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Investigation of low energy e-beam from STM aligned field emission(SAFE) microcolumn system

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A Scanning Tunneling Microscope(STM) aligned field emission microcolumn system has been constructed. This system consists of an STM, a microcolumn, a field emission source, and a three-dimensional micropositioner. Main concept of SAFE microcolumn system is as following ; Using the micropositioning technique and the feedback of STM, we were able to align the tip, the field emission source, to a hole of the microlens. As the tip approaches the hole within a distance of ~1 μm, the e-beam can be turned on with the source voltage of less than 1kV. This improves aberration of the system substantially and brightness and resolution more enhanced comparing to conventional e-beam system. We were able to reduce the proximity effect using low voltages(<1 kV) compared with the conventional e-beam system(30-50 kV). The microcolumn consists of these 4 components : a microsource, a beam dump, a quadrupole and an Einzel lens. These were fabricated using the silicon micro-fabrication techniques. The overall size of microcolumn is < 6 mm.

We have measured the performance of SAFE microcolumn system in a UHV chamber. Tip preparation, heating procedure and xyz approaching method having resolution 0.1 μm have been achieved. We have obtained the image and emission current of the ballistic electron from the tip. We were able to observe behavior of the e-beam emission pattern while aligning the tip to the hole of the lens and focusing the e-beam. The emitted current follows Fowler-Nordheim dependence, showing the characteristics of the field emitter source. SAFE microcolumn system opens new possibilities of application to nanofabrication and low energy electron holography and low energy electron projection microscopy.