Patterning of ≤ 16 nm defect arrays with electron beam lithography which are used to develop a high throughput electron beam defect inspection tool

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SEMATECH has established an infrastructure development program to ensure needed metrology tools and techniques are available for leading edge semiconductor processes and devices. The primary goal of this program is to identify, evaluate and develop disruptive technologies to enable multibeam electron beam inspection as a high throughput replacement for bright field optical inspection.

The design, development, and fabrication of high quality dense array samples with ≤ 16nm defects at known locations is a key requirement to assessing new multibeam inspection technologies. Due to the technical difficulties of creating high quality programmed defect samples at the required sizes, we have undertaken multiple paths of electron beam tools, supporting organizations and processing techniques to optimize and deliver the needed samples. In doing so this program has created a snapshot of electron beam lithography capability throughout the world.

In this material we will discuss the requirements of the different defect arrays needed for our program and the early issues we observed with "standard" electron beam lithography. In addition we will compare the exposure tools and processes tested as well as the different optimization techniques used to finally achieve the desired samples.

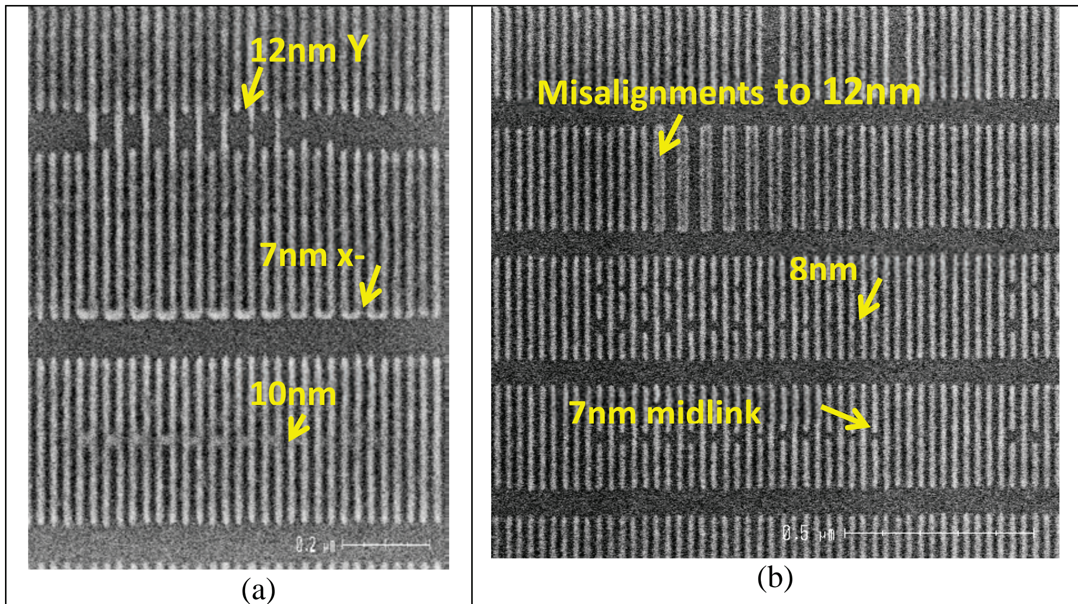

Figure 1: SEMs of electron beam lithography which will lead to a successful 15 nm intentional defect array. In (a), starting at the top, we are seeing 12 nm bridges in the Y lines, 7 nm bridges in the X lines and 10 nm islands. In (b), starting from the top, we see 12 nm placement errors, 8 nm mousebites and 7 nm midlink gaps.

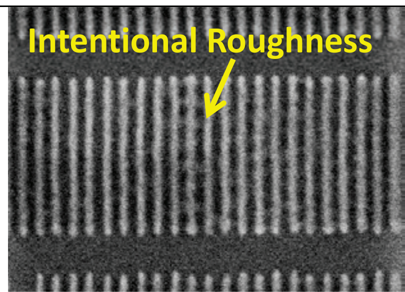

Figure 2: SEM of electron beam lithography showing the ability to purposely adjust the line width roughness of an individual 15 nm line.

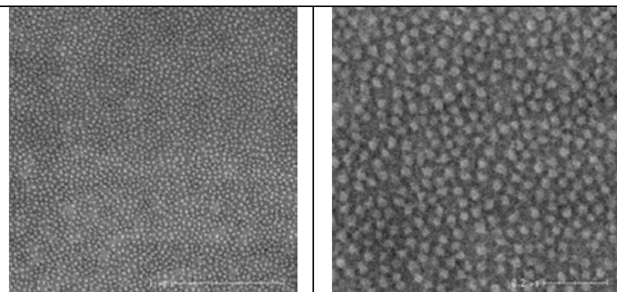

Figure 3: SEM image of random dot array patterns, important for characterization of electron beam imaging characteristics. Design rule of features shown are 16nm dot diameter with 16nm minimum space. a) Image at 50kX. b) Image at 150kX.