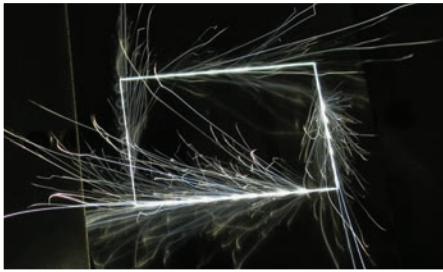


# Laser Micromachining

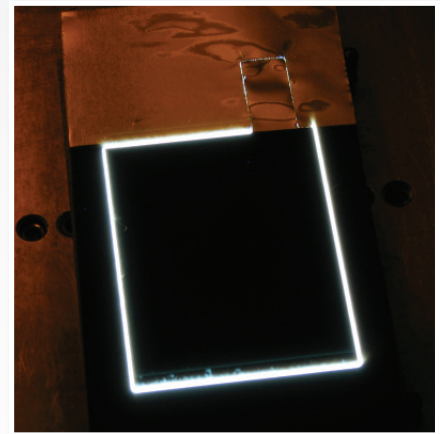


*Laser Remote Cutting of Stainless Steel*

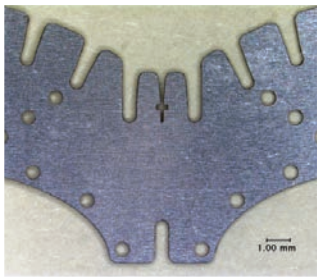
## AREAS OF EXPERTISE

In laser micromachining, a highly focused laser beam provides very controlled small amounts of energy into the material to cause it to melt or vaporize and enable material removal with or without assist gas. Micromachining includes processes such as laser micro-cutting, remote cutting, ablation, scribing and laser milling.

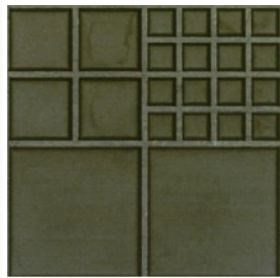
Fraunhofer has extensive experience in providing laser micromachining services for a wide range of materials including metals and non-metals. High beam quality laser sources are available in both continuous wave and pulsed modes which can be focused to spot sizes down to 10  $\mu\text{m}$ . High peak power pulsed lasers with suitable wavelengths (UV, Vis, IR) pulse lengths (millisecond-nanosecond) and processing heads (fixed optic, scanner optic and combination) can cut metals and non-metals, remove coatings or paint, ablate material, clean and polish surfaces, and form shallow grooves and channels.



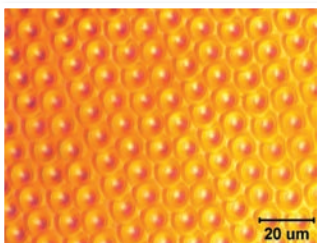
*High Speed Laser Cutting of an Electrode*



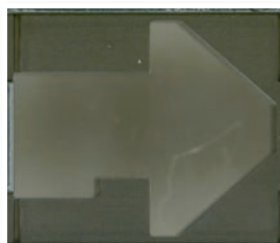
*Laser Microcut Valve Part  
for Surgical Application*



*Laser Engraving*



*Laser Textured Surface of  
Silicon*

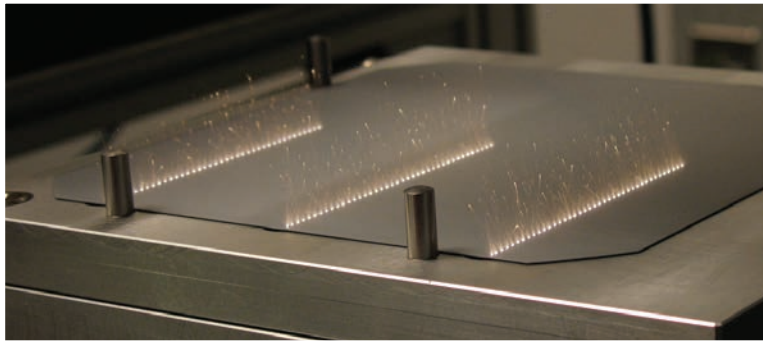


*Silicon Micromachined Part  
for Optoelectronic Application*

## APPLICATIONS

- Contour cutting of thin (<1 mm) materials
- High speed (>3 m/sec) remote cutting
- Precision cutting of small components
- Cutting of non-metals such as diamonds, silicon, paper, polymer
- Coating/paint removal
- Wire stripping
- Laser polishing
- Forming grooves, channels or micro surface features

# Laser Drilling



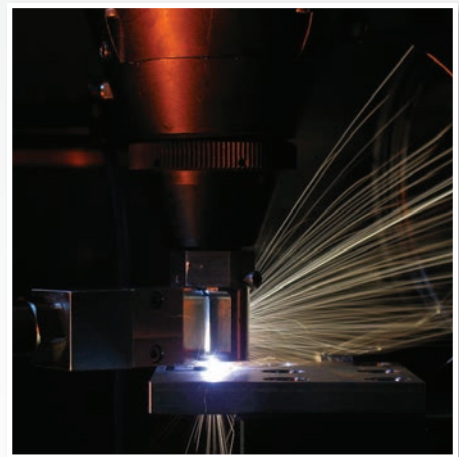
*High Speed Drilling of Silicon Produces 15000 holes/second*

We have capability to drill precision holes with diameters between 10  $\mu\text{m}$  and 500  $\mu\text{m}$  in thin foils (down to 10  $\mu\text{m}$  thickness) as well as thin sheets (up to several mm thickness). We use high peak power pulsed lasers with suitable wavelength (UV, Vis, IR), pulse lengths (millisecond-nanosecond) and drill heads (fixed optic, scanner optic and combination). Depending on hole requirement, single pulse, percussion or trepanning drilling approaches can be selected.

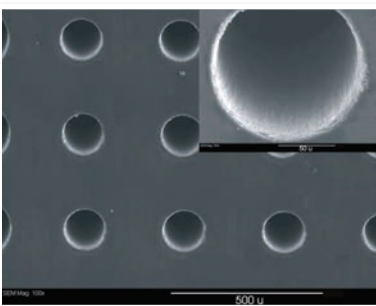
We have developed unique laser drilling processes for very high speed drilling (upto 15,000 holes/sec in silicon), high aspect ratio (>40:1) and high open fraction area (>50%).

## AREAS OF EXPERTISE

Laser drilling is a well-established industrial laser application that can produce both blind and through holes in metals and non-metals. Laser drilling involves heating up the material to its melting point or vaporization temperature and may or may not require assist gas to blow away the molten material or vapor.



*Drilling of Tantalum using Hybrid Nozzle*



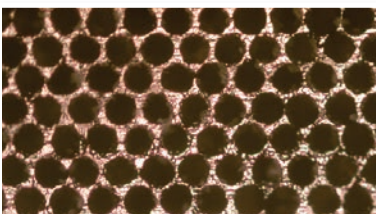
*Laser Drilled Holes in Silicon*



*Drilling Ta 2mm*

## APPLICATIONS

- Precision hole drilling
- Perforating
- High aspect ratio holes
- Surface pitting and dimpling



*Laser Drilled Surface (Ta)*

 **Fraunhofer**  
USA  
Center for Laser Applications