An Enhanced E-beam Pattern Writing for Nano-Optics Based on Character Projection

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Electron beam lithography is well known as a flexible and high resolving, but also expensive and slow writing technique. This makes e-beam lithography often useable for the science case proof of principle only. Additional, especially in optical applications like diffractive elements, effective media and metamaterials, periodic and statistic stitching errors may have an impact on the optical properties of the fabricated elements. Thus, e-beam lithography fails often in real applications because weeks and months of writing time as well as the optical quality reached are not acceptable.
High-end e-beam writers are going to overcome these problems step by step. One solution for this problem is parallelization. The Variable Shaped Beam writing principle, where expanded geometrical primitives such as rectangles or triangles of flexible size can be exposed with a single shot, is a first step towards this direction. Next, highly repetitive pattern, such as parts of gratings, can be exposed by a so called character projection, which ensures an enormous reduction in shots and writing time (up to 1/1000). This benefit can be used to demonstrate the feasibility of an element and /or to reduce the fabrication costs. Applying advanced writing strategies too, the pattern quality can be further improved. The strategy of character projection has been implemented in a Vistec SB350 OS Variable Shaped Beam writer. The writing time in the cell projection mode of several hours for a 100 x 100 mm² area is nearly independent on the pattern. To overcome the limitation in flexibility more than 2000 characters for nano-optical applications can be used to expose a large number of various and complex patterns.

The paper will present first exposure results. The impact on shot count reduction, write time and pattern quality will be discussed.
Figure 1 shows the character cell of a diffractive lens; Figure 2 shows the resist Pattern of a 100nm period grating.

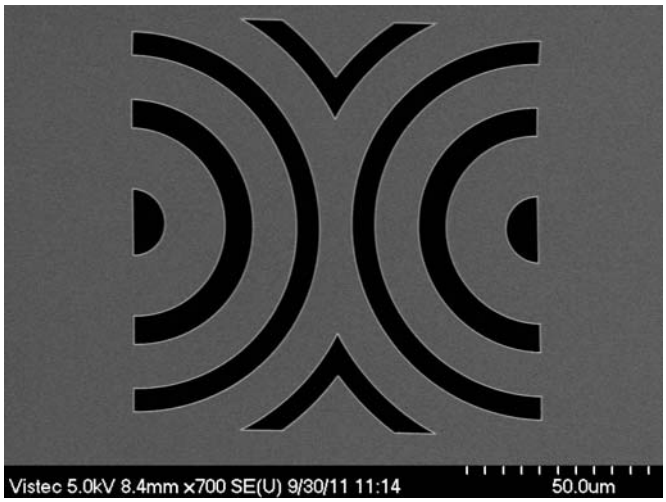

Figure 1: Character cell for a diffractive lens

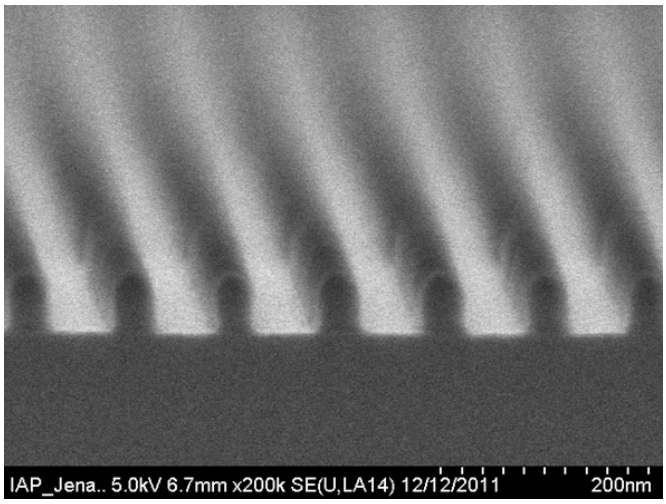

Figure 2: Resist Pattern, 100nm Pitch