Evaluation of Each Electron Beam and Exposure Results with Four Column Cells in Multi Column E-Beam Exposure System

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In the Mask Writing Equipment Technology Research Laboratory of Association of Super-Advanced Electronics Technologies (ASET) Mask Design, Drawing, and Inspection Technology Research Department (Mask D2I), we are developing an e-beam exposure system introducing concepts of multi column cell (MCC) and character projection (CP), which has several times higher throughput than currently commercially available e-beam writing systems. We have already assembled an e-beam system made up of four column cells for the proof-of-concept (POC) of MCC with CP technology as shown in Fig. 1.

Figure 2 shows contours of current density deviations in the beam deflection fields on a CP mask in each column cell. We have developed beam calibration software to find relative strengths of the deflectors Mk-def 1, 2, 3, and 4 in Fig.2. The beam calibration could minimize the current density deviations down to within 0.2 %, which were related to the astigmatism of beams at the R-APT position caused by CP deflections. We can compensate the deviation to less than 0.02% by adjusting the flashing time of each shot during exposure.

The beam position variation in one column cell caused by deflections in other columns was investigated with a modulation method. We applied a saw tooth shaped deflection signal of a basic frequency of 12.5 kHz to the deflector of one column cell, and measured the variations of beam position of neighboring column with a knife-edge method. As shown in Fig. 3, the impact was measured to be less than 0.1 nm. We could conclude that there is no deflection impact from the other column cells in the POC system.

We started exposing various patterns for the debug of the exposure sequence in the MCC system. Figure 4 shows a 200nm LS pattern exposed preliminarily with a column cell in the four-column-cell system. The dotted lines show the borders of major deflection fields, which have the field size of 100x100 um in width. There are a hundred 10x10 um minor deflection areas in each major field.

In the conference, we will show evaluation results of each electron beam and some exposure results with four column cells in the POC system.

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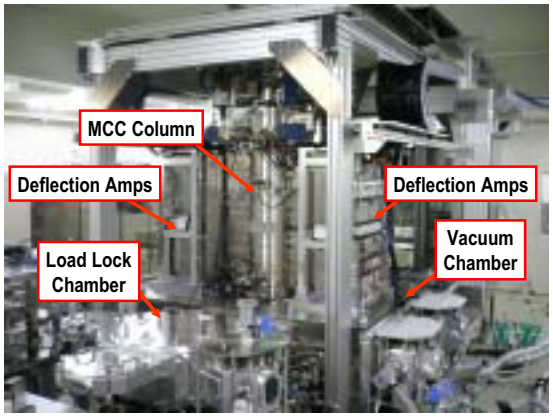

Fig. 1. A MCC-POC system: The multi column with four column cells is located between two deflection amplifier boxes. An exposure sample is on an air-bearing and air-drive stage in the vacuum chamber.

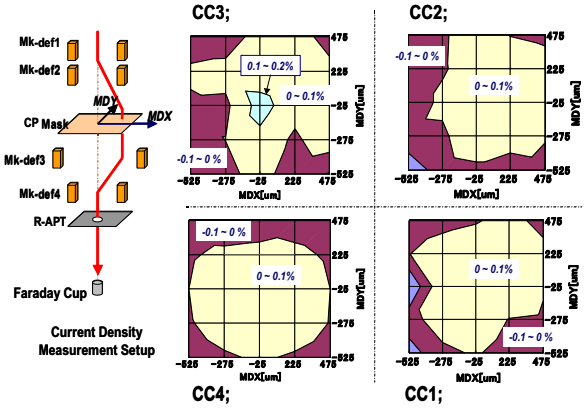

Fig. 2. Contours of deviations in current densities from the average value in a CP deflection field: The beam calibration could minimize the deviations to within 0.2% in the deflection field to select CP.

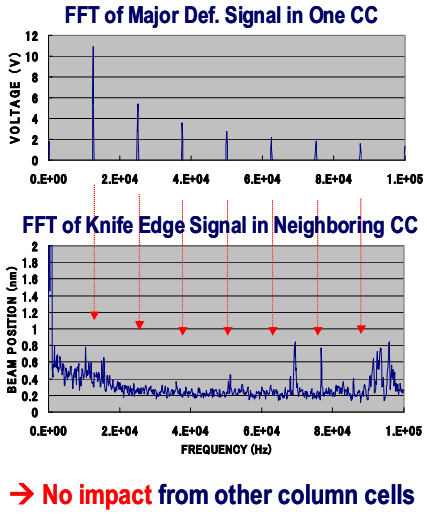

Fig. 3 Impacts on beam positions in neighboring column cell caused by major deflections in one column cell: There is no corresponding peak after background was removed.

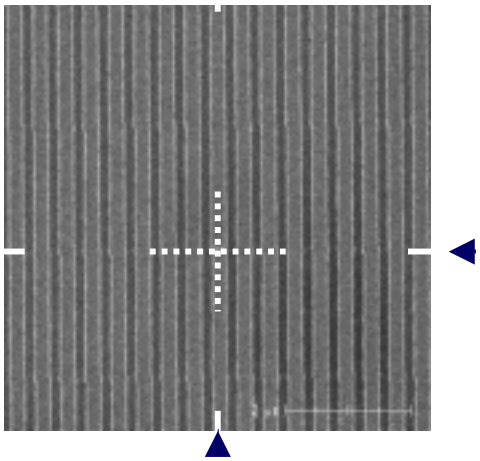

Fig. 4 A 200nm LS pattern exposed preliminarily with a column cell in the four-column-cell system.