Measurements on the electron optical properties of a multi electron beam source in a SEM chamber

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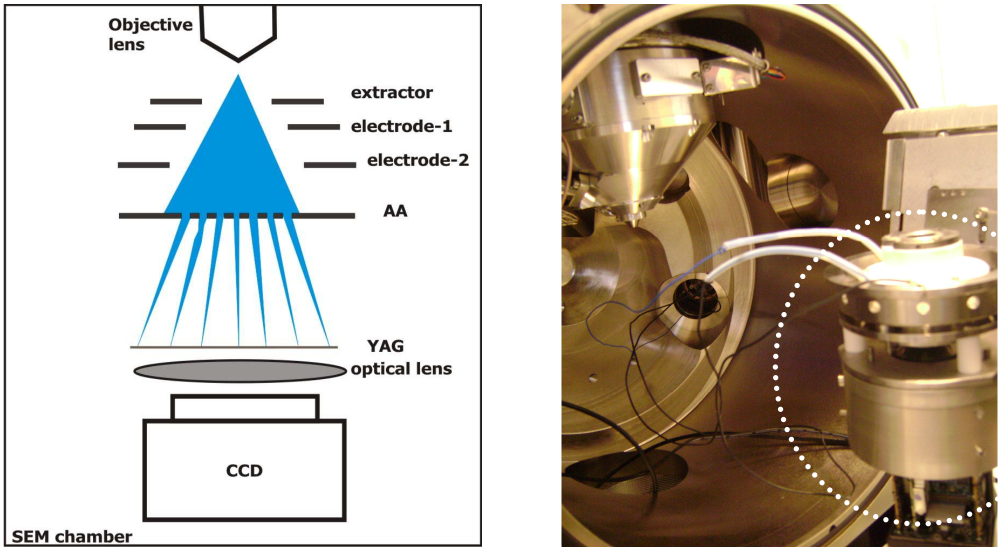
A 100 beam scanning electron microscope is being developed for high speed fabrication of sub-10 nm structures with electron beam induced deposition (EBID). This system will consist of a standard column of the state of the art high resolution Nova Nano-200 SEM (FEI Company.) equipped with a newly designed 100 beams source module. The source module consists of a Schottky source, a 10 by 10 aperture array (AA) for splitting up the beam into 100 beamlets, a 10 by 10 electrostatic micro-blanker array for individual switching on/off and an accelerator lens[1]. Although it has been shown that it is theoretically possible[2] to design such a source module, so far no experimental evidence has proved it. In general, doing this experiment in a separate setup is straightforward but not so easy. The main challenge is to make a proper environment for Schottky source operation such as ultra high vacuum with all throughputs for high voltage. The preparation of these preliminary requirements, especially obtaining ultra high vacuum, is rigorous and time consuming. We used a SEM chamber as an experimental setup, in which the focused beam can serve as an electron source for any kind of electron optical experiment that needs an electron beam.

In this paper, the experimental procedure for testing the 100 beam source module in the SEM and some results achieved so far is presented. A schematic overview of the electron-optical mounting stage is presented in fig.1. The basic components are: the extractor electrode (here the standard Schottky source unit without emitter), two macro-electrodes(1,2), the aperture array, a commercially available YAG screen coated with a very thin layer of Al and a recording system comprising an optical zoom lens and a CCD camera. It should be noted that in order to use a standard CCD camera inside the vacuum (~10^{-5} mbar) some modifications have to be made. In order to make enough space, the stage of the SEM has been tilted (fig.1-b). The alignment can be simply done by using the manipulators of the SEM stage although in different directions depending on the tilt angle. Fig. 2 shows some results of the series of focusing with the multi-beam lens array. It can be seen that it is possible to focus the beamlet without changing the pitch and to some extent it is also possible to change the pitch independent of the beamlet focus. Moreover, the absence of field curvature (the unsharpness of the beamlets in the right corner comes from the optical lens of the recording system) as a result of this particular design. More quantitative results will follow.

[1] M.J.van Bruggen, *PhD thesis*, Delft University of Technology, the Netherlands, 2008.
[2] Y. Zhang, P. Kruit, *Physics Procedia*, 1:553-563, 2008.



a) b)

Fig.1: Schematic of the electron-optical and recording components (a) and the components mounted on the SEM tilted stage (b).

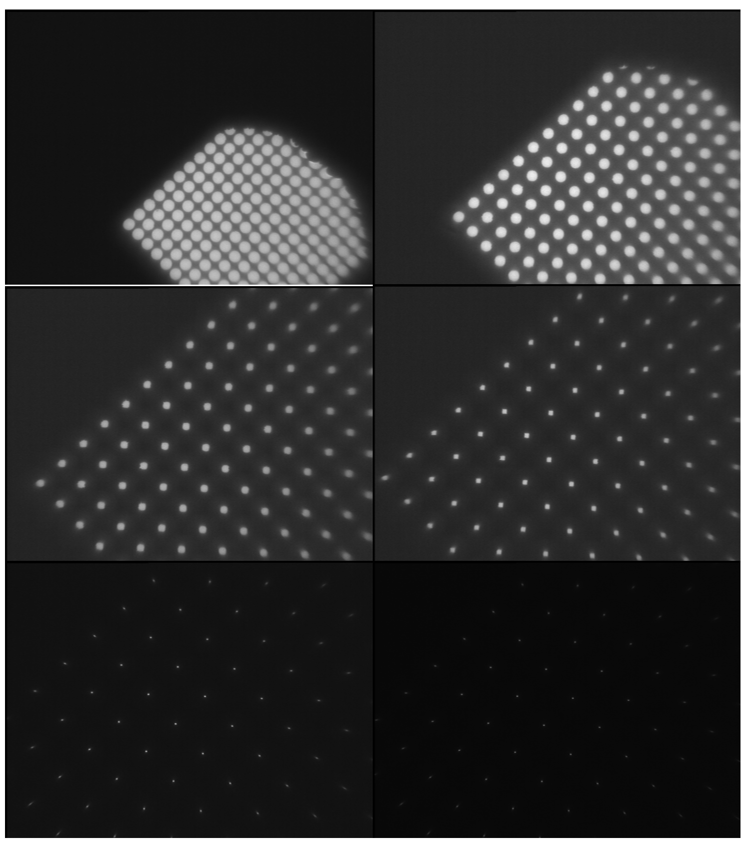


Fig.2: Focus series by changing the voltage of the macro-electrodes (the upper left image is just a shadow image of the aperture array).