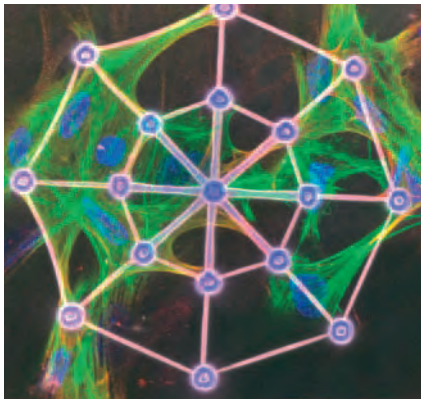
Piezo · Nano · Positioning

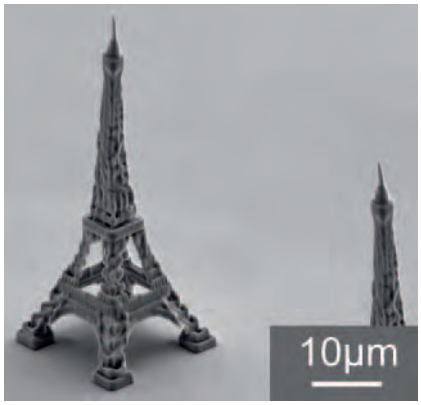
news

Issue 38

3D Structuring in Nanotechnology



Cell embedded in artificial three-dimensional extra-cellular matrix. (Photo: Nanoscribe)



Complex three-dimensional structure: An Eiffel tower 50 micrometer in height was produced using the Nanoscribe 3D lithography process (Photo: Nanoscribe)

A novel 3D laser lithography system based on PI nanopositioning technology is now available from Nanoscribe GmbH (www.nanoscribe.de). The new system allows for the first time the fully automated production of complex three-dimensional microstructures and nanostructures using photosensitive materials.

Typical fields of application for the new technology are, for example, the production of three-dimensional matrices for cellular biology, the manufacture of micro-optical components or photonic crystals and also as a rapid-prototyping instrument for microfluidic and nanofluidic systems and their production in small batches. The desired structures can be designed and then imported using any CAD software which supports the DXF format.

Track Widths to 150 nm and Below

The operating principle of the new lithography process, which is suitable for all commercially available photoresists, is easily understood: Ultrashort laser pulses are strongly focused into the material, which is then exposed by means of a nonlinear optical process in the focal point. Like a pen that is moved in three dimensions, the laser beam writes on the material following arbitrary paths. It is thus possible to achieve track widths from several micrometers down to 150 nm. Two-dimensional 2D structuring or $2^1/_2$D structuring with surface profiles are, of course, also possible and have a resolution which is significantly higher than that allowed by conventional instruments up to now.

The P-563 PIMars™ Piezo Stage is a fast & accurate 3D positioning system based on piezo drives, friction-less flexure guides and non-contacting capacitance sensors.

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Nanopositioning in 3D Structuring

The PI nanopositioning system used by Nanoscribe for its lithographs consists of a 3-axis P-563 stage and an E-761 digital controller. The P-563.3CD PIMars™ multi-axis nanopositioning stage provides travel ranges of up to 300 x 300 x 300 µm 4 nanometer repeatability. Its construction as a parallel-kinematics multi-axis system contributes to the high positioning accuracy. All piezo actuators act on a central platform so all axes behave with identical dynamics. One "slower" axis, mostly unproblematic for linear scans, would have detrimental effects here. Moreover, the high-resolution capacitive sensors can register any deviation from the commanded path in 3D space in real time. This type of position measurement directly at the moving platform against a fixed reference (parallel metrology) allows the immediate determination and active compensation for axis crosstalk and lateral runout. The PCI-board-based E-761.3CD digital piezo controller is matched to the multi-axis parallel-kinematics piezo nanopositioning system and provides the exact trajectory control necessary for this task.

The P-563.3CD nanopositioning system with its E-761, PC plug-in digital controller (foreground) is ideally suited to the application because of its high positioning accuracy and travel range of 300 µm in three axes.

Novel laser lithography system which – for the first time – allows the production of complex three-dimensional microstructures and nanostructures using photosensitive materials. The precise adjustment of object or sample is achieved by using a P-563 PIMars™, a parallel-kinematics multi-axis piezo nanopositioning system (Photo: Nanoscribe)