

## **SEM dimensional metrology on sub-15 nm bit-patterned media using model-based analysis**

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SEM-based metrology is the most important technique to provide feedback for nanofabrication of bit-patterned media. Analytical SEMs are not optimized for the task of quantitative metrology;<sup>1</sup> nevertheless, this is the only tool available to most companies at the R&D stage. SEM imaging on templates provides not only individual dot size, but also information for dot size distribution, the location of dots, pitch and array alignment quality, etc. SEM metrology involves uncertainty of the measurement in the image-processing step, and yet, it is very important to know the SEM measurement limitations, because the dot feature sizes on templates are smaller than 20 nm.

In this work, we used an analytical SEM for CD metrology of a bit-patterned media, quartz, nanoimprint template. The SEM was tuned first to find the best reasonable conditions for consistent manual operation. Beam characterization was done using the BEAMETR beam measurement technique. A series of images was obtained on a 27 nm nominal pitch dot array pattern (see example in Figure 1). The images were analyzed using two approaches for metrology: a) regular image-processing software and b) a physical model-based processing tool, myCD-CH. A fundamental limitation of analytical SEM operation with regular imaging processing was identified. A considerable improvement was found with physics-based imaging processing that involves analysis of SEM setup, along with material information. It was found that measurement precision when using model-based metrology was improved by up to a factor of five; the results are shown in Figure 2. This is because SEM signal formation is a complex process depending on the pattern geometry, materials, and SEM setup. Using a model in image analysis significantly alleviated measurement uncertainty.

1. D. C. Joy, "Some Issues in SEM-Based Metrology", Proc. SPIE 3332, 102 (1998)

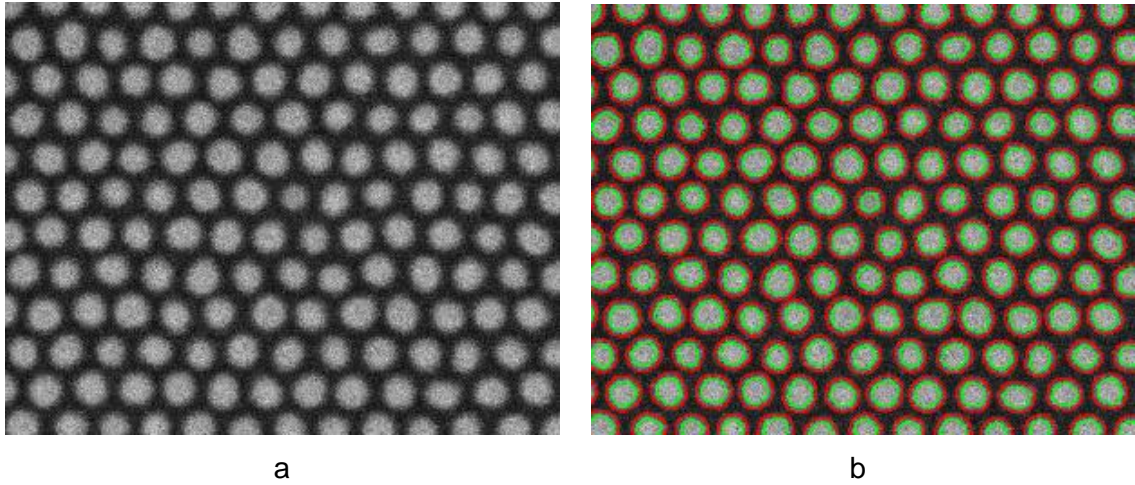


Figure 1. a) SEM image of the nanoimprint template for bit-patterned media at 27 nm pitch; b) with extracted bit contours at the top and bottom.

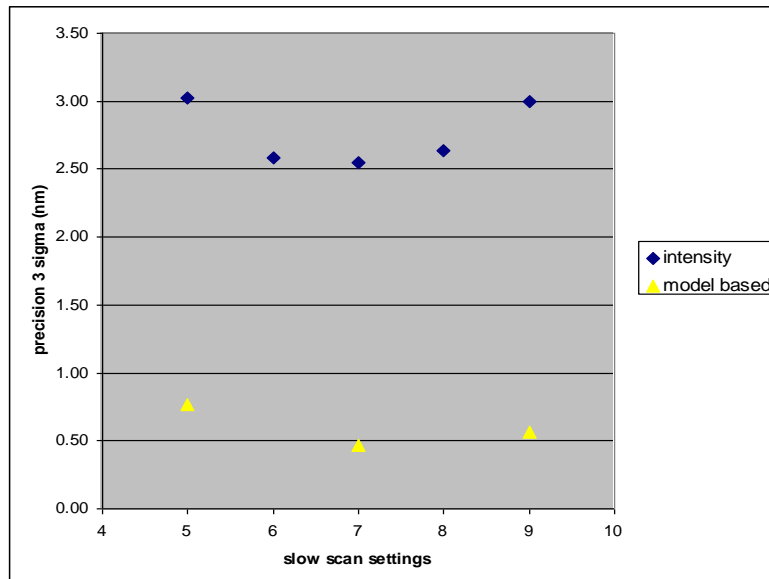


Figure 2. Measurement precision from SEM images of NIL templates was considerably improved when using model-based image analysis compared to regular image-processing software. Also, the optimum scan speed to achieve the best precision was established.