Automated Geometry assisted PEC for electron beam direct write nanolithography

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The proximity effect correction (PEC) in electron beam lithography has been extensively researched for the past thirty years [1-3]. In spite of this there is a need to revisit PEC for nanostructures below 50 nm. The existing PEC paradigms impose constraints such that PEC is hardly used for features this size. The problem is that in conventional PEC the assumption is that the feature layout, which is supposed to be the final product of the fabrication process, is also the input and boundary condition. This over restricts the possible locations of dose and causes most features below 50 nm to have no sharp corners and appear round.

In the area of proximity effect for optical lithography, serifs have been used to modify the aerial image to print geometries that are sharper than the incident wavelength [4]. In optical lithography serifs are the only means to create localized dose variations to improve patterning performance. In electron beam lithography the use of serifs, or geometry alterations to modify dose, has been proposed and used already [5, 6] and for nanoscale structures that need sharp corners [7]. However, this prior implementation was cumbersome and done manually.

In this paper we present the implementation of this nanoscale PEC (NanoPEC) by using scripts in a commercially available PEC software (Layout Beamer, GenIsys GmbH). The concept is the same as previously reported [7]. By a series of biasing it is possible to create the serifs needed (see Figure 1) for arbitrary shaped structures to enhance the dose sharpness at structure corners (see Figure 2). Preliminary results show promise of this technique (Figure 3). The entire pattern on the right side of Figure 1 was the result of a single set of biasing parameters for all features, thus to show the generality of the method. We tested the approach by exposing two samples, one coated with PMMA resist and another with GL-2000-12 resist (similar to ZEP 520). The samples were both developed in a new developer: Ethanol in water solution in a 4 to 1 volume ratio. All structures were exposed with the same PEC parameters and exposure conditions, thus highlighting the effect of the geometry on the final developed strucures.

This PEC method will be applied on plasmonic structures and optical data will be presented.

References

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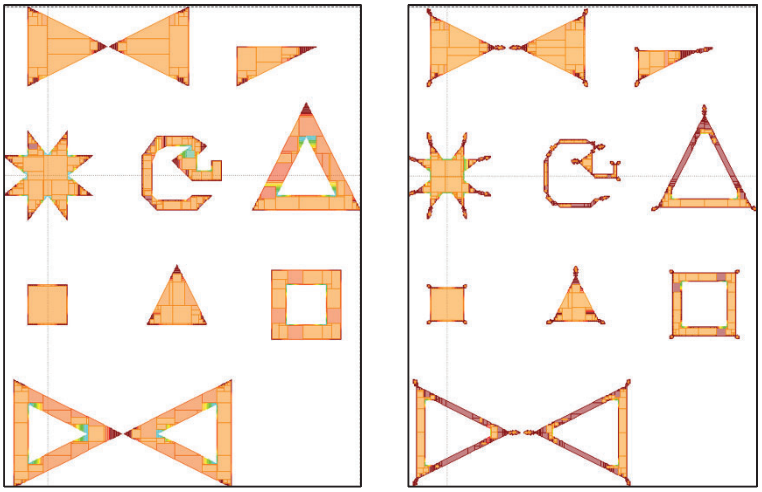

Figure 1. Fractured data of arbitrary shapes using standard PEC (left) and automated NanoPEC (right).

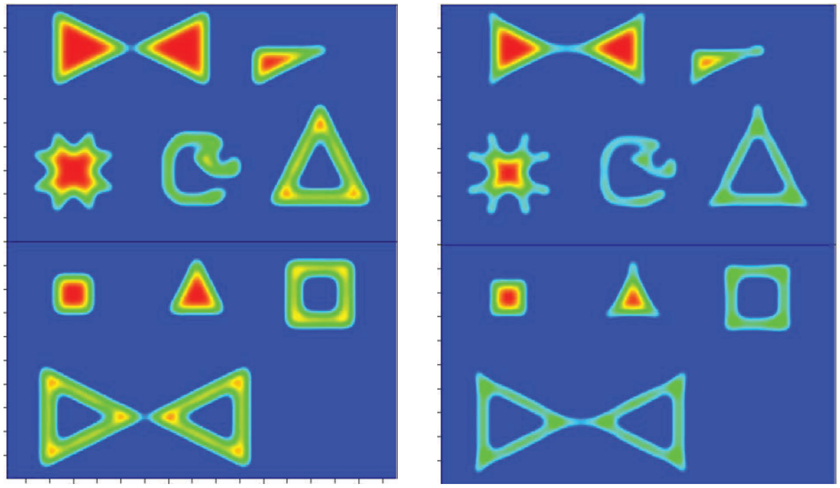

Figure 2. Ebeam energy distribution simulation of arbitrary shapes using standard PEC (left) and automated NanoPEC (right).

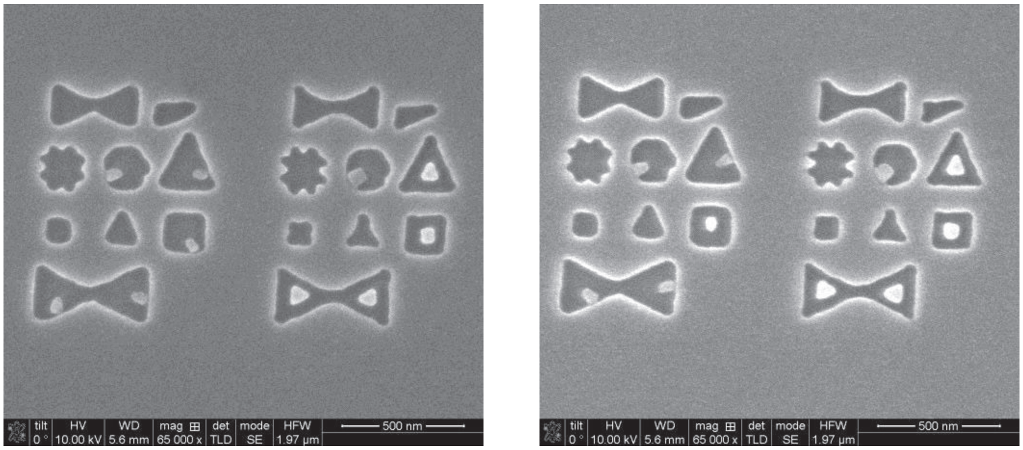

Figure 3. SEM micrographs of developed arbitrary shapes using standard PEC (left of micrographs) and automated NanoPEC (right of micrographs). Left sample is PMMA resist and right sample is Gl-2000-12 resist. Both were developed in a 4:1 solution of Ethanol in water.

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