# 5kV multi electron beam lithography: MAPPER tool and resist process characterization

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Preferred presentation method: oral presentation

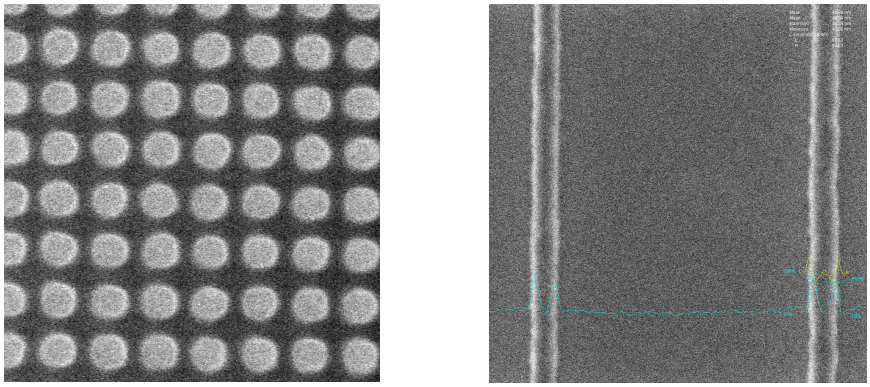
Electron beam lithography leads to high resolution patterns, but poor throughput. The FP7 European project MAGIC aims at the design of a multi electron beam machine. Such a solution will provide in 2012, to industrial mask less platforms, high resolution capability, and high throughput. Involved into MAGIC, MAPPER lithography develops the future beta platform. In this beta tool, each of the 13,000 beams has an acceleration voltage of 5kV, lower than 20kV to 100kV voltages usually used in standard high resolution EBDW lithography.

A 300mm pre-alpha platform (with 110 beams) from MAPPER lithography was installed into LETI premises in July 2009. As soon as the tool was operative, our first task was to perform acceptance tests. This study will present its results. They were obtained on a positive and on a negative tone resist. Test patterns were composed of 45nm isolated and dense trenches/lines and contact holes/dots. Two of them are presented in **Figure 1**. Beam to beam uniformity was measured.

Then we carried on with tool characterization. A spot size evaluation method based on line width measurement is proposed. It is compared to tool direct spot size measurement. Background exposure leading to an increase of line edge roughness is also studied. Two origins of this background exposure are pointed out and quantified. One of them comes from randomly scattered electrons on chamber chuck. They generate backscattered electrons that are able to slightly expose resist. The other contribution is due to the writing strategy, especially the beam step size exposure. Since our pre-alpha tool has no blanker, a low amount of electrons are deposited between exposed patterns. Resist process and writing strategy avoiding any background issue are discussed.

We also studied 5kV resist processes. Contrast curves were obtained on PMMA and HSQ. They were compared with high voltage results, as presented in **Figure 2** for instance. We observed a higher line edge roughness (LER) at 5kV. We use this comparison to stress the shot noise impact on LER. We also determined experimentally the point spread function (PSF). Experimental PSF is compared with Monte Carlo simulation.

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n°214945 - MAGIC



a) b)

*Figure 1: Example of exposures performed for MAPER tool acceptance tests on PMMA and HSQ. a) 45nm dense contact holes in PMMA. b) 45nm isolated HSQ lines.*

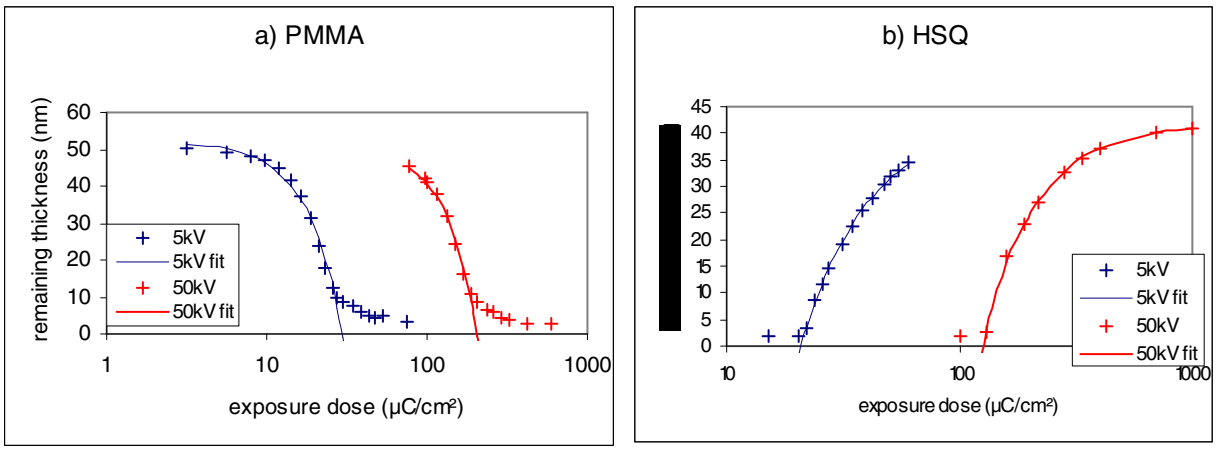



*Figure 2: Contrast curves obtained at 5kV and 50kV. a) PMMA exposures. b) HSQ exposures.*