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NOVEL TOOLS FOR NANOPROTOTYPING USING DUALBEAM^{TM} FIB/SEM

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The potential of focused ion beam equipment for prototyping of micromechanical structures has been recognized and described in the past [1]. Until recently, this potential has mostly been exploited using case-specific deposition and milling geometries and design/fabrication strategies that were tailored to individual designs [2]. This way of working limits the design complexity because of the limited amount of milling/deposition operations that can be done in a practical and timely fashion.

Traditional microelectronics design as well as EBL (electron beam lithography) typically use advanced CAD packages to layout complex two-dimensional geometries. The design is often presented in the form of a GDS-II file. We have recently introduced a turnkey solution for translating these GDS-II designs into native FIB (focused ion beam) and DualBeam format: this software module is called “GDStoDB”. The conversion is done in a way that enables a reliable transfer of the design onto the substrate material. Recent investigations have shown that this is not straightforward [3, 4], as the end result may depend strongly on the exposure strategy: the ion beam current, scanning trajectory and speed, as well as single-pass versus multipass exposure must all be taken into account. The new software module allows the translation of a two-dimensional design into individual dwell points for the ion beam, relying on traditional FIB-based parameters such as “overlap” and “depth” and taking proper exposure startegies into account. Combining this with the excellent ion beam quality enables the quick and elegant realization of complex designs, from virtually any layout editor.

An example is shown in Figure 1, which shows a simple split-ring resonator. This design was realized in a Au layer on a glass substrate. The total width of the U-shape is around 300 nm, with the legs well below 100 nm. It is realised by cutting out a relatively large field of tens of micrometers around it (rather than milling the U-shape, all the surrounding material is milled while the U-shape remains unaffected in the middle). The required layout is easily drawn in a CAD package, and conversion into dwell points using the “GDStoDB” tool results in a single file containing the complete design, ready for direct execution on the DualBeam instrument. Since the scanning strategy is optimized for FIB, the shape will be reproduced in a reliable manner, avoiding artifacts that may result from a typical EBL exposure strategy (single pass).

We see applications of this design-and-prototype technique in MEMS (post-processing, mechanical tuning), micro-optics and microphotonics, micro- and nanofluidics, nanoimprint template fabrication, and other fields of nanotechnology fabrication.

References:

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Figures:

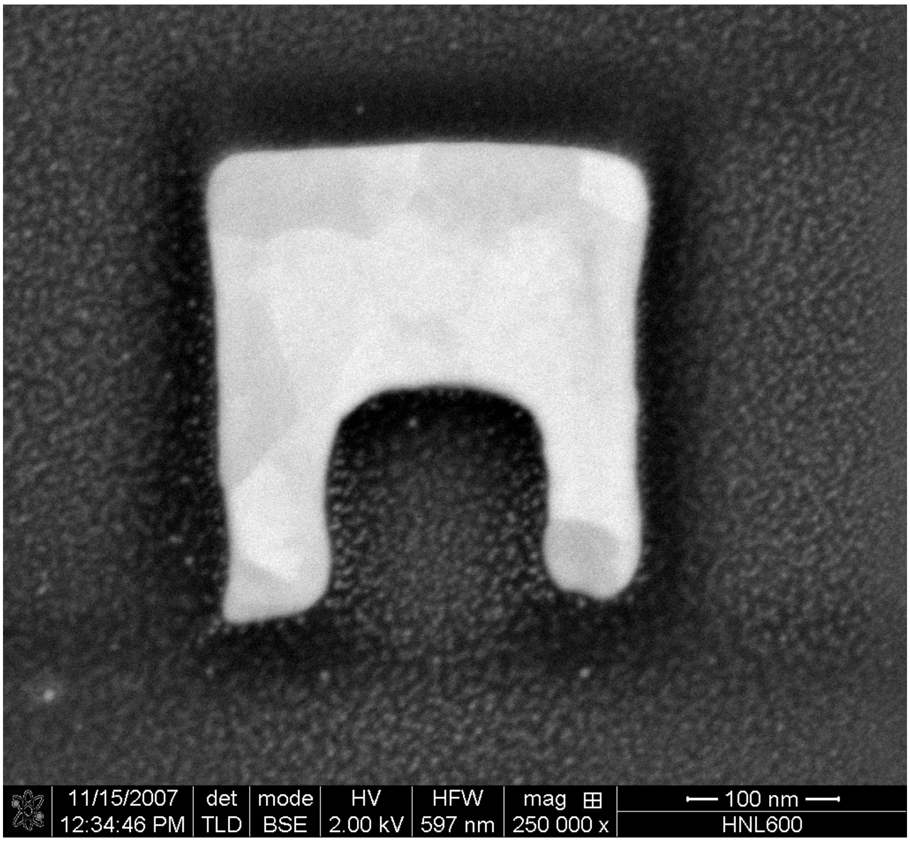

Figure 1: Close-up of split-ring resonator, fabricated by FIB-milling a thin Au layer around a U-shaped resonator, on a glass substrate