Fast-writing E-beam for large arrays of nano-holes

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Publication date:
2013

Document Version
Publisher's PDF, also known as Version of record

Citation (APA):
Fast-writing E-beam for large arrays of nano-holes

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Efficient nanoscale patterning of large areas is required for sub-wavelength optics. For example, 200 nm periodic structures are often too small to be made with standard UV- and DUV-equipment. Still, the final product must be made at an economic cost. EBL writing time consists of shape time, beam time, stage time and calibration time.

Single shot Exposure
Conventionally, EBL uses multiple exposures of slightly overlaying spots. Instead, the fast-writing strategy uses the machine as a raster scan tool to write a large rectangle, using a beam step size larger than the spot size [1,2].

Validation and Experimental Results
The JEOL JBX-9500FS is a prototype EBL 100 keV system with electron-beam scanning speeds up to 100 MHz. Writing time tests of exposing 5 mm x 5 mm can be seen in Fig. 5 as function of dose for different writing field side lengths with array periods in the range 150-250 nm. Y-axis b-parameter. Exposure includes 5 min cyclic calibration. Initial machine calibration not included.

Efficient nanoscale patterning of large areas is required for sub-wavelength optics. Here we use a fast-writing strategy described in [1], where electron beam lithography (EBL) with a focused Gaussian beam is used to define shapes directly. The serial technique is optimized for speed and pattern fidelity to a maximum writing speed of around 30 min/cm\textsuperscript{2} for 200 nm periods in 2D lattices. The overall costs in terms of machine time and feasibility are assessed.

Conclusion
An EBL writing time below two hours per cm\textsuperscript{2} provides new possibilities where sub-wavelength structures can be used to provide functionality such as anti-reflective or plasmonic effects for large area applications in a cost-effective manner, similar to traditional parallel processing techniques.

Work was supported by the EC FP7 funded Plast4Future (Contract No. 314345) project.

References