Multiple Electron-Beam Generation from InGaN Photocathode

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Semiconductor photocathodes are one of the candidates for multiple electron-beam sources owing to their characteristics such as controllability of spatial distribution of electrons with laser, the small energy spread of less than 0.1 eV[(1)], and large current of more than 1 mA[(2)]. In this contribution, the generation of multiple electron-beam from an InGaN photocathode was demonstrated.

A p-type InGaN grown on a double-side polished sapphire substrate was used for the photocathode. The surface of p-InGaN was cleaned by heating in the vacuum chamber with a base pressure of 5×10^{-9} Pa. Cs and O_2 were alternately supplied on the surface for activation of the photocathode[(3)]. The quantum efficiency immediately after the activation process was 14%. The electron gun test system was composed of a cathode electrode, an anode electrode, an electrostatic lens, and a fluorescent screen. The voltages applied to the cathode electrode and the electrostatic lens were -15 and -8.6 kV, respectively. A Gaussian-distributed laser with a wavelength of 405 nm was diffracted by liquid crystal on silicon, divided into 25 laser beams, and irradiated on the InGaN photocathode from its backside. Each laser beam had Gaussian distribution with a diameter of 30 μm and an interval of 310 μm (Figure 1(a)). The generated multiple electron-beam was observed by the fluorescent screen. Deviations in the diameter of each electron beam was evaluated.

25 electron beams were observed by irradiating 25 lasers as shown in Figure 1(b). The averaged diameter was 0.6 mm with a gaussian distribution. The deviation in diameter was 17%. The diameter increased with the distance from the center of the electric field. The results will be discussed focusing on the energy spread of the electron beam and the beam dynamics of the electron gun.

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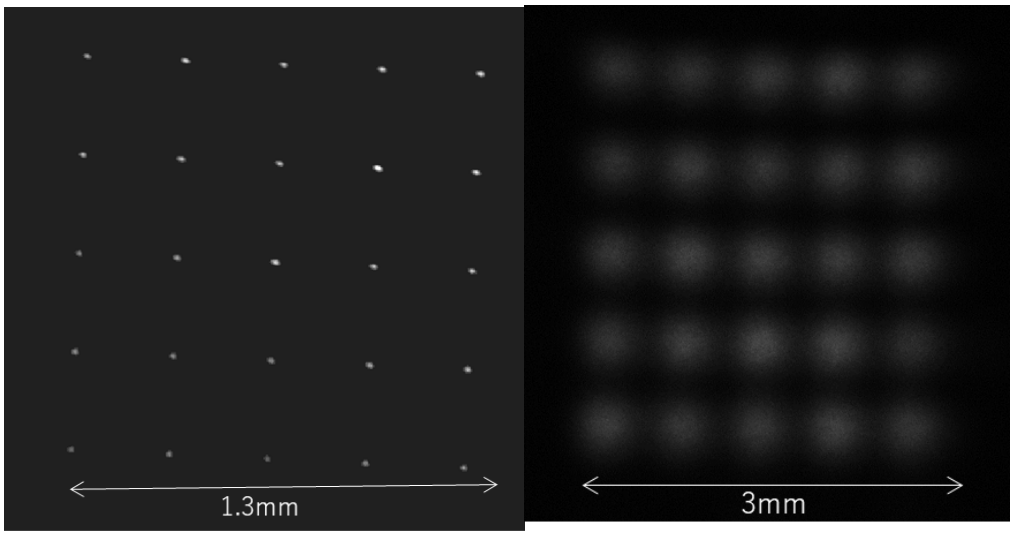

(a) (b)

Figure 1(a)The Profile of multiple laser-beam: The wavelength is 405 nm. The diameter and interval of each laser are 30 and 310 μm, respectively. *(b)The Profile of the multiple electron-beam projected on the fluorescent screen:* The diameter is 0.6 mm in average.