

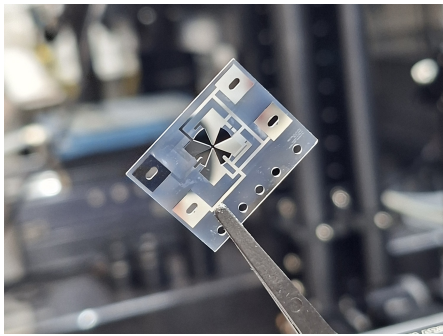
# Microfabrication of NIST wheel trap in fused silica by selective laser etching

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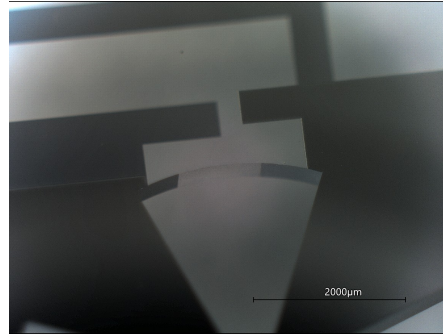
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The NIST-type wheel trap, an open-geometry linear Paul trap with excellent optical access, is increasingly used in levitated optomechanics. The original design relies on laser-cut CVD diamond with sputtered gold electrodes ( $\sim 4250$  EUR per device, several-week outsourced lead time) - a thermal-conductivity argument inherited from atomic-ion clocks that does not apply at the kHz-range, sub-300 V drives used for levitated micro- and nanoparticles. We present a fully in-house, lithography-free wheel-trap fabrication route in fused silica, performed entirely on a single femtosecond laser workstation: fs laser writing in a  $500\ \mu\text{m}$  JGS2 wafer, KOH wet etching ( $\sim 250\ \mu\text{m}/\text{h}$ ,  $\sim 2$  h release), RF magnetron sputtering of  $\sim 500$  nm Ag, and direct fs laser ablation ( $515$  nm) of the silver film for electrode patterning. No photolithography, masks, or external contractors are required; nine devices per 4-inch wafer are produced in a single working day at  $\sim 500$  EUR fully-loaded cost per trap (materials, consumables, and amortized instrument time). Functionality is confirmed by confinement of  $0.95\ \mu\text{m}$  polystyrene microparticles at atmospheric pressure ( $10$ – $20$  kHz,  $\leq 245$  V). Ongoing work with IOM Leipzig integrates post-FLISE smoothing: CO<sub>2</sub> laser polishing reduces sidewall roughness from Sa  $\sim 524$  nm to  $\sim 4$ – $6$  nm, with Ar atmospheric-pressure plasma jet reaching Sa  $\sim 2.7$  nm, paving the way toward near-optical-quality trap surfaces within the same beam-based, single-workstation workflow.



(a) Completed fused silica wheel trap with sputtered Ag electrodes patterned by fs laser ablation.



(b) Optical micrograph of an ablation track defining electrode isolation

Figure 1: Fabricated fused silica wheel trap: (a) etched geometry with ablation; (b) micrograph of ablated perpendicular wall.