THROUGHPUT ENHANCEMENT TECHNIQUE FOR MAPPER MASKLESS LITHOGRAPHY

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MAPPER Lithography is developing a maskless lithography technology based on massively-parallel electron-beam writing with high speed optical data transport for switching the electron beams. With 13,000 electron beams which each deliver a current of 13nA, a throughput of 10 wph is realized for 22nm node lithography [1]. By clustering several of these systems together high throughputs can be realized in a small footprint. This enables a highly cost-competitive alternative to double patterning and EUV.

The most mature and reliable electron source currently available that combines a high brightness, a high emission current and very uniform emission is the dispenser cathode. For this electron source a reduced brightness of 10^6 A/m^2SrV has been measured, with no restrictions on emission current [2]. With this brightness however it is possible to realize a beam current of 0.3nA (@ 25nm spotsize), which is almost a factor 50 lower than the 13nA that is required for 10 wph.

Three methods can be distinguished to increase the throughput:

1) Use an electron source with a 50x higher brightness
2) Increase the number of beams and lenses 50x
3) Patterned beams: Image multiple sub-beams with each projection lens

MAPPER has selected option 3) ‘Patterned beams’ as the method to increase the beam current to 13nA. This because an electron source with a 50x higher brightness is simply not available at this time, and increasing the number of beams and lenses 50x leads to undesirable engineering issues.

During the past years MAPPER has been developing the concept of ‘Patterned beams’. By imaging 7x7 sub-beams per projection lens the beam current is increased to the required 13nA level. This technique will also be used to maintain throughput at 10 wph for smaller technology nodes by further increasing the number of sub-beams per projection lens.

In this paper we will first provide an update on the imaging results of current 110-beam systems that have been installed at TSMC and CEA-Leti sites, then we will describe the electron optical design used to image these multiple sub-beams per lens, as well as experimental demonstration of this electron optical configuration. Also the writing strategy will be discussed that will be used, as well as the first patterning results. One of the key components for ‘Patterned beams’ is the beam blanker array, since each sub-beam must be switched on and off individually. The design of the blanker deflectors, the circuitry, as well as experimental results of the blanker will be shown. Finally the roadmap to further technology nodes will be discussed.

[1] M.J. Wieland et al., Proc. of SPIE Vol. 7271, 72710O1, (2009)
[2] A. J. van den Brom et al, J. Vac. Sci. Technol. B 25(6), Nov/Dec 2007, 2245