Novel Microcolumn Using a Multi-gated Field Emitter

Hidenori MIMURA[1], Yoichiro NEO[1], Toru AOKI[1], Tomoya YOSHIDA[2], and Masayoshi NAGAO[2]
[1]*Research Institute of Electronics, Shizuoka University,* [2]*AIST, Japan*
mimura@rie.shizuoka.ac.jp

Recently, our group has developed four- and five-gated field emitter arrays (FEAs) with an electrostatic lens (einzel lens).[1, 2)] The five-gated FEA has successfully realized a crossover of the electron beam without any external optical system. However, these multi-gated FEAs has large aberrations due to the highly negatively biased einzel lens with a small aperture and a large electron emission angle at the incident plane of the lens electrode. In addition to it, the speed of electrons accelerated by the voltage of the extractor is much higher than that expected for a micro scale electrostatic lens.

In this presentation, we have designed and fabricated a novel microcolumn with multi-gated FEAs, as shown in Fig. 1. The microcolumn consists of an objective lens and an electron gun. An acceleration lens was used as the objective lens. The electron gun was designed to produce a parallel electron beam. The electron gun has three gates and a field emitter tip. The key components are the second (focusing) and third (waist) electrodes. The focusing electrode can focus and align the electron beam like a condenser lens without reducing the electric field at the top of the emitter tip. The waist electrode with a small aperture can electrically isolate the condenser from the acceleration lens just above the electron gun. By applying a lower voltage to the waist electrode than to the first electrode, which acts as an electron extractor from the tip, the electron beam can be decelerated before being injected into the objective lens. The slow electron beam enables us to use an acceleration lens as an objective lens.

We measured current-voltage characteristics of each electrode for the microclumn. The current variation of each electrode indicates that each structure controls the electron beam and the objective lens focuses the electron beam of about 40 mm at working distance 2 mm and a magnification of 400 times without applying an electric field from the microcolumn to the anode.

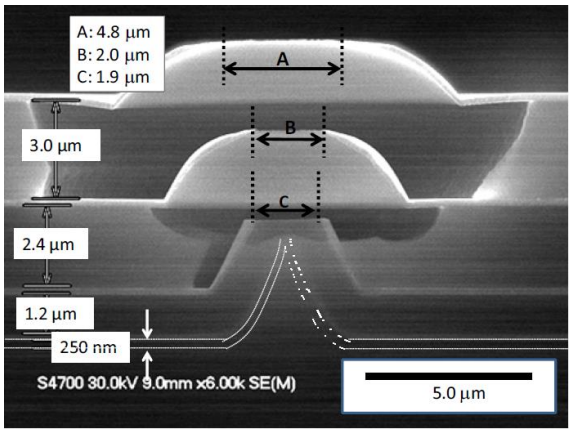

Fig. 1 Cross sectional SEM image of the microcolumn

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