NEWS AND REVIEWS
JULY 2013

Fabrication of Macro-Objects

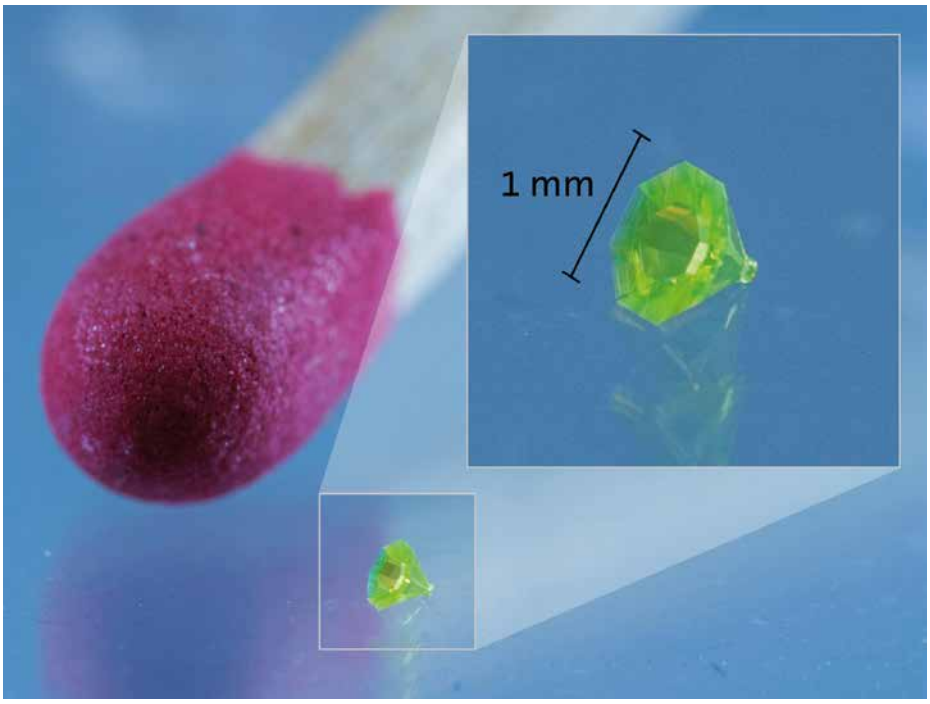
Photonic Professional GT and DiLL - a fast and precise combination

The concept of Dip-in Laser Lithography (DiLL) together with our *Photonic Professional* systems allows an easy workflow for three-dimensional nano- and microfabrication. It is the ideal tool for the fabrication of tall structures in the millimeter-range providing a constant feature size along the entire fabrication height.

SIZES UP TO THE MILLIMETER RANGE

The DiLL process hereby uses a liquid photoresist both as an immersion medium and the photosensitive material to be structured at the same time. This allows to circumvent the general limitation of the structure height to the working distance of the high-NA objective typically in the range of 170 µm.

> read more on page 2

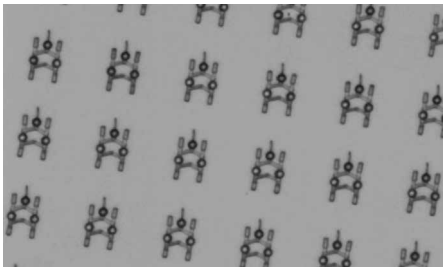


Prototype of a miniature nozzle with a diameter of one millimeter fabricated for the precise formation of liquid micro-droplets.

Publication in Optics Express

Researchers at the University of Bristol used *Photonic Professional* systems for the fabrication of probes that can be controlled in three dimensions using optical tweezers, and demonstrate their use in imaging surface topography with nanometre precision whilst applying ultra-low femto-Newton scale forces.

> read more on page 4



An array of micro-tools on a glass surface before they are transferred into a sample cell.

Software Release

NanoWrite is the graphical user interface for controlling and monitoring all aspects of our *Photonic Professional* systems. The most prominent new feature in this release is the PerfectShape® exposure mode which increases average writing speeds and simplifies the writing process.

> read more on page 3

News Ticker

Nanoscribe expands its distributing activities. After installations of *Photonic Professional* systems in Europe, Asia, Japan and North America within the last five years, our systems are now also used in Israel and Russia. Furthermore we want to introduce Toshniwal Bros. (SR) Pvt., Ltd. as our new sales partner in India.

> read more on page 5

In this issue

Fabrication of Macro-Objects

Photonic Professional GT and DiLL – a fast and precise combination

continued from page 1 The benefits of DiLL can also be used in combination with the new *Photonic Professional GT* (fig. 1) systems to provide a fast and easy 3D printing process for the rapid prototyping of large structures within reasonable time. The miniature Eiffel Tower (fig. 2) serves as a perfect demonstration of the superior resolution provided by the DiLL assisted 3D printing process. A total height of one millimeter allows to see this structure with the bare eye, as the photograph taken with a consumer DSLR and a macro objective documents.

Only the SEM image of the very same structure (fig. 2 (b)) reveals the fine details and proves the high resolution of the process. The *Photonic Professional GT* systems provide the speed-up of the printing process to finish such structures in about two hours total printing time.

While there is obviously little use of this miniature model besides demonstration purposes, the benefits of the DiLL and *GT* combination provide the basis for a large range of applications where sub-millimeter miniature parts and elements with a sub-micron resolution are needed.

A prototype of a miniature nozzle for the precise formation of liquid microdroplets was as well fabricated using the DiLL and *GT* combination (page 1).

fig. 1 The novel Photonic Professional GT system enables high-speed and best-resolution printing of 3D micro-objects.

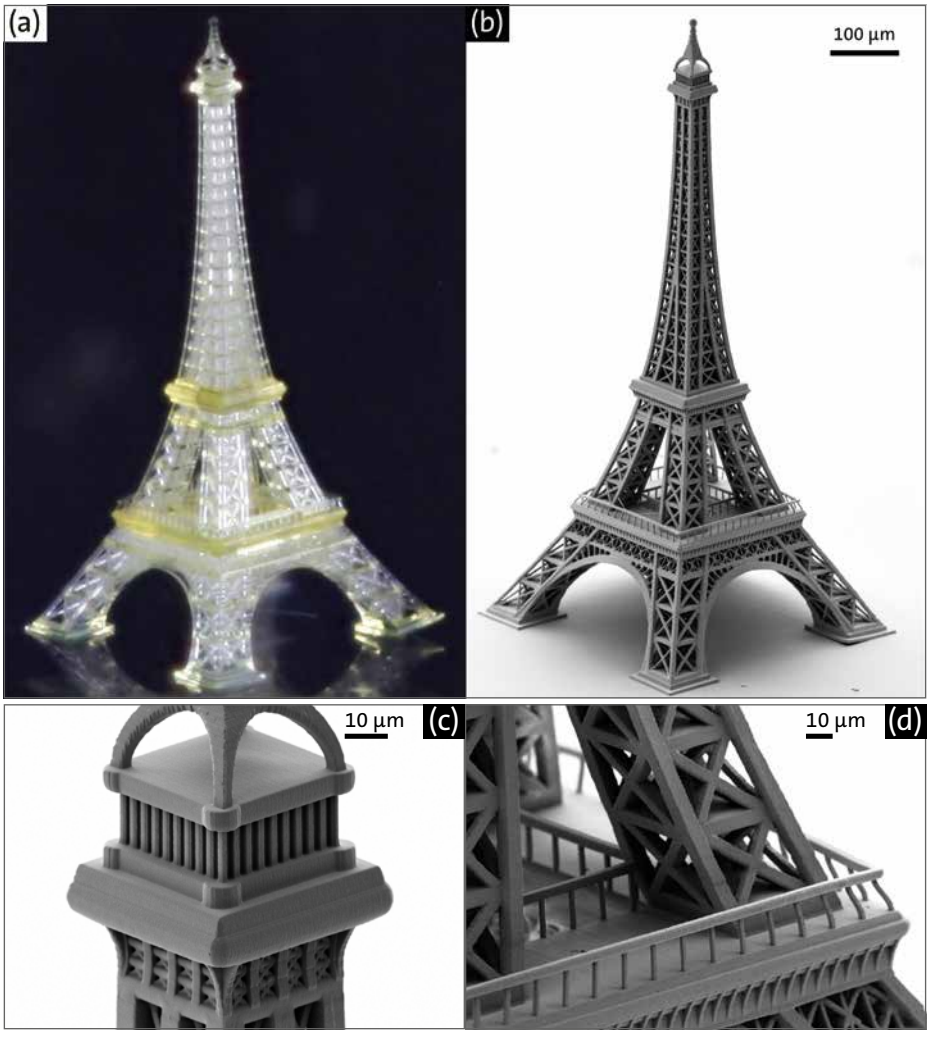


fig. 2 Did you know that there are more than 30 Eiffel Tower replicas around the world with different heights?
Well, this one is definitely unique: Our miniature Eiffel Tower with a total height of 1 mm was 3D printed using the Photonic Professional GT combined with DiLL technology.

Imprint

News and Reviews, Issue: July 2013
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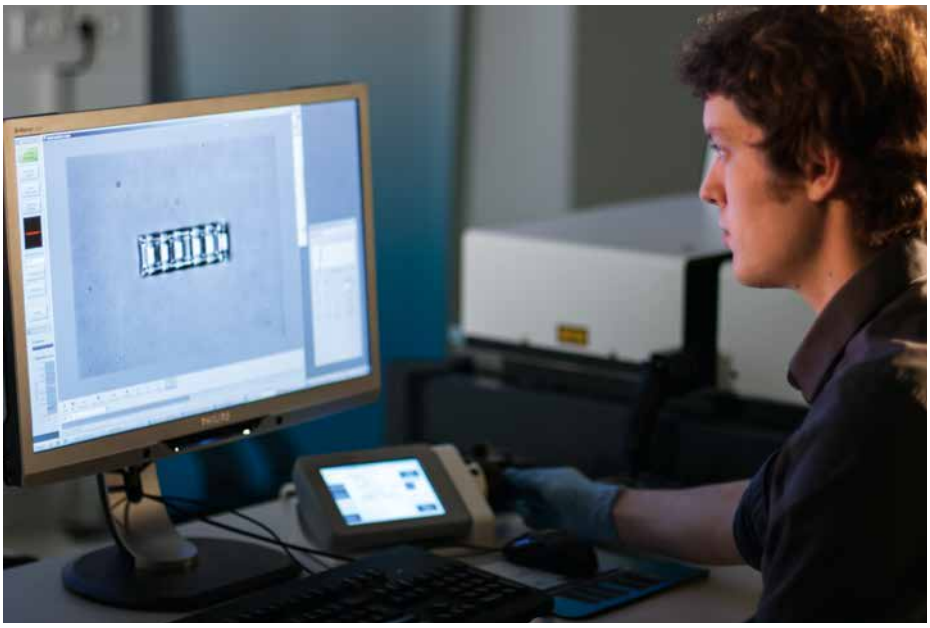
NanoWrite 1.7

PerfectShape® increases writing speed

NanoWrite is the graphical user interface for controlling and monitoring all aspects of our *Photonic Professional* laser lithography systems. In early June, we released NanoWrite 1.7 to our customers.

The most prominent new feature in this upgrade is the PerfectShape exposure mode which increases average writing speeds and simplifies the writing process. During exposure, the photo-sensitive sample is moved relative to the laser focus by a high-resolution three-axis piezo stage. Due to Newton's Third Law, the inertia of the moving mass and the maximum force that can be generated by the piezo actors limit the minimum radius of curvature of the motion trajectory at a given speed.



NanoWrite 1.7 includes the new PerfectShape® feature which increases the average writing speed and simplifies the writing process.

In previous versions, NanoWrite drove the piezo stage at constant speed and the operator had to determine the appropriate speed for achieving sharp corners through experimentation. In NanoWrite 1.7, PerfectShape calculates the optimum velocity profile based on a physical model of the piezo stage. During exposure, it uses lower speeds to traverse corners and higher speeds for straight segments of the trajectory. In addition, NanoWrite dynamically adapts the laser power to the current speed in order to maintain a constant width of exposed lines.

After PerfectShape has completed its fully automated calibration routine, the system operator only has to set the laser power for a certain reference speed. Selecting one of the predefined PerfectShape configurations then determines the inevitable trade-off between speed and accuracy. It is no longer necessary to determine the appropriate scanning speed for a given trajectory by experimentation. Therefore, PerfectShape simplifies the whole writing process and in many cases significantly reduces the writing time, all via a software-only upgrade and no further investments in hardware.

Besides the new PerfectShape implementation, NanoWrite 1.7 also improves the loading time for large and complex input files. We added configuration options for fine-tuning the autofocus system for speed and accuracy. The WriteText command is now capable of including values of GWL variables in the output, making it much easier to properly label your written structures, especially when conducting loop-based parameter sweeps. Finally, we added a one-click button for generating a comprehensive service report that will make it easier for our service team to diagnose any problems encountered during operation of the system.
Coinciding with NanoWrite 1.7, we also released DeScribe 2.0.1 with a few bug fixes and support for the newly introduced GWL commands.

Our service team will be happy to assist you with upgrading to NanoWrite 1.7 and DeScribe 2.0.1.

E-mail: service@nanoscribe.de

Overview: Nanoscribe-Software

NanoWrite
NanoWrite is the easy-to-use graphical user interface for controlling *Photonic Professional* 3D laser lithography systems.

Nanoslicer
Nanoslicer converts STL-files of 3D solid objects to the *Photonic Professional*'s native data format GWL.

DeScribe
DeScribe is a custom editor for the GWL file format. It includes a syntax check and fast interactive 3D preview.

Optically Actuated Micro-Machines

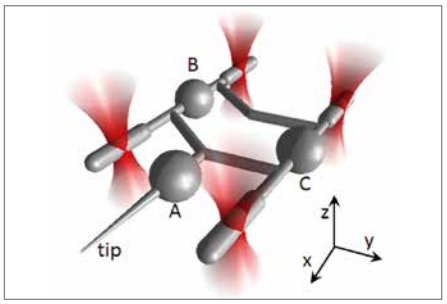
Publication of the University of Bristol

(David Phillips) Nano-scale topography can be imaged by raster scanning a sharp tip over a substrate, and measuring its deflection as it glides over surface features. When imaging biological samples in this way, it is crucial to avoid any disruption to the surface by minimising contact forces.

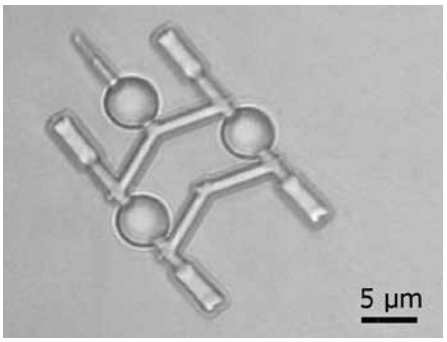
In this work [1] we use the *Photonic Professional* direct laser writing system to fabricate probes that can be controlled in three dimensions using optical tweezers, and demonstrate their use in imaging surface topography with nanometre precision whilst applying ultra-low femto-Newton scale forces.

The flexibility of the *Photonic Professional* systems allowed us to take a rapid prototyping approach to our probe design. A variety of designs were fabricated, tested and iteratively improved. This resulted in probes that are equipped with cylindrical trapping handles to ensure a low force is exerted on the sample during imaging, and large spherical tracking points giving nanometre accuracy position tracking of the position of the probe. By scanning our probes over a test sample, also fabricated with the *Photonic Professional* system, we demonstrated that this technique has a spatial resolution of approximately 11 nm and applies an average force of only 140 fN normal to the sample, making it ideal for examining soft biological specimens that would otherwise be deformed or damaged.

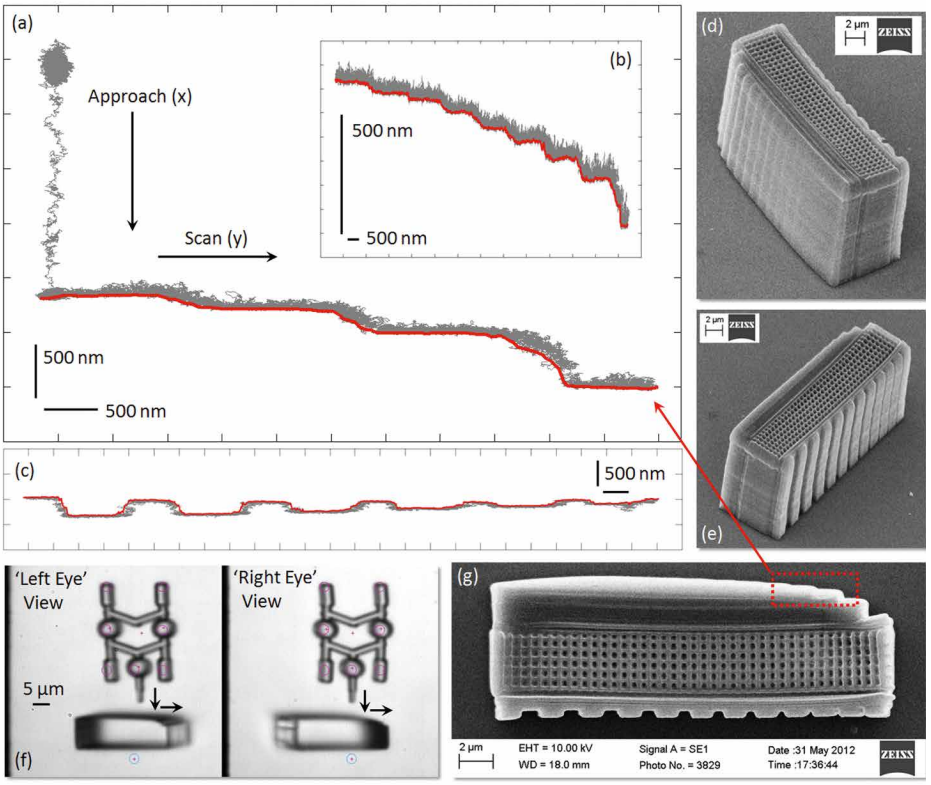
This project was carried out at the University of Bristol in the nanophysics and soft matter group, headed by Professor Mervyn Miles, in collaboration with Professor John Rarity of electrical and electronic engineering at the University of Bristol, and Miles Padgett at the University of Glasgow.



A rendering of our probe design showing the four cylindrical trapping handles and three tracking spheres.



An optical image of an optically trapped probe.



Measurement of the surface topography of a test sample.
(a) The trajectory of the probe tip (grey line) as it approaches the sample, and then scans laterally over steps of 100, 200 and 500 nm in depth. The red line indicates the measured interface. (b) A scan over shallower steps (40, 50, 60, 70, 80, 90, 100, and 200 nm in depth) to test the height resolution. In (b) the horizontal axis has been compressed to more clearly reveal the steps, the scale bars show the relative scaling along each axis. (d) A scan over a corrugated part of another test sample, similar to that shown in (e). All scale bars on (a), (b) and (c) represent 500 nm. (d), (e), and (g) are scanning electron microscope images of the test sample. (f) 'Left eye' and 'right eye' stereo-microscope images of the probe held adjacent to the test sample prior to the start of the experiment.

[1] „An optically actuated surface scanning probe", DB Phillips, GM Gibson, R Bowman, MJ Padgett, S Hanna, DM Carberry, MJ Miles & S. Simpson. 2012, Optics Express, 20 (28), 29679.

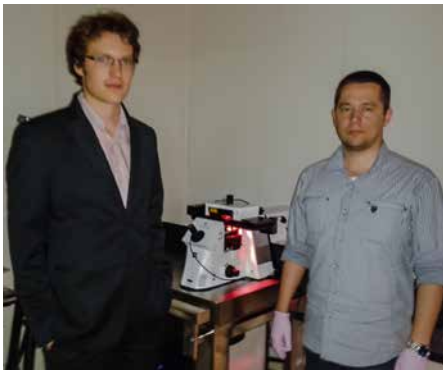
News Ticker

Nanoscribe continues to expand
Installations in Israel and Russia

A.V.B.A. Hitech Services Ltd. and Nanoscribe congratulate the Hebrew University of Jerusalem in Israel on the opening of "The Miniature Integrated Systems Laboratory". 3D lithography plays a crucial role in the pioneering work at the Brojde Center. With about 100 invited guests, the opening was celebrated together with the donors, partners both from science and industry.

Official ceremony of the new laboratory: Martin Hermatschweiler (CEO of Nanoscribe) and Aviv Eliahu (Sales Manager of A.V.B.A.).

With the first installation of a *Photonic Professional* system in Russia, Nanoscribe expands its global coverage to one of the biggest and fastest growing economies worldwide. We wish the Perm State University good luck in their research activities and are eager to see outstanding results coming up.



Nanoscribe´s field engineer Frédéric Husser (left) and Anatoly Ostroshchenko (right) of the Perm State University after the installation.

New Application Flyer
3D printing opens new dimension

Our new application flyer demonstrates the wide field of applications of *Photonic Professional* systems. It presents research results *e.g.* in photonics, cell biology, biomimetics, micro-optics, microfluidics, and micro rapid prototyping by using Nanoscribe´s laser lithography systems for the fabrication of three-dimensional micro-objects and structures on the micrometer scale. The flyer is available as a printed version or for download on our homepage.

MULTITUDE OF APPLICATIONS

For more information, don´t hesitate to contact our sales managers, e-mail: sales@nanoscribe.de

Welcome Toshniwal
New Sales Partner in India

We are very pleased to announce our new representative in India: Toshniwal Bros. (SR) Pvt. Ltd.
The Bangalore-based new distributor distinguishes as an ideal partner with their longstanding expertise in instrumentation supply and committed support to the Indian scientific community since 1948. We are very excited about this new co-operation and we are confident that this partnership will strengthen our presence in the South Asian territory as a response to the significant market demands on 3D micro- and nanofabrication.
If you live in India and want to find out more about Nanoscribe's 3D laser lithography systems, please visit Toshniwal Bros. under www.toshniwalbros.com.

Toshniwal
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Upcoming exhibitions

IEEE Nano
Beijing, China
August 5 - 8, 2013

MNE
London, United Kingdom
September 16 - 19, 2013

NanoForum
Rome, Italy
September 18 - 20, 2013

CHInano2012
Suzhou, China
September 24 - 26, 2013

Micro TAS
Freiburg, Germany
October 27 - 31, 2013

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