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Micrion

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June 11, 1990

Mr. Robert Reams
U.S.Dept. of Army
Harry Diamond Laboratory
2800 Powder Mill Road
Adelphi, MD 20783-1197

Dear Mr. Reams:

This is the fourth technical report on Contract N00014-89-C-2238, reporting on work done in April and May 1990. The majority of the work was on advanced column development, clear and opaque repair processes, imaging, and development of a new electron flood gun for charge neutralization.

2.31 Advanced Column Development

We worked on three aspects of column develoment - 1) detailing optics design, 2) assembling the ion column test stand and 3) planning mechanical concepts and having the parts fabricated for testing. We have finalized details for the proof of concept column. It will be a two-lens column, capable of both pre- and post-lens deflection. We will operate it at an accelerating voltage of 30 kV, the second lens at -38 kV and use it at a working distance of 40 mm. The calculated optimum performance from this column is 25 pA of beam current in a 24 nm spot, providing for 5.5 A/sqcm current density. We have calculated distortions in the beam for different fields of views; at a 1000 micron field of view the distortion is acceptable.

The majority of the components of the ion column test stand are assembled as shown in the block diagram in Figure 1. We are waiting for some electronics, and Ray Hill is writing code to run the system.

The test stand will be ready to operate a column in August, which is when we plan to put the proof of concept column on the stand. We will be able to do basic field strength experiments on separate lens elements prior to August, however.

Parts for a column design were designed, detailed and sent out for fabrication. A prototype was received in-house so we can analyze potential problems. The design uses a castlated, stacked disk approach that Billy Ward discussed with Lloyd Harriott. A further mechanical design review will take place this month, and then we will begin preliminary high-voltage testing.

XR3-4 Repair Processes

Jacob Fuchs had to repeat a large series of mills (opaque repairs) and depositions (clear repairs) because a service analytical lab spoiled a sample mask when we took it for evaluation. We spent several days evaluating SEM's and taking SEM micrographs of these mills and depositions.

For opaque repairs, a dose of 1-1.5 nC/sqmicron is sufficient to clear the gold absorber. In some cases a lower or even slightly higher dose may be necessary but apparently that is related to mask processing issues. We will fine tune this required dose as the program continues.

We have not been able to test the opacity of our tungsten depositions to synchrotron X-ray exposures yet. We are able to deposit tungsten greater than 5000 Angstroms thick for all beam sizes and feature sizes using a dose of 5-6 nC/sqmicron. We will continue to use this dose until we get further data. Hampshire and Dupont are working with us to get additional exposure results using their X-ray sources as well as that at U. of Wisconsin.

Preliminary Auger analysis and EDX analysis of the proximity distortions of the gold absorber due to the tungsten deposition shows that the distortion is probably redeposited tungsten. We plan to continue the analysis as well as working to reduce this effect.

XR5 System Stability

We are beginning to develop a working relation with the company called Vibration Engineering. They have been to Micrion to conduct tests on various components of the government machine. For example, their analysis of the mounting plate, ballast bins and supporting legs suggested stiffening these components to improve stability. Also, the analysis of the ion pump on the column showed that we should provide a more uniform and consistent method of mounting.

XR6 Charge Neutralization

Dave Edwards developed a new electron flood gun to be used with a 'funnel' (electrostatic shield). The gun will provide for 40 nA in a 4 mm spot at the sample with 20 uA emission current at 100 eV. The new design provides for longer lifetimes of both the electron gun and the funnel while minimizing sensitivity of the e- beam to various charging processes near it's path. It is being tested on the government machine this month, and we will develop hardware and software controls during the next several months.

XR7 Imaging

Different X-ray masks,(Hampshire, Dupont and IBM) image differently: the contrast data from the gold and membrane differs among the mask types as well as differing among IBM masks.

We have investigated different grounding techniques to minimize differences, and have found that silver paint, back springs, and a top clip individually ground the maks and improve the contrast and reduce noise. However, we are still working on new imaging techniques to reduce the effects due to ion channeling in the multi-crystalline gold absorber.

KLA - Defect Data Transfer

Mary Ellen Kenney visited KLA in May to begin discussions regarding defect data transfer to Micrion from KLA's UVIS system. We recognize at least four problems - reference mark accuracy, potential KLA inaccuracies due to their method of printing and then inspecting, mirroring, and other false defects such as voids.

We are beginning to define specs that we need - for example, Micrion needs defects transferred in a 1 x 1 micron field of view, not a 5 x 5 micron as KLA proposes (we can not find a 0.25 micron defect in a 5 x 5 micron field of view). We are also working on other imaging issues with KLA. We will attend their review in July.

Sincerely,

Diane K. Stewart

Diane K. Stewart
X-ray Program Manager

Figure 1 - Ion Column Test Stand