Reference markers for e-beam lithography with Electron Beam Induced Deposition

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Recently more interest has been shown in electron-beam patterning on three-dimensional, i.e. non-flat, surfaces. Nanometer scale patterning on such surfaces creates engineering challenges, in particular to keeping the substrate in e-beam focus. On flat surfaces this is accomplished with an optical height meter system, using a laser beam that relates the substrate to the e-beam focus. This does not work for non-flat substrates. To be able to pattern a non-flat surface one needs an accurate height map referenced to the coordinate system of the electron beam writer. In the Vistec Electron Beam Pattern Generator (EBPG) the substrate is kept in e-beam focus, with a z-stage.

For three-dimensional objects of a well-defined shape, such as optical spherical lenses, the shape is a mathematical function and the height map can be calculated. On such spherical lens it would only require three markers, that can be retrieved in the EBPG, and the height map of the object can be referenced to the EBPG coordinate system. For more complicated surfaces the number of needed markers will depend on the number of mathematical variables of the function. The problem is, how to fabricate these markers, that can be detected in the EBPG, on a non-flat surface. The usual lithographic techniques to make markers are limited to flat surfaces.

A solution is offered by a direct deposition technique called Electron Beam Induced Deposition (EBID)[1]. EBID is routinely done in a SEM, and the first fabrication results of EBID markers are presented here. Markers were deposited on a flat chrome-coated glass wafer using $MeCpPtMe_3$ as a precursor gas, and consist of 20% Pt and 80% C, approximately. Figure 1 shows the result of such an EBID marker imaged with the EBPG. These markers are easy to detect and are well suitable for automated focus and positioning. As EBID is a technique that is not limited to flat surfaces, EBID markers can be fabricated on non flat surfaces in exactly the same way. Results will be presented on the use of EBID markers in the EBPG to reference the height profile of spherical lenses to the EBPG coordinate system. Examples will be shown of nano-fabricated patterns on these lenses.

[1] Utke, I., Hoffmann, P., and Melngailis, J. (2008). Gas-assisted focused electron beam and ion beam processing and fabrication. *Journal of Vacuum Science & Technology B: Microelectronics and Nanometer Structures*, *26*(4), 1197.

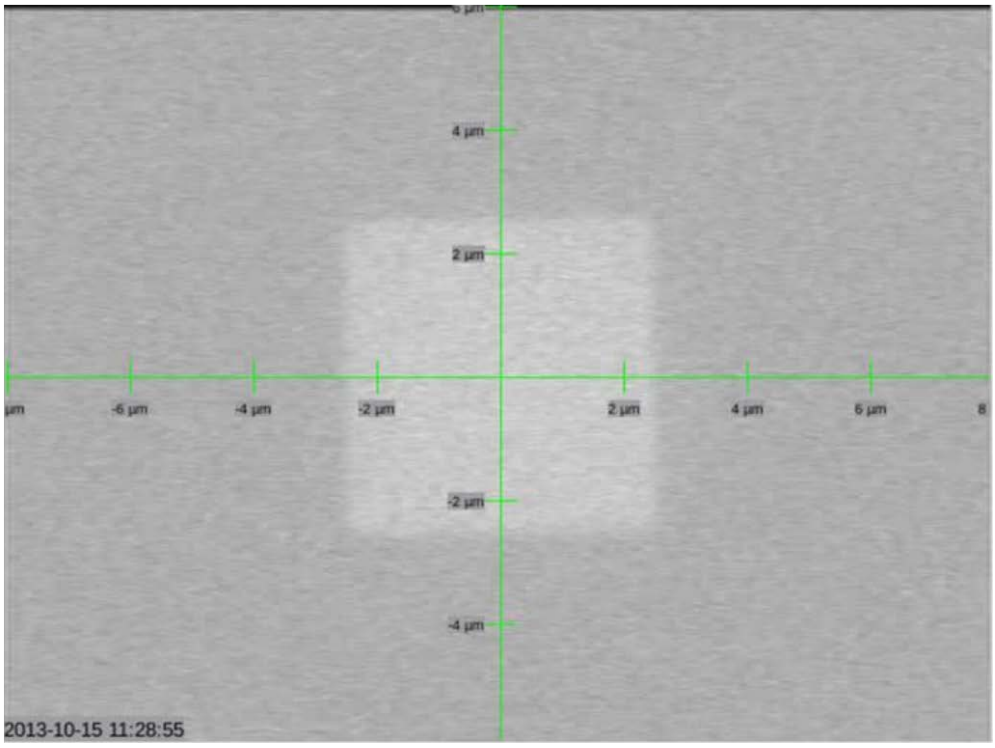

Figure 1: A 5 by 5 micron Platinum/Carbon marker deposited using EBID on a chrome-coated glass wafer imaged in a Vistec EBPG 5200 tool at an accelerating voltage of 100 keV, with a probe current of 1nA.

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