Advanced electron-beam grayscale lithography writing strategies using optimized dose gradients in the pattern design

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In this work, we emphasize the significance of electron-beam writing techniques, particularly focusing on the implementation of newly developed dose gradient shaping methods in the Raith EBPG Plus system for advanced grayscale lithography. Electron-beam lithography stands as a crucial technology for micro- and nano-scale structure fabrication, with grayscale lithography playing a pivotal role in developing advanced photonic structures and high-resolution diffractive optical elements.

Various methods, including proximity effect correction, multi-pass writing, and dose gradient shaping, have been utilized for grayscale lithography [1,2]. Our investigation specifically addresses the dose gradient shaping technique, where precise control over electron doses in minute steps leads to the creation of smoother structures on the sample. This approach has demonstrated its efficacy in producing high-quality grayscale patterns with exact control over structure shape and height [3], illustrated in Figure 1.

Our study showcases the successful integration of these newly developed dose gradient with various writing strategies into the Raith EBPG Plus system. This implementation allows for the precise modulation of dose in specific shapes, facilitating the creation of highly complex and accurate 3D structures. The initial results highlight faster writing times and enhanced flexibility, offering a seamless approach for generating customized grayscale patterns with the Raith EBPG system.

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References:

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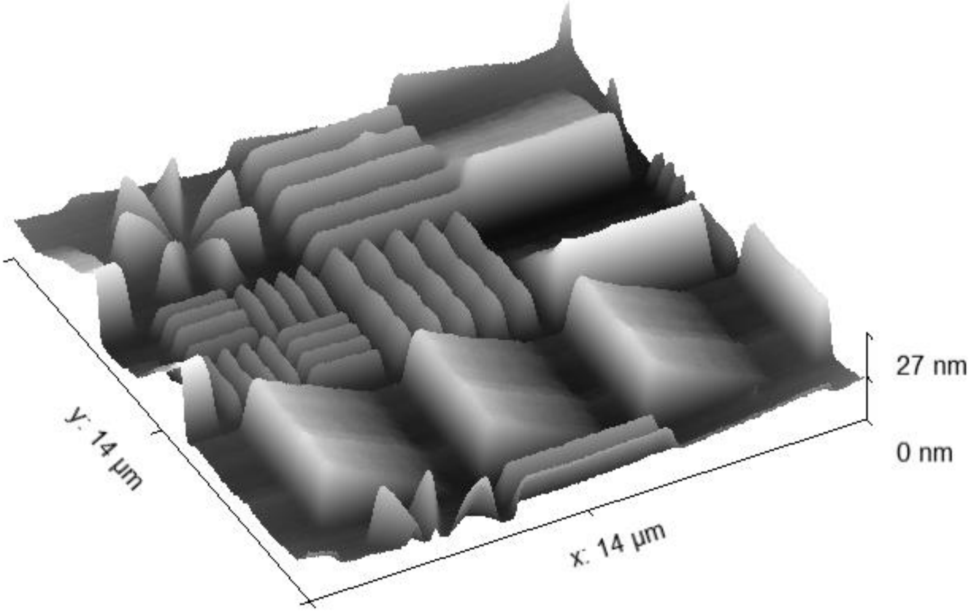

Figure 1. Atomic force microscopy image of Silicon structures on a 14 x 14 μm^2 area, made by oxidation through a silsesquioxane (HSQ) mask. The HSQ mask with height modulation (around 150nm) is removed in BOE resulting in a pattern transfer with 27 nm height differences [3].