Advanced Microcolumn with a Quadrupole Electrostatic Lens

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A new design of a microcolumn is proposed in order to achieve a low-aberration and low-distortion electron beam while maintaining the wide deflection field. A microcolumn consists of an electron emitter, a source lens for extracting, accelerating, and controlling electron beam, an Einzel lens for focusing the electron beam, and pre-lens double deflector for deflecting the electron beam onto a target point.[1] Generally the prelens deflector is located between the source lens and Einzel lens. However, a new designed Einzel lens is composed of four electrodes. The central electrode of the conventional Einzel lens is replaced by two electrodes with key-hole type of apertures.[2] A deflector is located after Einzel lens.

Figure 1 (a) and (b) show conventional and advanced microcolumn structures. The two electrodes with key-hole type of apertures of a quadrupole lens (QL) are showing in Fig. 1 (c). The QL can be constructed by using two opposing plates with elongated rectangular apertures in 90^{o} degree staggered position and different potentials are applied to each electrode. A key-hole shaped aperture is made by overlapping a rectangular aperture (140 μm×250 μm) on a circular aperture of 200 μm diameter.

The adjustments of focusing voltage and deflection scan view in the QL are showing in Figure 2. The same voltage is applied to two outer electrodes and the focusing voltage to the two inner electrodes. The spacing between electrodes is 250 μm. The quadrupole lens provided an adjusting function of the astigmatism when the different voltage was applied to the two inner electrodes as showing in Fig. 2(a). The deflection field of QL is larger than that of a conventional column at a same deflection voltage as given in Fig. 2(b)

The experimental results of the construction and operation of advanced microcolumn for large sample application will be discussed in more detail.

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[1] E. Kratschmer *et al.*, J. Vac. Sci. Technol. B **12**(6) 3503 (1994).
[2] T. S. Oh, *et al.*, J. Vac. Sci. Technol. A **26**, 1443 (2008)

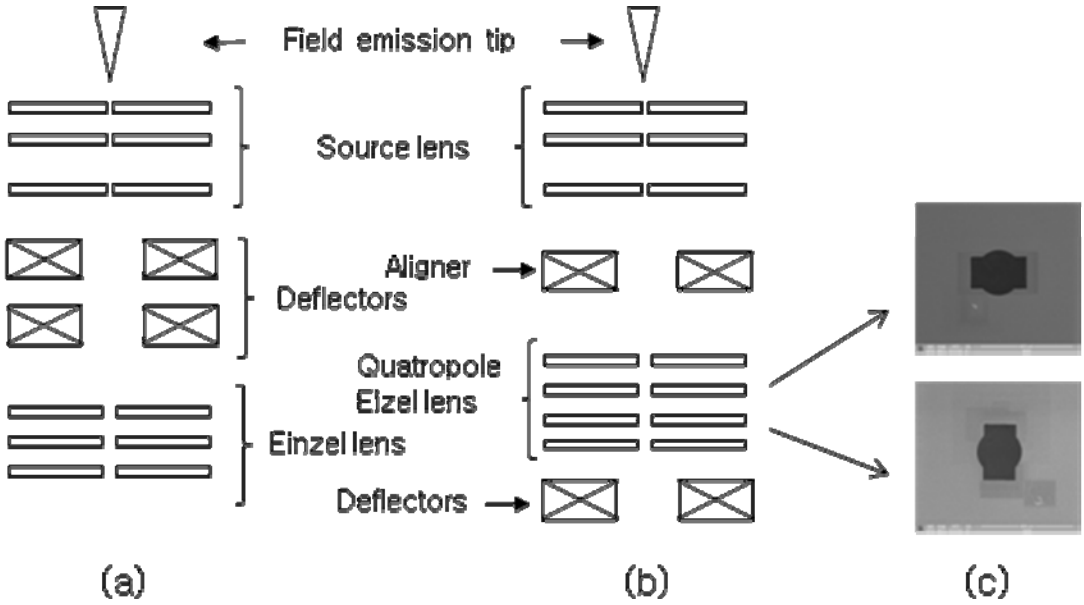

Figure 1: (a) Microcolumn structures with a conventional double deflector and Enzel lens components. (b) Advanced microcolumn structures with a deflector and a quadrupole lens unit. (c) Key-hole shaped apertures for a quadrupole lens.

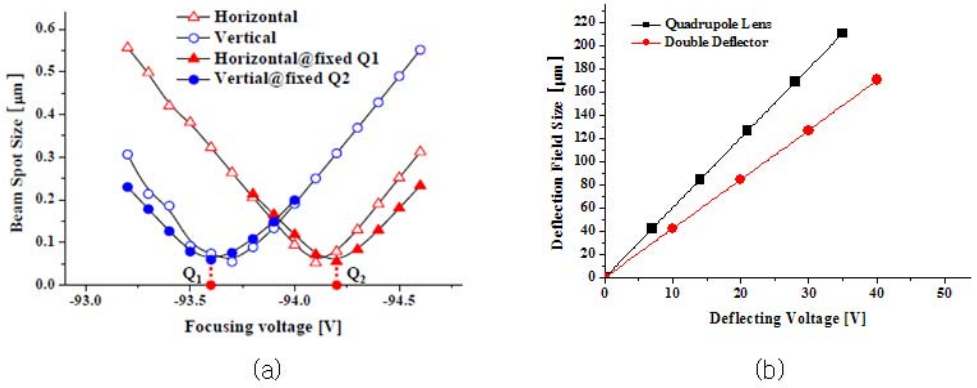

Figure 2: Simulation results of advanced microcolumn. (a) beam spot size versus focusing voltage. (b) Deflection field size versus deflecting voltage.