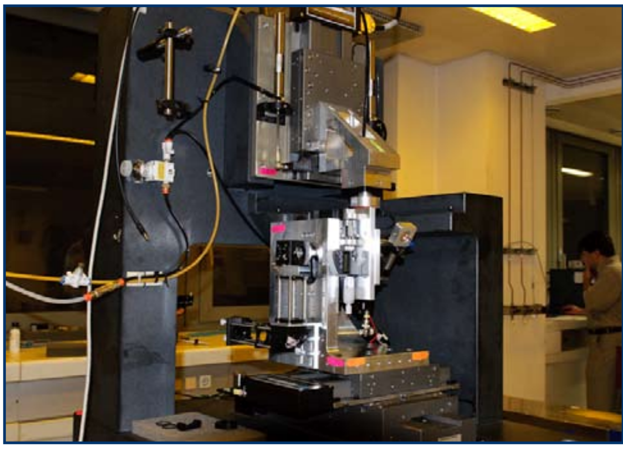
HIGH Q LASER®

Application Note

Two-photon polymerization (2PP)

Two-Photon Polymerization (2PP) has recently gained a lot of interest as Additive Manufacturing Technology capable of fabricating complex three-dimensional submicron structures using a fs-pulsed NIR laser. With this methode a feature resolution down to approx. 100 nm is achievable which is about one order of magnitude better than other methods such as µ-stereolithography. Furthermore, due to the nonlinear absorption process it is possible to directly write inside a given volume ("real" 3D writing), since the polymerization only takes place inside the focus of the laser beam. Therefore, complex 3D-structures can be inscribed into a suitable matrix material and/or a resin (e.g. acrylate based) which is selectively cured. These advantages perfectly fulfill the demands for various future applications requiring three dimensional (3D) structures with resolutions in the (sub)micrometer range, such as different mechanical, electronic and optical micro devices, polymer-based optical waveguides on integrated circuit boards or bio-inspired architectures.

Experimental setup



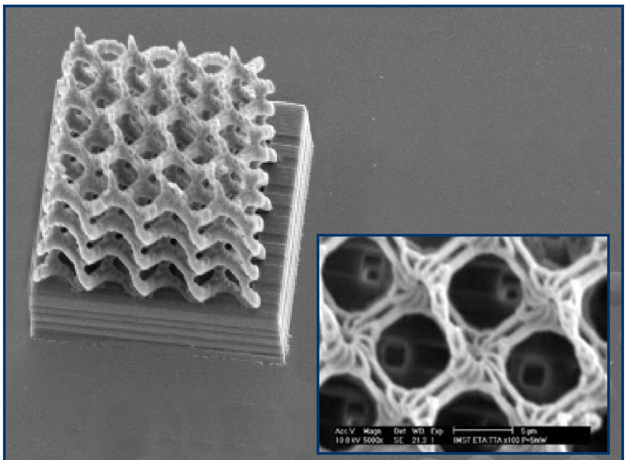
2PP structuring device

Laser	Ti:Sapphire oscillator
Wavelength	λ = 800 nm
Pulse duration	τ = 100 fs

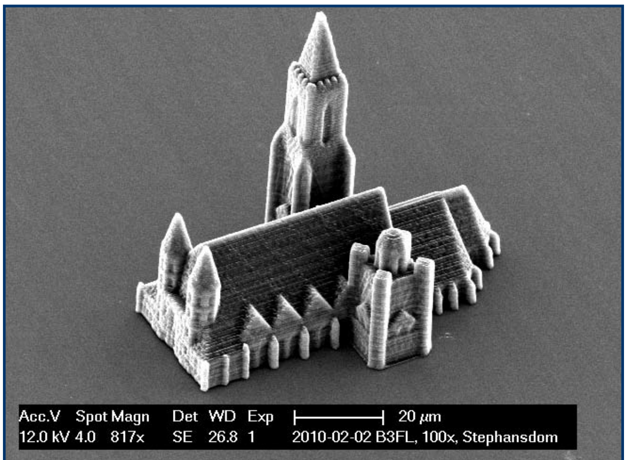
Build envelope: 40 x 40 x 60 mm^3

Minimum resolution in xy-plane: 200 nm
Minimum resolution in z-plane: 200 nm

2PP structuring examples

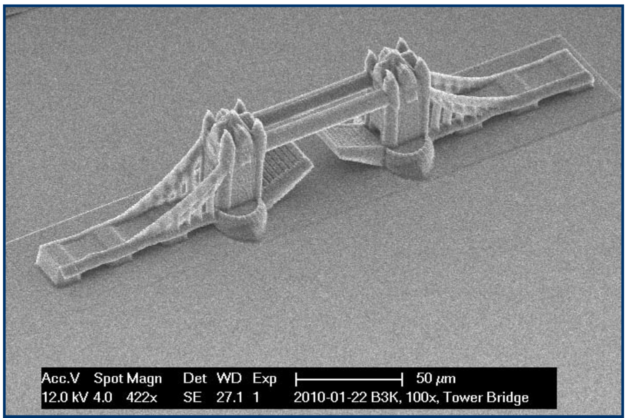


Scaffold

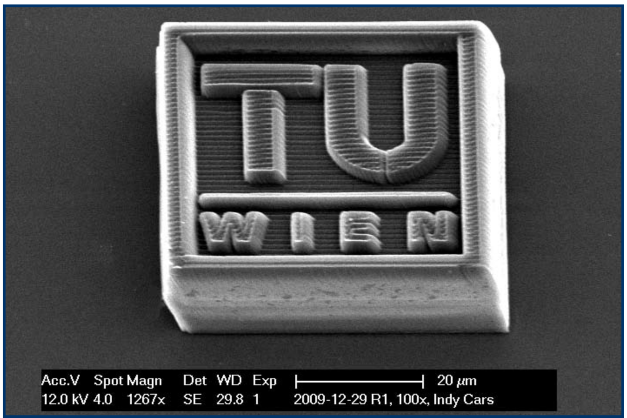


St. Stephen`s Cathedral in Vienna

HIGH Q LASER INNOVATION GMBH • 6830 Rankweil, Austria • Phone: +43 (0)5522 82646 • sales@highQlaser.at www.highQlaser.at
HIGH Q LASER (US) INC. • Watertown, MA 02472 USA • Phone: (617) 924 1441 • sales@highQ-us.com www.highQ-us.com

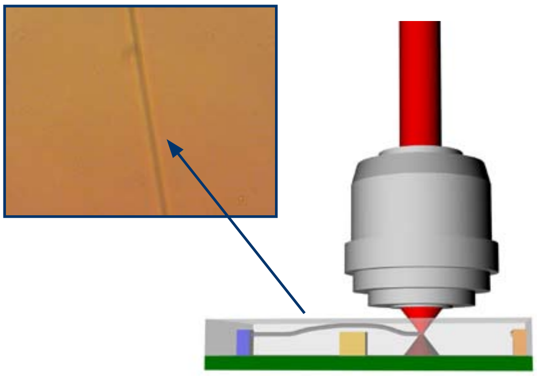


Tower bridge



Logo of the Technical University of Vienna

Waveguide writing



Waveguide writing

Highly transparent and flexible silicon rubber is used as matrix for waveguide writing. After swelling by volatile monomers, waveguides can be written directly into the 3-dimensional volume by 2PP.
By selective photopolymerization the refractive index is locally increased. Remaining monomers are removed by heating or under reduced pressure.
For waveguide applications the 2PP has to induce a minimum refractive index change in the range of $\Delta n/n$ » 0.1% – 1% .

Laser used

*femto***TRAIN**™ Ti:Sapphire for 2PP

The *femto***TRAIN**™ Ti:Sapphire offers light pulses with a duration of 100 fs at an average power of 200 mW. It is available at fixed center wavelengths of 790, 810, 850 or 870 nm (SHG optional). The *femto***TRAIN**™ Ti:Sapphire incorporates, at a footprint of only 53 cm by 20 cm, fs-resonator and pump laser in one monolithic housing. It is the ideal femtosecond laser source for 2PP due to its compact size, its hands-free, true turnkey operation and its attractive price.

Acknowledgements

This work was performed at the
Technical University of Vienna - TU Wien
Institute of Materials Science and Technology
Favoritenstraße 9-11
1040 Wien

Contact
Dr. Jürgen Stampfl
Tel. +43.(0)1.58801.30862
E-mail: juergen.stampfl@tuwien.ac.at
http://www.tuwien.ac.at/wwwt