14x14 Beams in a Scanning Electron Microscope

Ali Mohammadi-Gheidari*, and Pieter Kruit

Delft University of Technology, Lorentzweg 1, 2628 CJ Delft, the Netherlands
*e-mail: A.MohammadiGheidari@tudelft.nl

The progress in microelectronics, micro-fabrication and material science demands an ever-increasing spatial resolution and throughput in charged particle beam lithography and inspection but conventional single beam systems are not able to meet these demands. We have developed the world's first Multi Beam Scanning Electron Microscope (MBSEM) which can deliver an array of beams onto a wafer with the resolution comparable to the resolution of the state of the art SEM. Although this system is mainly developed for high throughput fabrication of sub-10 nm structures by electron beam induced deposition (EBID) where resist based electron beam lithography fails [1], it can also be used for high throughput electron lithography and inspection. This system consists of a state of the art Nova nano 200 SEM (FEI Co.) optics column equipped with the multi electron beam source module.

In this paper, the multi-beam source (MBS) unite is analyzed and the experimental results are presented. The basic concept in the MBS is that the broad beam of a high brightness Schottky source is split up into multiple sub-beams by an aperture array (AA). The AA is a silicon wafer with 100 holes and together with two macro electrodes acts as an aperture lens array (ALA) to focus each beam individually on to the blanker array (BA). Fig. 1 shows a schematic overview of the MBS design. The macro-electrodes with the extractor create a zero strength lens (ZSL) serving two important roles: the potential difference between electrode-2 and the AA creates the ALA and by manipulating the voltage of the electrode-1 the electric field in the ALA is changed in such a way that the total field curvature (F.C) in the image plane is minimized. The compensation of field curvature for outer beams is indeed one of the unique properties of this specific design. The type of MBS described here has been presented by Y. Zhang and P. Kruit [2] for a low extraction voltage Schottky electron source. However, for application of the MBSEM, this unite is adapted to the existing infrastructure of the SEM with a 5KV extraction voltage.

Currently the first experiment has been carried out using the MBS in the Nova nano SEM to create an array of 14x14 electron beams at the wafer and the performance of the MBS has been studied. Fig.2 shows an example of the multi beam images created by MBS in the SEM. This image was created by scanning the array of beams over an aperture and measuring the transmitted current (crossover mode). The more comprehensive results of the simulations and experiment on the MBS performance will be presented.

References

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[2] Yanxia Zhang, Pieter Kruit, Physics Procedia 1,553 (2008).

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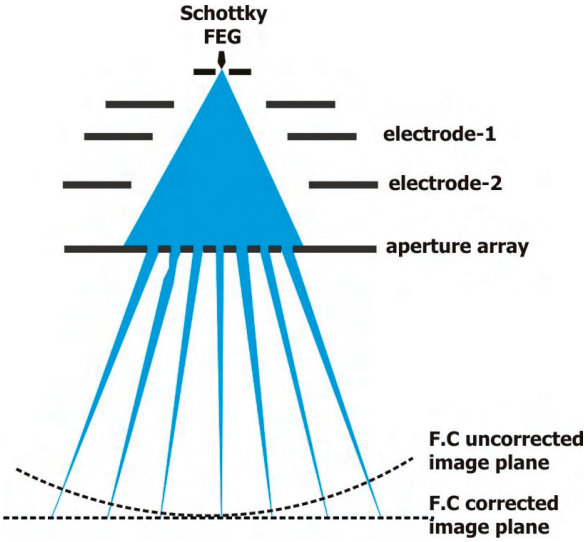

Fig. 1: The schematic of the MBS with AA and ZSL and the concept of compensation of the F.C at the image plane. Note: here the BA is omitted from the image plane.

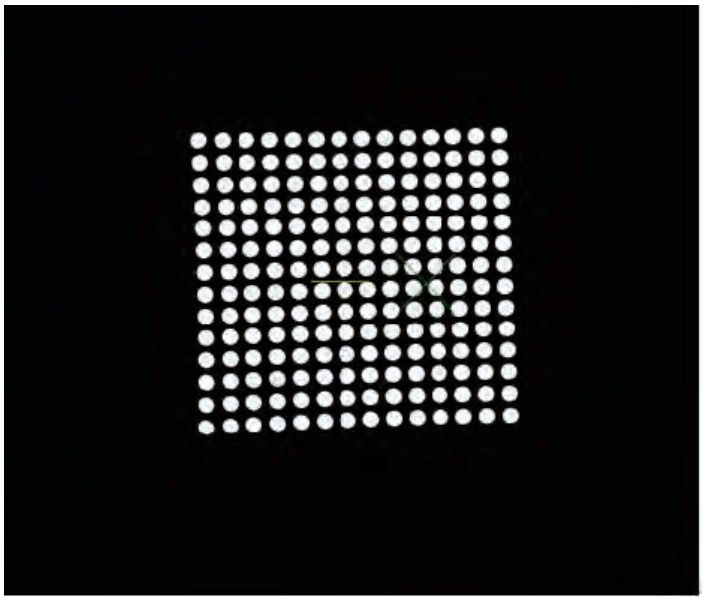

Fig. 2: array of electron beams created by MBS: the image is taken in the crossover mode of the SEM.