Development of high spatial resolution ion imaging system with focused electron beam

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We have developed a high spatial resolution ion imaging system using a focused electron beam. The local ion concentration distribution that occurs near the ion channel can be imaged. Cells maintain their activities through the exchange of various ions. Therefore, the ability to measure local ion concentration distribution with high spatial resolution is important for elucidating biological functions. In this system, we use a semiconductor ion sensor substrate and a focused electron beam for ion imaging. Since the electron beam can be focused to a spot of nm size, the spatial resolution is greatly improved. The principle of ion concentration measurement of this system is the same as a that of a light addressable potentiometric sensor [1]. When a part of the semiconductor surface is irradiated with an electron beam, electron-hole pairs are generated, and an electron induced current corresponding to the ion concentration flows.

In this study, an ion sensor (p-Si(210 nm)/SiO_2(50 nm)/SiN(75 nm)) with a membrane window structure was fabricated to reduce electron beam scattering inside the ion sensor. Increasing the spot size of the electron beam due to electron scattering reduces the spatial resolution.

Figure 1(a) shows an electron-induced current image acquired for spatial resolution evaluation using the knife-edge method. The knife edge was fabricated by photolithography and half of the sensor surface is covered with photoresist. We used pH 9 standard solution as a solution, and -1.5 V of bias voltage was applied. From the image, it was found that the intensity differs between the part with and without the photoresist. Figure 1(b) shows a line-profile curve along the solid-line rectangle indicated in (a). From the line-profile curve, the spatial resolution (20–80% rise) is 0.62 μm.

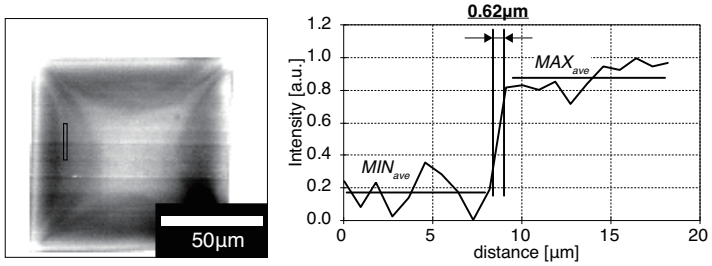

Figure 1 (a) Electron induced current image (b) Line-profile curve

REFERENCES:

[1] D.G. Hafeman, *et al*., *Science*, **240**, 1182-1185 (1988)