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MeDuSA

# Multifunctional feedthroughs in sapphire made of aluminum

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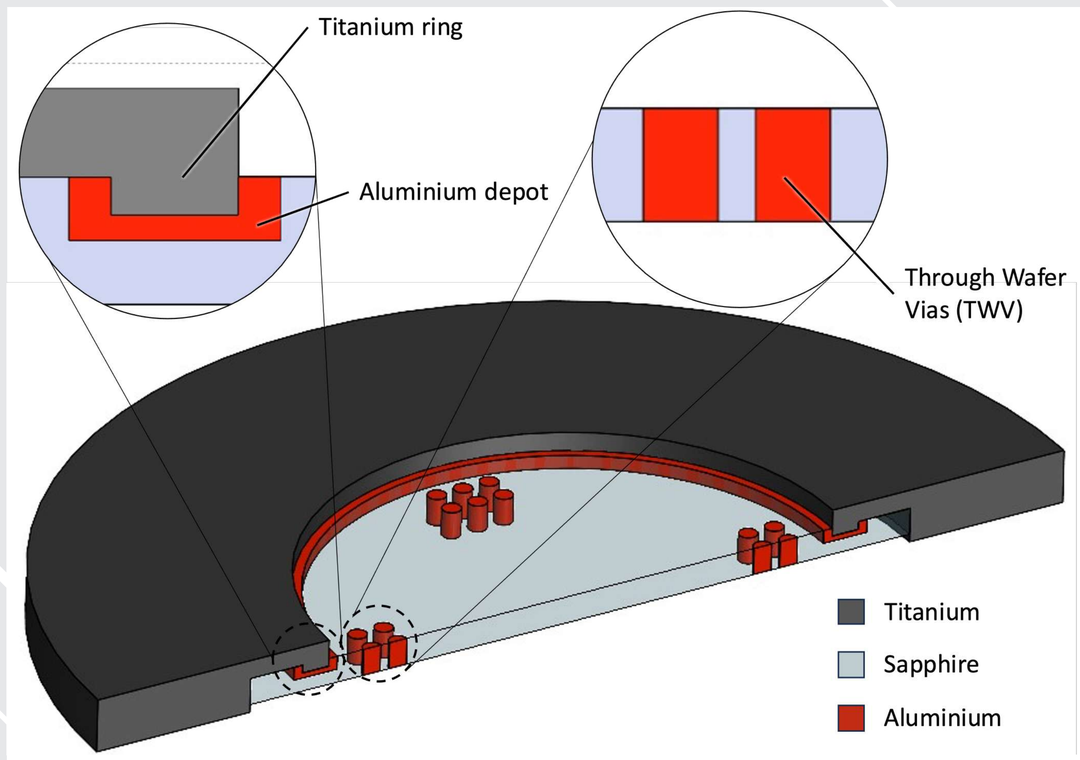
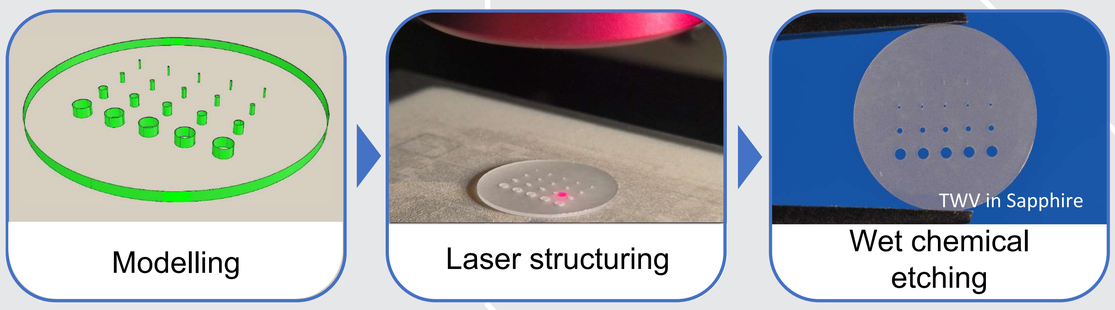
## 1 Motivation & Flange design




**Challenge:**
- No commercially available ultra-high vacuum flanges with both electrical and optical feed-through
- Established solution approaches with diffusion soldering lead to high stress formation and thus birefringence in the transparent material

**Solution:**
- Sapphire window with integrated TSV (through substrate vias)
- Titanium as material for the flank (low CTE mismatch to Sapphire )
- Process chain of: SLE (sapphire window), aluminum filling technology (electrical feed-through), laser-based soldering (stress free soldering)

## 2 Fabrication of flange sapphire blank




Modelling | Laser structuring | Wet chemical etching

SLE-Process for creating 3D structures from transparent dielectrics (for example: fused silica, BOROFLOAT, sapphire)

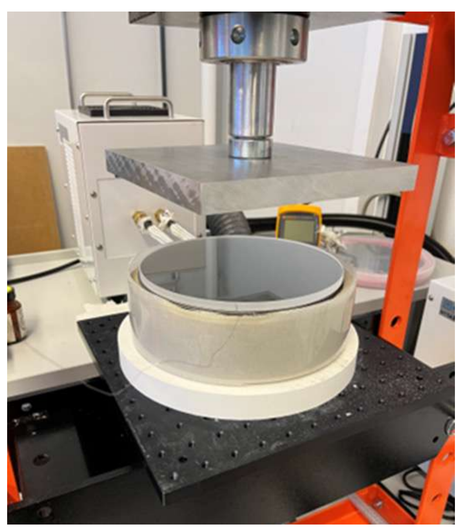
1. **Modeling**
- Slicing of the CAD flange model and calculation of laser vectors along the component surface

2. **Laser structuring**
- Structuring of modification lines within the transparent material using tightly focused USP laser radiation

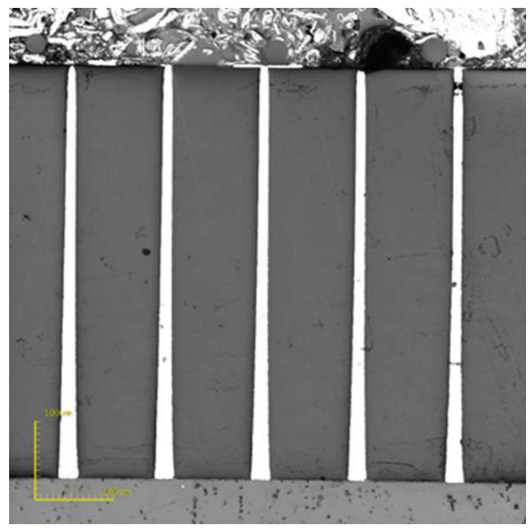
3. **Wet chemical etching**
- Etching of the modified areas using KOH or HF

## 3 Feed-through fill-in with molten Aluminium

TSV fill-in process:
- feedthrough channels in glass & sapphire are filled with liquid Al
- Al (liquid) is pressed into the channels at T=700°C
- Via diameters of 15 µm in 500 µm thick quartz glass demonstrated
- Target in MeDuSA: substrate thickness 3 -5 mm



Experimental set-up for the press-in of molten Aluminium



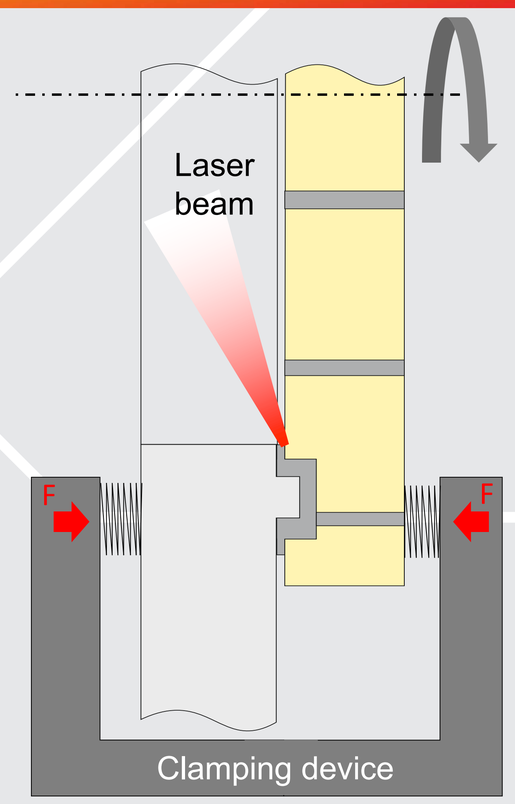
Vias filled with molten Al in fused silica
Wafer diameter 200 mm, thickness: 0,5 mm

## 4 Laser beam soldering of titanium & sapphire

- Selective laser-based transparent soldering of sapphire disc and titanium flange
- Uniform heating by rotating compression device
- Laser beam (1064 nm) focused through the transparent sapphire disc
- Innovative custom-designed pressing fixture for uniform pressure and rotational capability

→ Minimized thermal stress on components

→ Reduced internal stresses and prevention of damage




## 5 Utilization

- UHV flank with optical access and electrical feedthroughts
- 3D SLE fabrication process for 3D sapphire components
- Al fill-in technology for TSV metallisation for HF applications
- Laser beam soldering process for stress free metal-dialectic joints

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