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October 13, 1992

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Dear Marty:

This is the 17th bimonthly report detailing work done on contract N00014-89-C-2238 during August and September 1992.

OVERVIEW

The program is due to be concluded in December 1992. The plan is to deliver the 0.25 um system in place and to demonstrate repair of both clear and opaque defects at that time.

75% of the subsystems designed for the 0.25 um Tool have been completed, tested and integrated. Four hardware systems are incomplete as of October 1992. These are gold deposition hardware, the differential laser interferometer, thermal isolation environment and the pattern generator electronics.

The design of these subsystems has resulted from the interaction between IBM and Micrion under the March 16, 1992 Alliance and the DALP-Manassas contract under P.O. #286323. It is the intent to make both the government 0.25 um system and the IBM system the same, transferrring the technology gained from the IBM interaction to the government 0.25 um tool.

Two software packages also need to be completed - these are support of the pattern generator and the ability to receive KLA 'Results', the second generation defect data transfer common to both UVIS and SEMSpec.

Task 3.1.1 0.5 um Tool

The 0.5 um tool is being maintained as GFE at Micrion and is available to outside users. Individuals from Hampshire Instruments, Motorola, IBM-Manassas, Burlington, and Yorktown Heights have repaired masks on the system, and ATT has expressed a desire to do so also.

The 0.5 um tool has been used for defect repair process development, development of gold deposition hardware, and both drift and imaging experiments.

Micrion has repaired the 'Perfect Mask' and one DRFM mask, as per our informal agreement, using SEMSpec data.

Task 3.1.2 0.25 um Tool

Repair Process Development

The goal is to repair clear and opaque defects by depositing gold to replace missing absorber and to sputter away excess absorber.

We have investigated deposition of high yield symmetric gold films. We have designed a set of hardware to provide for films of this quality, and to maintain sufficient imaging capability. We evaluated internal vs external reservoir designs, tube diameters, gas delivery apertures, the geometry of the delivery orifice, the heights of the mechanism from the surface, and temperature variations.

The prototype hardware installed on the 0.5 um system has an unheated, internal reservoir, held 8 ± mils above the mask surface. The images of X-ray masks are satisfactory. The overall pressure rise in the chamber is from 1-3 e-07 torr to 3e-06 torr, with a time constant of 1-2 s. Proof of Concept hardware will be installed on the 0.25 um system in October.

The initial results of gold deposition on the 0.5 um system are encouraging, even without the advanced analog electronics, which are designed to deflect the beam across the surface at 10 MHz. We have achieved deposition yields of greater than 30, compared to 1 for tungsten (yield is the number of atoms deposited per incident ion). A higher deposition yield has been shown to significantly reduce or eliminate redeposition. The depositions themselves are symmetric.

We still need to determine the X-ray opacity of the films.

To repair opaque defects we need to remove gold absorber without causing additional defects. We have simulated repair strategies intended to minimize both internal and external redeposition on the 0.5 um system. Preliminary data suggests that a guard wall (removing the defect in two steps, leaving a thin wall to shield nearby features) is effective at reducing redeposition. We intend to investigate framing on the 0.25 um system: the plan is to mill the center of the defect first, followed by a second mill around the perimeter. This framing capability will exist in the pattern generator and will be supported by software.

Perfect Mask/DRFM

The inspection-repair loop was exercised using substrates provided by IBM-the 'Perfect Mask' and a 'DRFM'. The masks were inspected by the KLA SEMSpec and the inspection data was then transferred to the 0.5 um tool, along with hard copies of the SEMSpec images and the coordinates.

30-50 defects were repaired on each substrate and the mask was returned to IBM for printing.

Advanced Electronics

Two critical subsystems have been designed for the 0.25 um tool. The analog deflection provides for deflecting the beam at a maximum rate of 10 MHz across the suface to allow for minimum gas depletion during repair of clear defects. The raster generator will allow for novel scanning strategies such as serpentines.

The analog deflection is complete, and tested. The noise is 10% greater than desired, from a system view, and some effort will be devoted to noise reduction in the circuit.

The raster generator schedule slipped by about 3 months, due to a learning curve associated with FPGA (field programmable gate array), and the overall complexity of the board. The design is complete, and the layout should be completed by mid-October. A tight schedule shows testing of a complete board done by early December.

As this is tight, our backup plan is to run the analog deflection with the existing 'multiscan' electronics. We will have the capability of rastering boxes 2-3x faster than on the 0.5 um tool, but 3x slower than intended on the 0.25 um tool.

Much of the process development and implementation of repair strategies will occur after the raster generator is tested. This will occur during the Micrion IBM-DALP work, January through April.

System Stability and Configuration

We have determined that thermal management is a critical aspect of machine design. Much of the heat load has been removed from the system chamber and column. We still need to provide a thermal enclosure capable of temperature control of $\pm$ 1°C. Our choices are passive or active management.

As we have seen that simple removal of heat has improved the stability, we plan to test the passive approach. Not only do we believe it will the best approach, but it is also 5x less expensive and something that can be implemented by November.

If this does not work, we may have to consider active thermal management.

However, we are also configuring a differential laser interferometer to eliminate apparent stage drift due to residual thermal variations. The existing stage design is adequate, and all observed drift characteristics were consistent with thermal effects.

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Task 3.1.3 Second Generation Defect Data Transfer

KLA has confirmed that 'Results' File Format will be the output common to both UVIS and SEMSpec. Mcirion has received the final specification and will complete and demonstrate the interface by December 1992. The file format will support image transfer.

In the meantime, Micrion is supporting an interim text file format to transmit defect locations from SEMSpec. It is being used by KLA and Micrion until the Results File Format has a final specification and implementation.

The Micrion 0.5 um tool has used this format to drive to defects with the defects appearing in the center of a 20 um field of view. We support users who bring in defect data to repair their masks.

Conclusion

Micrion is on schedule to deliver a 0.25 um repair tool in December 1992. At this review, we plan to demonstrate existing machine capabilities - however, additional process development will continue to occur funded by the DALP-IBM contract. Like the 0.5 um machine, the 0.25 um tool will become available to members of the X-ray community.

The 0.5 um tool has been used by Motorola, Hampshire Instruments and IBM-Burlington, Yorktown Heights and Manassas.

0.25 um Masks

Micrion needs masks with 0.25 um features to demonstrate repair using the 0.25 um tool. Motorola has informally offered to provide a Motorola style mask with 0.25 um features. Micrion has also requested such a mask from NRL, who has been providing us with IBM masks.

Sincerely,

Diane K. Stewart

DKS/mam