Study on writing strategy for multiple electron-beam lithography at 5keV

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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. Each beam has an acceleration voltage of 5kV, whereas energies of 20keV to 100keV are more usually used in standard EBDW lithography.
A 300mm platform from Mapper lithography will be installed within Leti premises, in May 2009. In order to prepare its arrival, preliminary work was performed on low energy lithography. It aims at the determination of a stable and robust resist process at 5keV.
Experiments have been perfomed on a Leica VB6 HR, designed for exposures between 20keV and 50keV. It is a Gaussian beam tool and beam energy was decreased down to 5keV for this work. The performances of the Leica VB6 HR at low energy will be characterized in this paper. Exposures at several energies have been performed, on CAR (chemical amplified resists) and non amplified resists (see *Figure **1***). The effect of a top coat from Showa Denko is also evaluated.
In agreement with Bethe equation, we noticed a decrease of the exposure dose as the energy decreases. An increase of the LER (line edge roughness) is also pointed out (see *Figure* **2**). The impact of the shot noise on LER is quantified, in comparison with other contributions, as tool performance, resist properties and physical phenomenon. Exposures with different beam step sizes helped to discriminate shot noise effect. Indeed the number of electrons per shot rises while this parameter is increased, lowering the shot noise per shot.
In order to reinforce the experimental results, Monte Carlo simulations are provided. Shot noise is simulated from a beam shot to another. Comparison between simulation and experimental results gives a good agreement.

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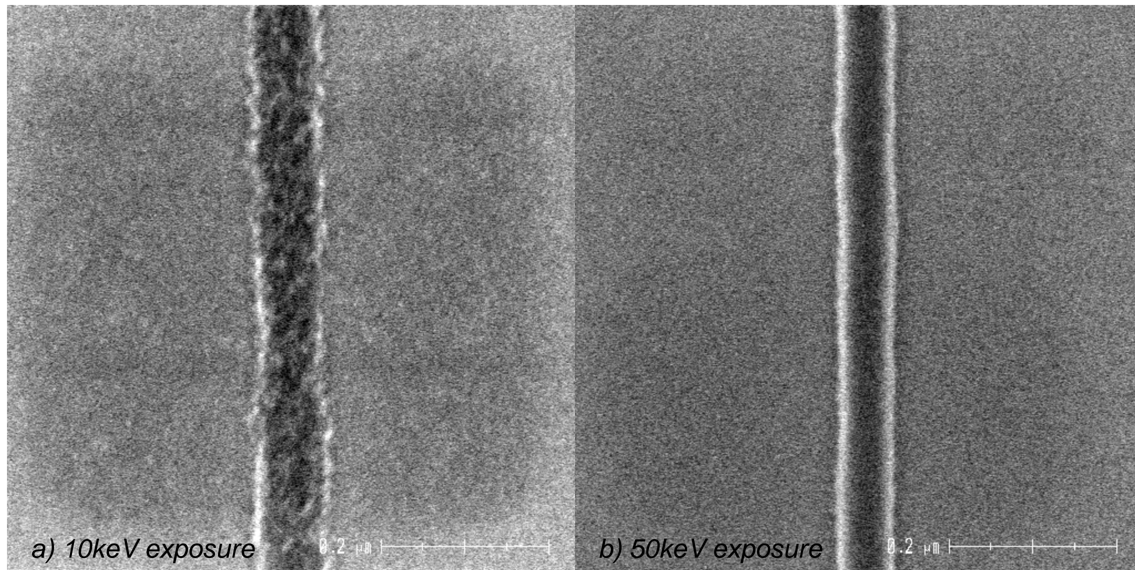

Figure 1: CD-SEM pictures of a same pattern, at 10keV and 50keV, on HSQ resist, at doses of 48µC/cm² and 300µC/cm² respectively.

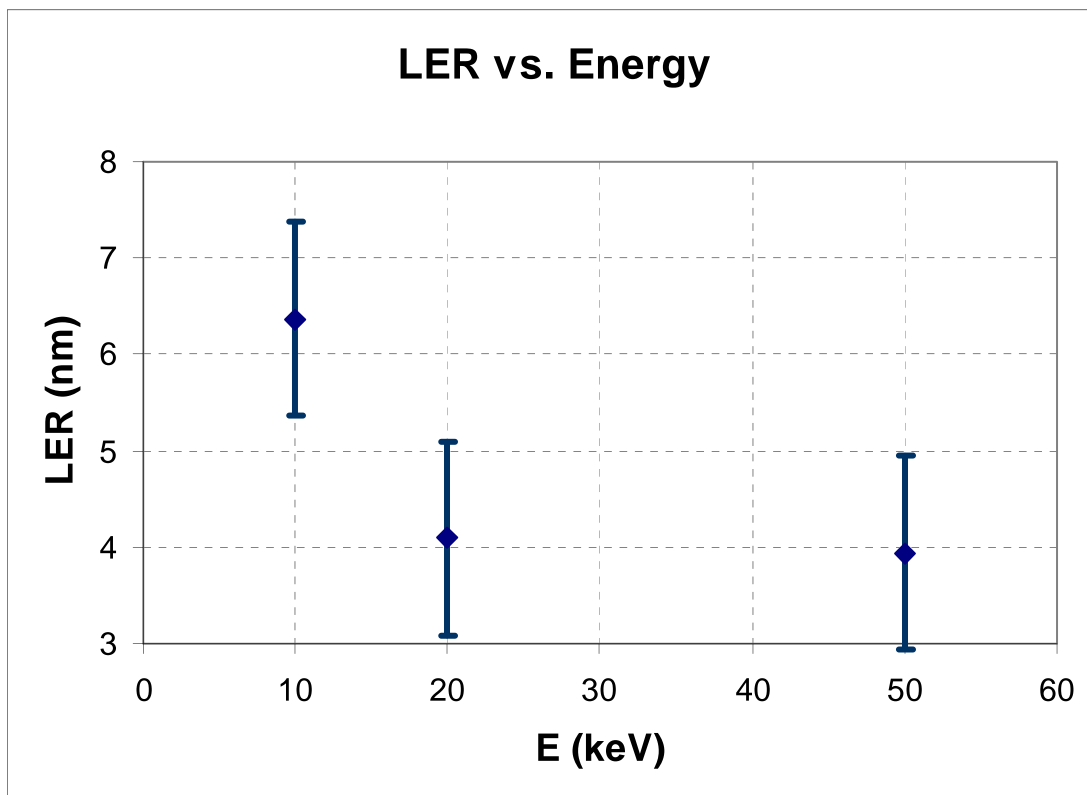

Figure 2: LER evolution with the energy, for a same pattern at the dose-to-size, on HSQ resist.