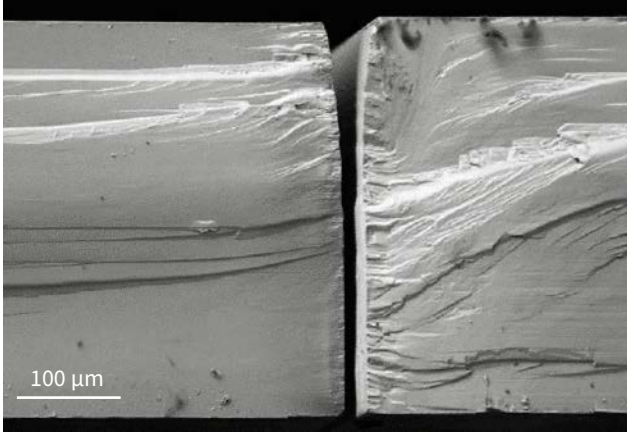


EXAMPLES OF INDUSTRIAL APPLICATIONS

Brittle & highly thermal-sensitive material cutting



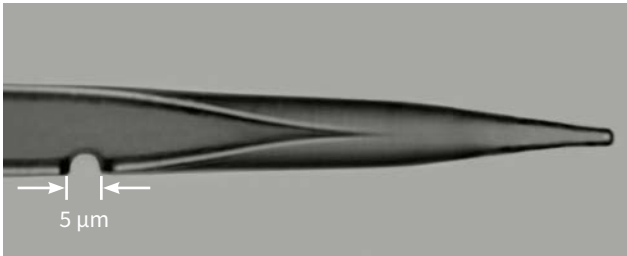
Multi-pass cadmium tungstate cutting. No cracks. All thermal trace effects eliminated. Source: Micronanics Laser Solutions Centre.

Stainless steel stent cutting



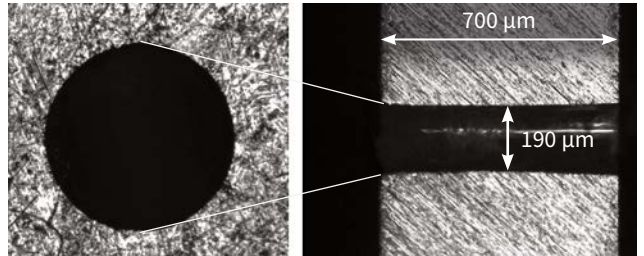
Stent cut using CARBIDE laser. Source: Amada Miyachi America.

Glass needle microdrilling



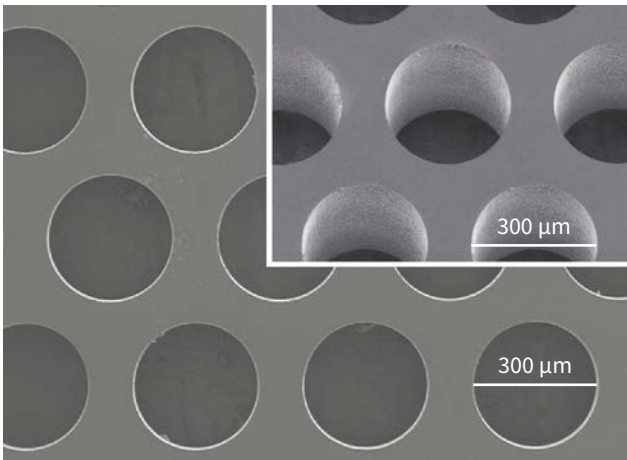
Glass needle microdrilling. Source: Workshop of Photonics.

Steel drilling



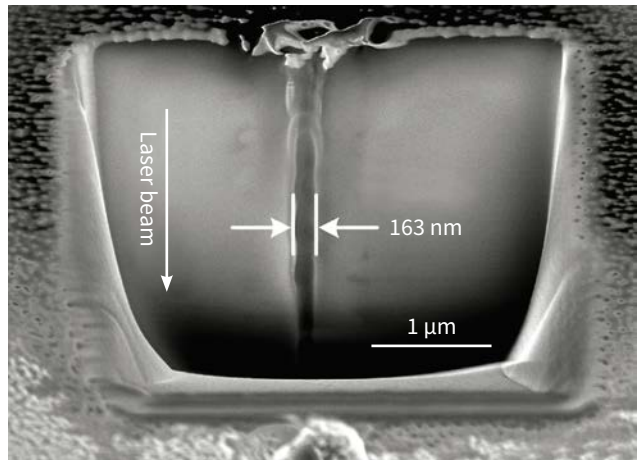
Taperless hole microdrilling in stainless steel alloys. Source: Workshop of Photonics.

Various type glass drilling



Various glass drilling. Source: Workshop of Photonics.

Nanodrilling of fused silica



Longitudinal section of a single void. Source: "Ultrashort Bessel beam photoinscription of Bragg grating waveguides and their application as temperature sensors", G. Zhang, G. Cheng, M. Bhuyan, C. D'Amico, Y. Wang, R. Stoian. Photon. Res. (2019).

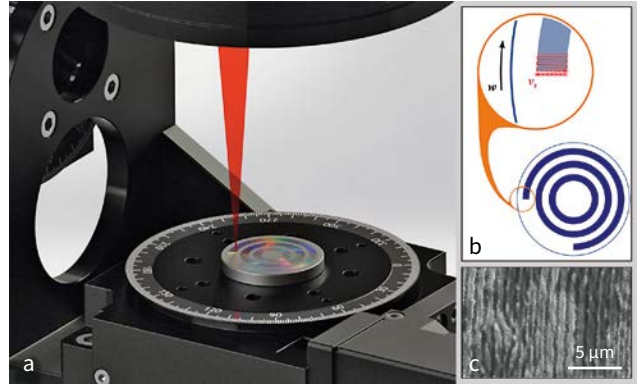
Milling of complex 3D surfaces



3D milled sample in copper. Zoom in SEM image.

Source: "Highly-efficient laser ablation of copper by bursts of ultrashort tuneable (fs-ps) pulses", A.Žemaitis, P.Gečys, M.Barkauskas, G.Račiukaitis, M.Gedvilas. Scientific Reports (2019).

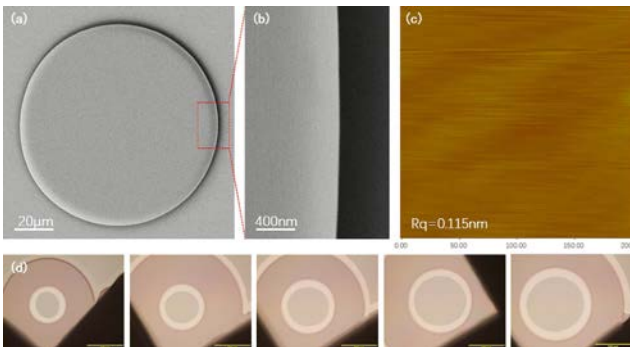
Friction and wear reduction



(a) Schematic of the laser treatment, (b) laser patterning strategy, (c) SEM image of induced LIPSS.

Source: "Tribological properties of high-speed uniform femtosecond laser patterning on stainless steel", I.Gnilitskiy, A.Rota, E.Gualtieri, S.Valeri, L.Orazi. Lubricants (2019).

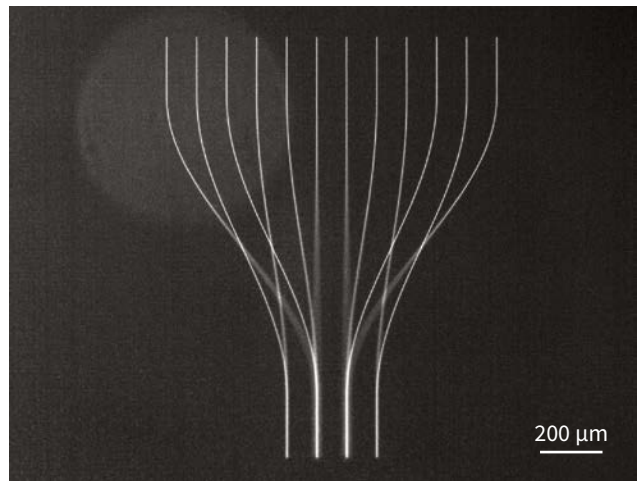
Selective Cr thin film ablation



Cr thin film ablation for creation of LiNbO_3 micro-disk resonator. (a,b) SEM images, (c) AFM image of micro-disk wedge, (d) optical images of micro-disk resonators with different diameters.

Source: "Fabrication of crystalline microresonators of high quality factors with a controllable wedge angle on lithium niobate on insulator", J.Zhang, Z.Fang, J.Lin, J.Zhou, M.Wang, R.Wu, R.Gao, Y.Cheng. Nanomaterials (2019).

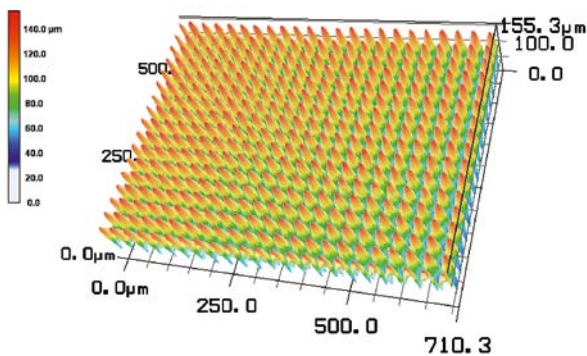
3D waveguides



3D waveguides fabricated in fused silica glass.

Source: Workshop of Photonics.

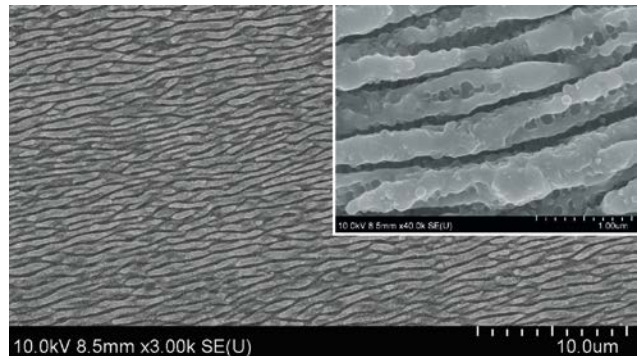
Terahertz broadband anti-reflection structures



Fabricated moth-eye 3D profile, taken by laser scanning microscope.

Source: "Terahertz broadband anti-reflection moth-eye structures fabricated by femtosecond laser processing", H.Sakurai, N.Nemoto, K.Konishi, R.Takaku, Y.Sakurai, N.Katayama, T.Matsumura, J.Yumoto, M.Kuwata-Gonokami. OSA Continuum (2019).

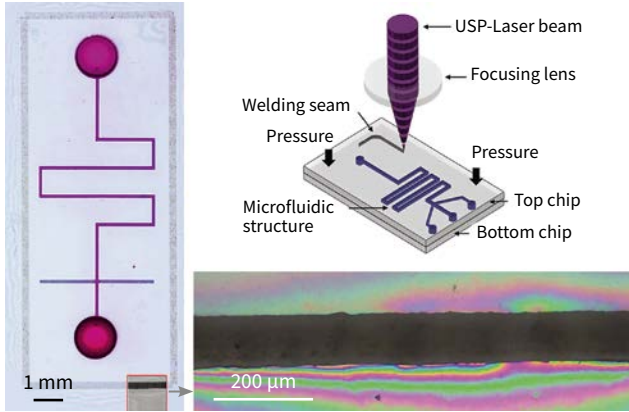
Surface-enhanced Raman scattering (SERS) sensors fabrication



SEM image of the Ti-6Al-4V (TC4) surface after irradiation with progressive laser scan.

Source: "Large-scale fabrication of nanostructure on bio-metallic substrate for surface enhanced Raman and fluorescence scattering", L.Lu, J.Zhang, L.Jiao, Y.Guan. Nanomaterials (2019).

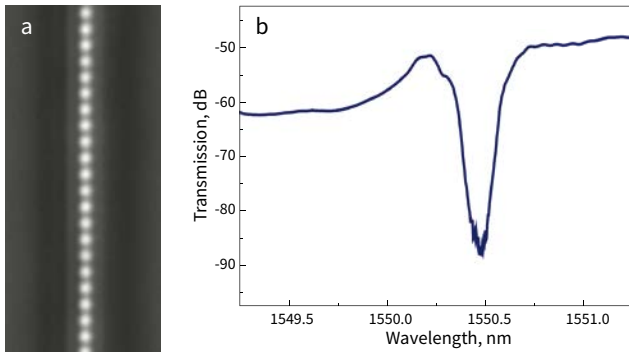
Lab-on-chip channel ablation and welding



Welding of transparent polymers for sealing of microfluidic devices. Top view on a sealed microfluidic device (left), welding seam (bottom right).

Source: "A new approach to seal polymer microfluidic devices using ultrashort laser pulses", G. Roth, C. Esen and R. Hellmann. JLMN-Journal of Laser Micro/Nanoengineering (2019).

Bragg grating waveguide (BGW) writing



(a) First-order Bragg gratings inscribed in waveguide, (b) Resonant spectral transmission of inscribed BGW.

Source: "Ultrashort Bessel beam photoinscription of Bragg grating waveguides and their application as temperature sensors", G. Zhang, G. heng, M. Bhuyan, C. D'Amico, Y. Wang, R. Stoian. Photon. Res. (2019).

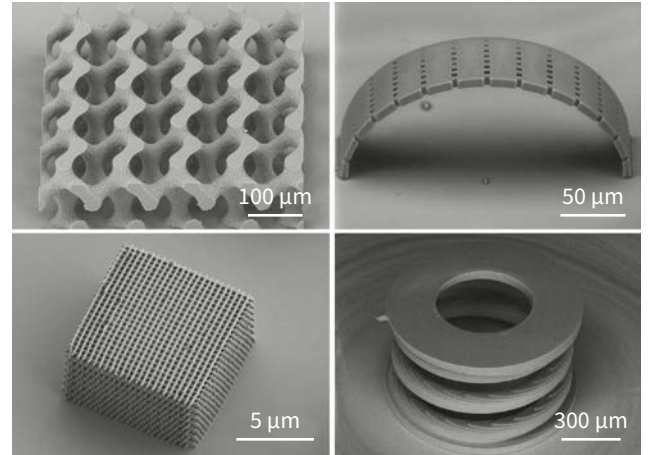
Birefringent glass volume modifications



Form induced birefringence-retardance variation results in different colors in parallel polarized light.

Source: Workshop of Photonics.

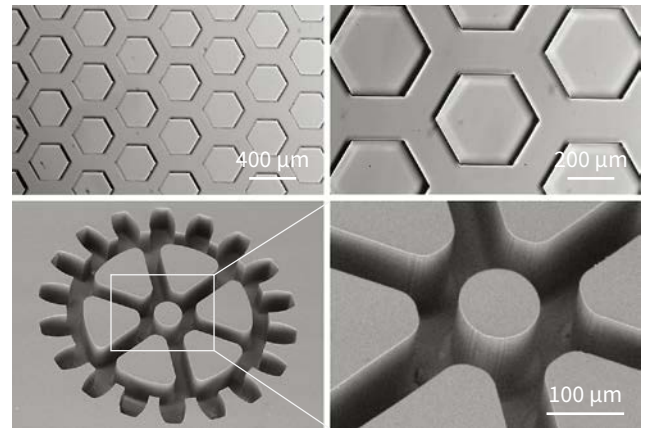
3D micro printing using multi-photon polymerization



Various 3D structures fabricated in SZ2080 polymer using multi-photon polymerization – nanophotonic devices, microoptics, micromechanics.

Source: Femtika.

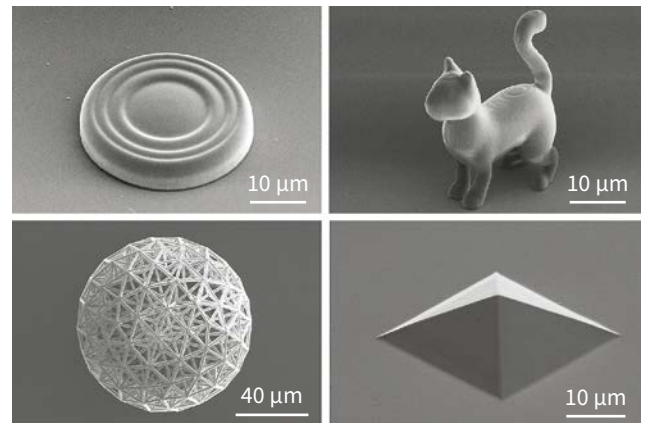
3D glass etching



Various structures fabricated in fused silica glass.

Source: Femtika.

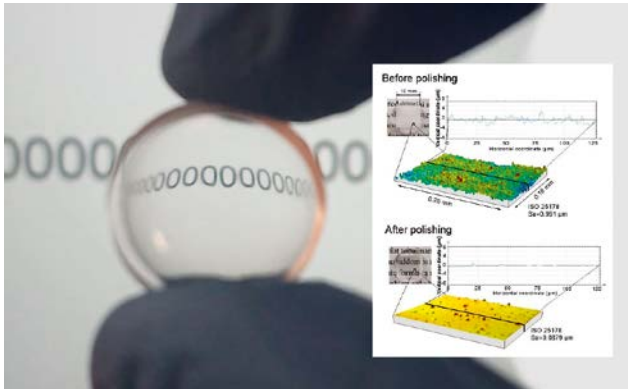
3D multi-photon polymerization



Various 3D structures fabricated in SZ2080 polymer using multi-photon polymerization.

Source: Workshop of Photonics.

Polymer polishing



Polished curved surface and surface roughness measurements before and after polishing with GHz BiBurst.

Source: "Micromachining of Transparent Biocompatible Polymers Applied in Medicine Using Bursts of Femtosecond Laser Pulses", E. Kažukauskas, S. Butkus, P. Tokarski, V. Jukna, M. Barkauskas, V. Sirutkaitis. *Micromachines* (2020).

QR code marking



High contrast QR codes markings on various samples. Size 3 × 3 mm. Sky-writing mode enabled.

Source: Light Conversion apps lab.

Color center creation

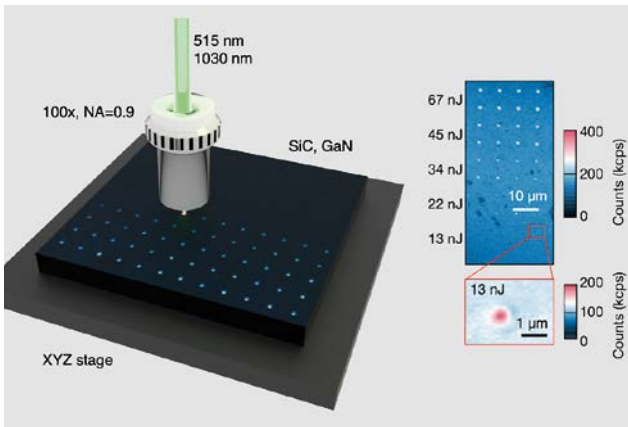
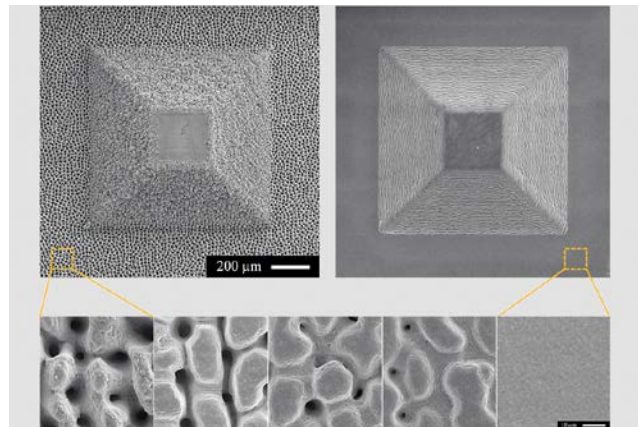


Illustration of the laser writing of color centers (left), silicon carbide containing arrays of laser-written color centers (right).

Source: "Color Centers Enabled by Direct Femto-Second Laser Writing in Wide Bandgap Semiconductors", S. Castelletto, J. Maksimovic, T. Katkus, T. Ohshima, B.C. Johnson, S. Juodkazis. *Nanomaterials* (2020).

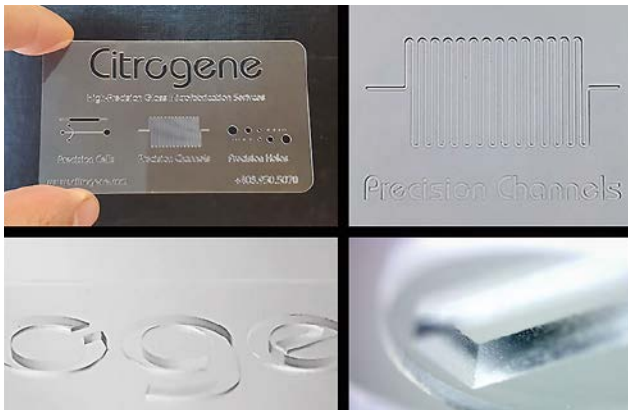
Stainless steel surface polishing



SEM image collage of structures ablated in stainless steel, before and after laser polishing. Typical micro-cone structure (bottom, left) and smoothing with GHz burst mode (right).

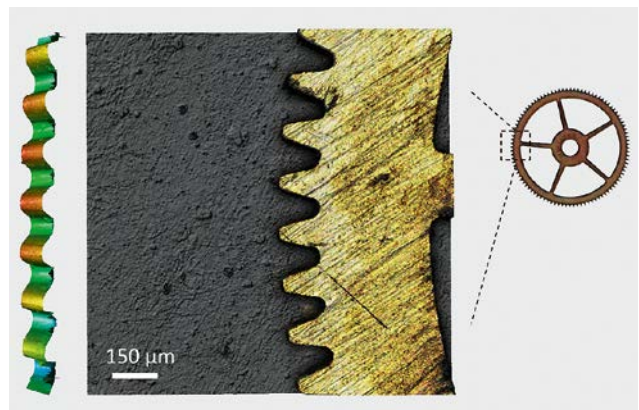
Source: "High-quality surface treatment using GHz burst mode with tunable ultrashort pulses", D. Metzner, P. Lickschat, S. Weißmantel. *Applied Surface Science* (2020).

Glass cutting



Example of glass cutting. Source: Citrogene.

Precision parts cutting from brass



Example of gear cut from brass. Source: Lasea.