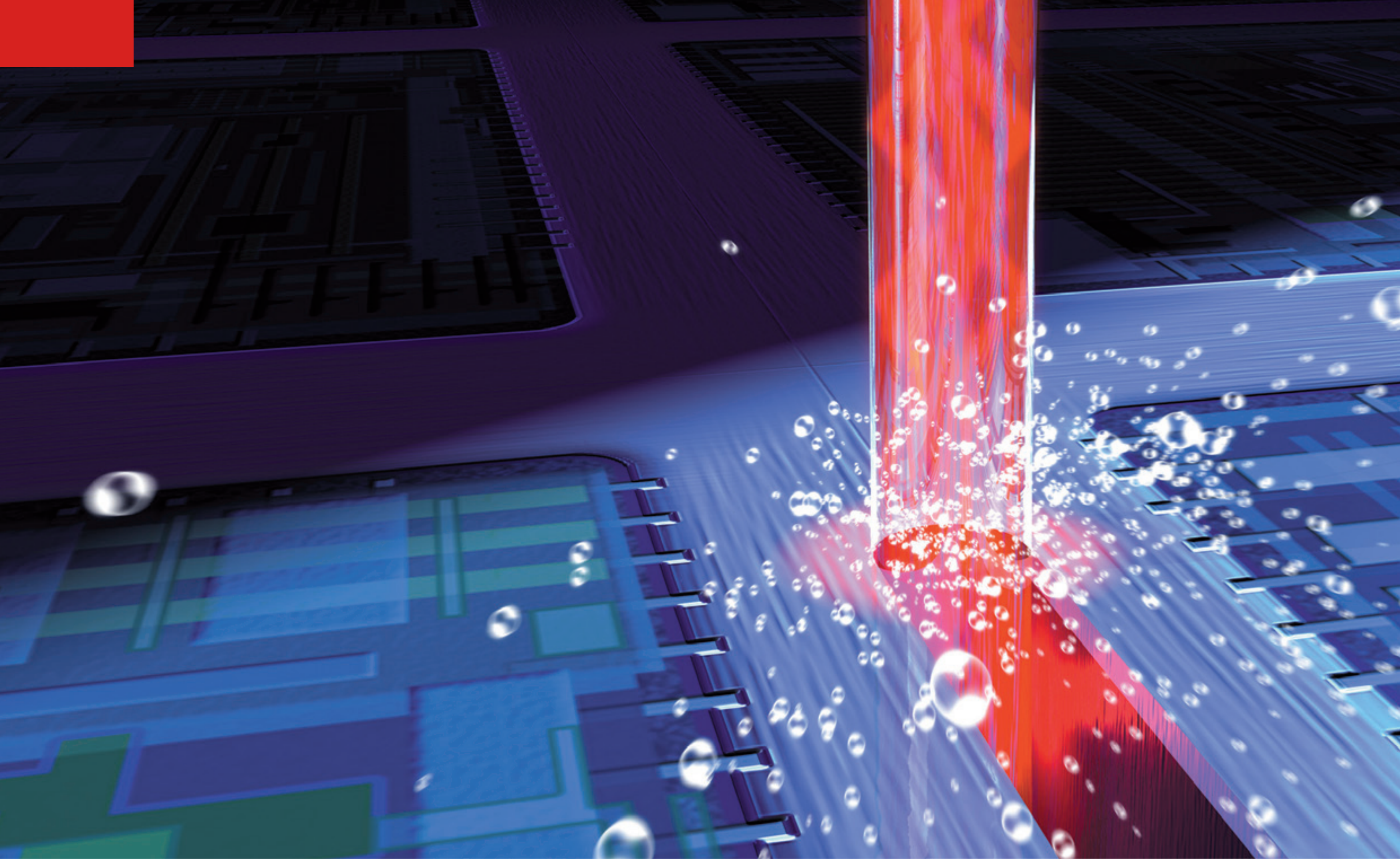
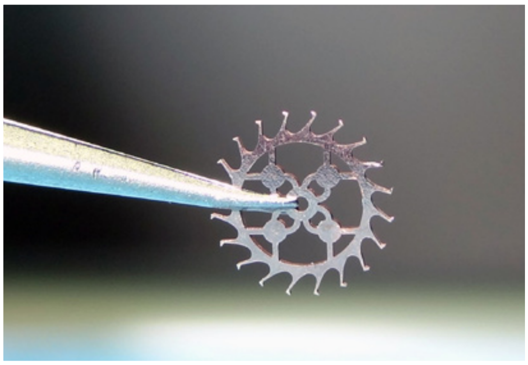
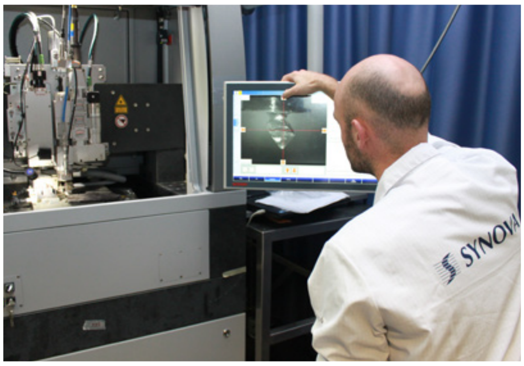
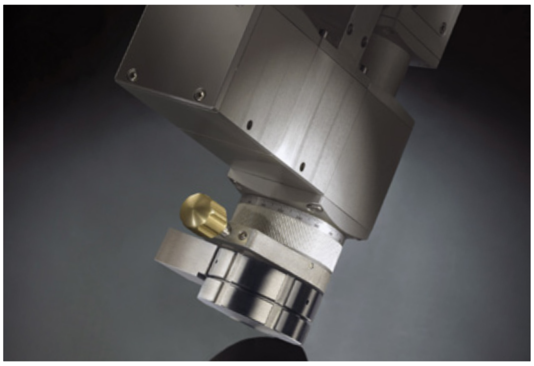








Laser MicroJet® Technology

SYNOVA

Cool Laser Micro-Machining

www.synova.ch


100

A Unique Invention

In the early nineteen-nineties a ground breaking new technology was successfully developed at the Federal Institute of Technology (EPFL) in Lausanne, Switzerland: **the world's first water jet guided laser**.

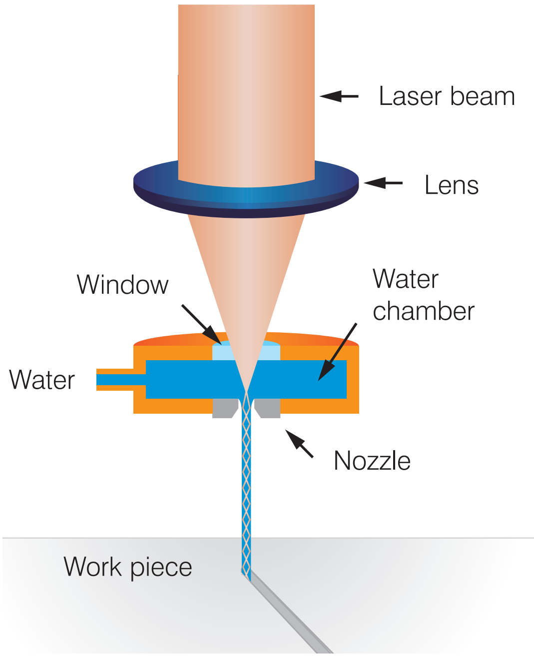
As the sole inventor of Laser MicroJet®, Synova has over two decades of accumulated expertise in liquid-guided lasers and holds all rights to this protected technology as well as numerous international awards.

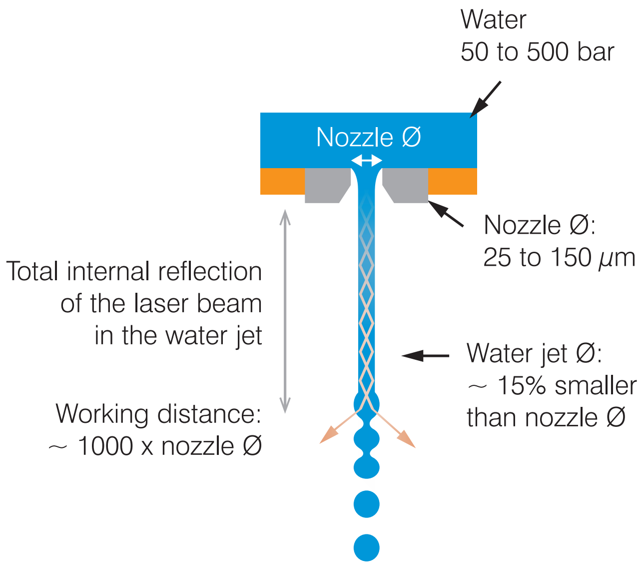
The Laser MicroJet® Technology

A SIMPLE PRINCIPLE

The Laser MicroJet (LMJ) is a hybrid method of machining, which combines a laser with a transparent water jet that precisely guides the laser beam by means of total internal reflection in a manner similar to conventional optical fibers. The low-pressure water jet continually cools the cutting zone and efficiently removes debris.

As a "cold, clean and consistent laser", Synova's LMJ technology resolves the significant problems associated with dry lasers such as thermal damage, contamination, deformation, deposition, oxidation, micro-cracks and lack of accuracy.





Technical Parameters

Lasers

- Diode pumped solid state pulsed Nd:YAG lasers with pulse durations in the micro- or nano-second range, operating at 1064, 532 or 355 nm
- Average laser power ranges from 5 to 200 W

Water

- Pure deionised and filtered water at low pressure
- Water consumption is extremely low due to "hair thin" jet: approx. 1 litre/hour at 300 bar pressure
- Resulting forces exerted are negligible (<0.1 N)

Nozzles

- Nozzles made of sapphire or diamond, as these materials' hardness enables the generation of a long, stable water jet over a long period of time without requiring replacement
- Diameter range: 25-150 µm

The Fusion of Water and Light

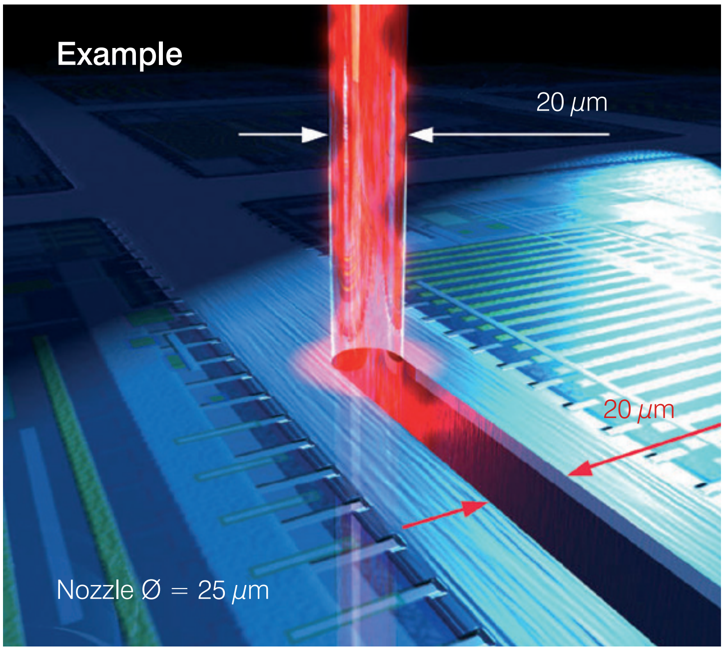
HIGH-PRECISION MICRO-MACHINING

The water jet guided laser is a revolutionary cutting technology, which combines the low-temperature and large working distance advantages of water jet cutting with the precision and speed of conventional dry laser cutting.

As a result, the Laser MicroJet has a remarkably wide range of applications and has established itself amongst other well-known cutting methods including dry lasers, diamond saws, EDM, stamping, water jet cutting and etching.

The LMJ technology is particularly valuable for very thin kerf cutting, delicate surface coatings and high-precision processing of thin work pieces sensitive to deformation and heat as needed in the semiconductor industry, for instance.

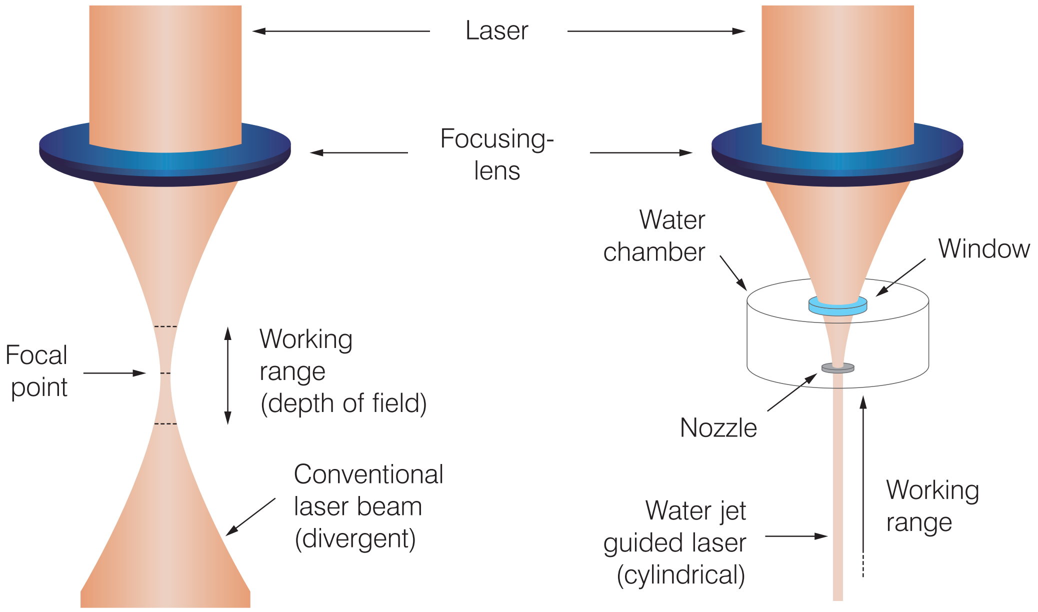
Finally, the cylindrically guided laser is ideal for the parallel cutting of super hard materials and rough diamonds with minimal material loss.



The cutting kerf width ranges from 20 to 150 µm

The Perfect Shape

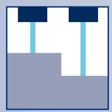
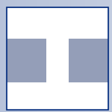
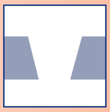
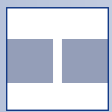
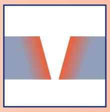
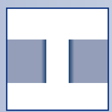
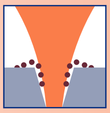
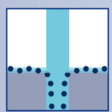
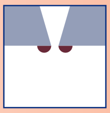
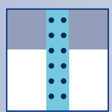
COMPARISON OF CONVENTIONAL AND MICROJET LASER BEAMS

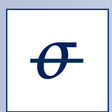
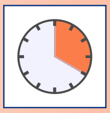
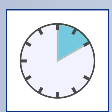


The conventional focused laser beam has a limited working distance of just a few millimetres to even fractions of a millimetre due to beam divergence.
This not only makes precise focussing and distance control necessary, it also limits the ratio of kerf width to depth.

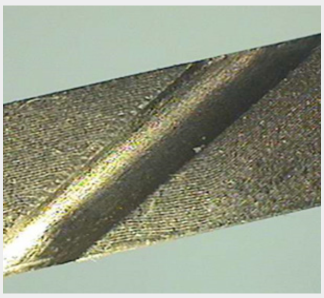
The Laser MicroJet technology employs a laser beam that is completely reflected at the air-water interface.
The beam can be guided over a distance of up to 10 cm, enabling parallel high aspect ratio kerfs.
No focussing or distance control is required.

Technology Benefits

Conventional Laser			Laser MicroJet
Requires precise focus adjustment			No focus adjustment required, non-flat surfaces are not an issue, 3D cutting possible, variable cutting depth of up to several cm
Conical laser beam leaves non-parallel kerf walls			Cylindrical beam results in parallel kerf walls, consistent high quality cutting
Limitations in cutting aspect ratio			High aspect ratio, very small kerf width (>20 μm), minimal material loss, with simultaneous deep cuts possible
Heat affected zone			Water-cooling process avoids thermal damage and material change, high fracture strength is maintained
Particle deposition			A thin water film eliminates particle deposition and contamination, no surface protection layer required
Inefficient material removal leaves burrs			High kinetic energy of the water jet expels molten material, no burrs form

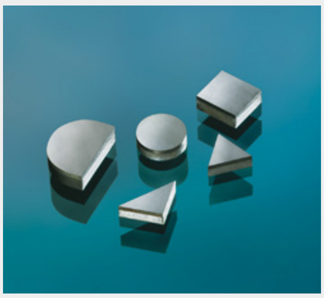
EDM			Laser MicroJet
Only electrically conductive materials			Wide range of materials
Slow ablation process and time-consuming preparation			Fast machining
Expensive consumables (EDM wire)			Low running costs (no tool wear, low water consumption and waste rates)

Applications



Energy/Aerospace: Drilling of turbines blades (superalloy)

Watchmaking: Cutting of gear wheels (durnico)



Tool manufacturing: Cutting of inserts (MCD, CVD, PCD, PcBN)

Diamonds: Cutting of rough diamonds

Applications and Performance Capabilities

THE STRENGTHS OF THE LASER MICROJET

Materials

The water jet guided method allows the machining of a **broad range of materials**. Since it's a very gentle process, the LMJ is particularly well-suited for machining brittle materials that are easily damaged using traditional cutting processes:

- Diamonds: rough and synthetic diamonds
- Metals: stainless steel, aluminium, copper, brass, shape-memory alloys (nitinol), titanium, nickel, superalloys
- Hard materials: polycrystalline CBN (PcBN), polycrystalline diamond (PCD), monocrystalline diamond (MCD), chemical-vapor-deposition diamond (CVD)
- Ceramics: zirconia (ZrO2), low-temperature co-fired ceramic (LTCC), aluminium nitride (AlN), aluminium oxide (Al2O3)
- Semiconductors: silicon (Si), gallium arsenide (GaAs), silicon carbide (SiC)

Operations

Thanks to its versatile technology, the LMJ can be used for a **multitude of processes** including cutting, drilling, edge grinding, grooving, scribing, milling, dicing, shaping in 3 and 5 axes, trenching, profiling and engraving.

Shapes

LMJ machines allow **omni-directional ablation** processes, making the creation of any shape possible. This provides customers with the flexibility to develop new ideas and applications, from making small wheels for the watchmaking sector to dicing chips of any shapes in the semiconductor industry.

Thickness

The LMJ can cut a **wide range of material thicknesses**, e.g. cutting of up to 20 mm thick silicon or drilling of up to 15 mm thick superalloy (hole diameter 800 μm).

Speed

The usage of industrial high-power lasers enables **high cutting speeds**, especially with thin materials: up to 300 mm/s in 50 μm thick silicon, up to 30'000 round holes/hour in 50 μm thick stainless steel (diameter 80 μm).

Accuracy

The lasers used in Synova's machines are **ultra-precise** tools which can achieve very small **parallel kerfs** – from 20 to 150 μm – with an absolute precision of +/- 3 μm, resulting in appreciable material savings.

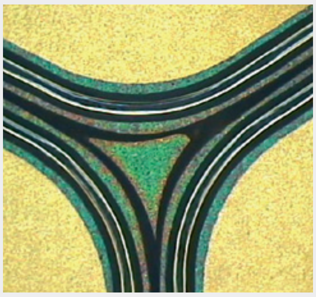
Quality

Thanks to the water jet cooling capability there is virtually **no heat impact**. The ablated material is removed with the water flow leaving **clean surfaces** and less scrap.

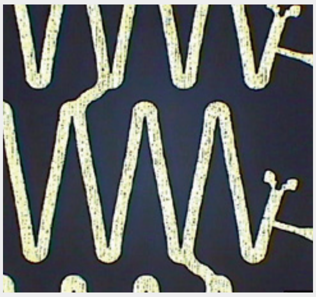
Costs

The efficient and precise LMJ technology enables **low running costs**: no tool wear, very few consumables and low waste rates.

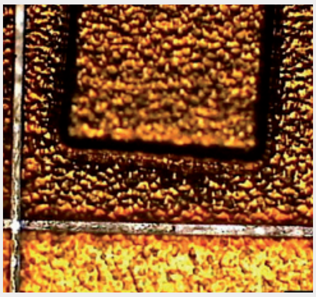
Automotive: Drilling of injection nozzles (stainless steel)



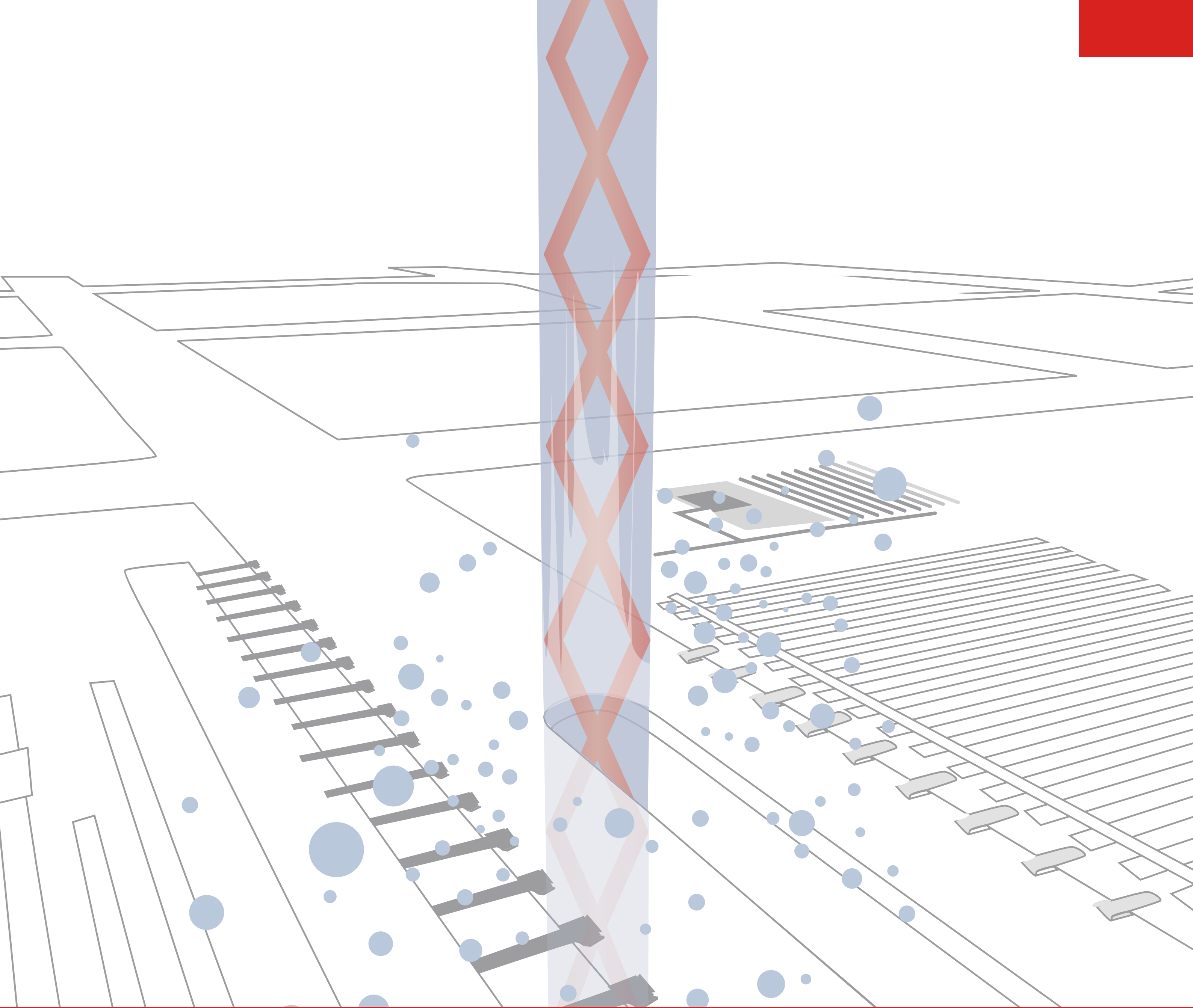
Semiconductors: Dicing of diode chips (silicon)



Medical: Cutting of stents (NiTi)



LED: Cutting of heat sinks (copper)



The Fusion of Water and Light

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