NRL Report - April, May and June 1995

Low Voltage Electron Beam Lithography
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Electron Specimen Interaction In Low Voltage Electron Beam Lithography

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April 1995

In order to understand resist charging effect and the interaction between low energy electrons and specimen, we set up experiments to measure secondary electron emission coefficient for the resist film. The samples are 0.4μm thick SAL601 on Chromium on quartz. Preliminary experimental results show that the SE emission coef. decreases from 0.95 to 0.17 as the electron energy increases from 1KeV to 7KeV. Further increase in electron energy doesn't decrease the SE emission coef. This corresponds to the point where resist surface potential changes from negative to a small positive constant value in our earlier resist charging result. Between 1KeV and 0.5KeV, we observed negative sample current about half of the primary beam current. This is because multiple scattered electrons were collected by the specimen.

May 1995

The SE measurement was improved by adding an electrode above the resist film surface. The electrode was biased to 70V to collect most of the secondary electrons. When the primary electron energy is larger than 1KeV, the SE emission coef. is about the same as that in the preliminary result (see Fig.1). Below 1KeV, a small positive specimen current was observed, indicating a positive surface potential SE emission coef. larger than one. From this we conclude that the second cross over point in the SE curve (E_2) for SAL601 is about 1KeV.

June 1995

We also measured the beam induced conductivity (BIC) in the resist film. In this experiment, a layer of 20nm Au/Pb was sputtered on top of our original sample, which is composed of 0.4μm SAL601 on Chromium on quartz. We applied 20V across the resist film. The electron energy was varied from 20KeV to 0.5KeV. Beam induced current was a small fraction of the primary current at 20KeV. The fraction increases as the electron energy is lowered. However, we didn't observe the multiplication of primary current when the primary low energy electrons dissipate all their energies in the resist. More experiments will be carried out to check the result. We'll also use the SE and BIC data to simulate the interaction between electron and specimen in low voltage ebeam lithography.

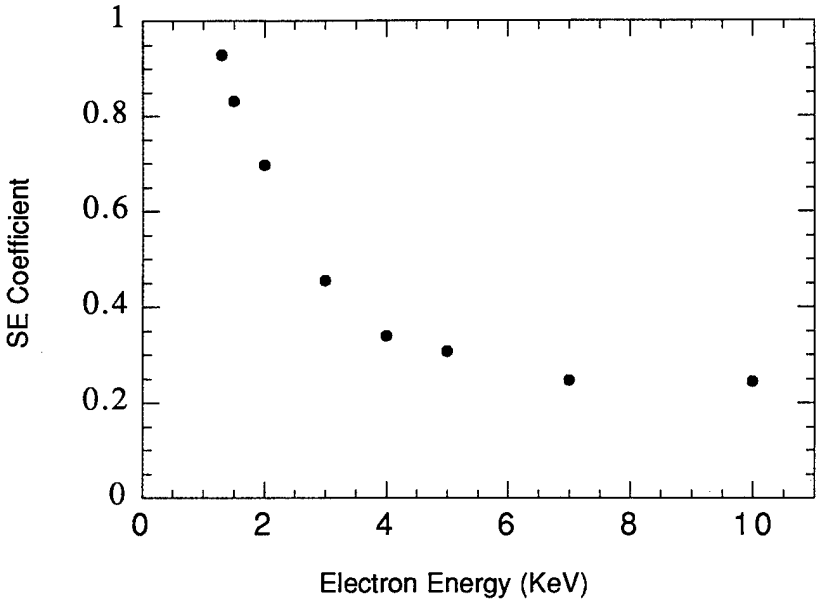

Fig. 1. Secondary electron emission coefficient
for SAL601 on Chromium on quartz
Resist Thickness = 0.4μm
SE extration Voltage = 70V

Aaron Baum

April 1995

Finished construction of new tube for investigation of brightness limits. Measured high-resolution energy spectra of GaAs NEA photocathode at several temperatures as the balance of cesium and oxygen in the activating layer changed from an overcesiated condition to an optimized condition. FWHM energy spread of 50 meV obtained. The movement of the vacuum level with changing surface conditions was observed, and the change in the energy spectrum with temperture was analyzed. Design of demountable electron gun and characterization station begun. 3D cathode model continued.

May 1995

New tubes completed. First results from cathode simulation obtained. Measurements on thinner photacathode show effects of "hot" electrons. Design of demountable electron gun and characterization station continued.

June 1995

Angular distributions measured in new tube with new, improved technique using phosphor, CCD camera, frame grabber, and digital analysis. Energy spectra measured in the same tube. Massive arc in tube destroys cathode before current density measurements can be made. Second tube of same design is prepared. 2 papers prepared for SPIE conference.