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Development of SEM-EDS analyzer utilizing 100-pixel superconducting-tunnel-junction array X-ray detector toward nanometer-scale elemental mapping

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An energy-dispersive X-ray spectroscopy (EDS) analyser combined with a scanning electron microscope (SEM) is suitable to obtain spatial and quantitative information on the elemental composition of a sample non-destructively. In particular, low-acceleration-voltage SEMs (LVSEMs) theoretically allow evaluating those informations of a sample with a nanometer lateral resolution [1]. However, it isn't suitable to use conventional EDS analysers such as silicon drift detectors (SDDs) for obtaining X-ray spectra from samples in LVSEMs, because emitted X-ray from samples in LVSEMs are only soft X-ray and the energy-resolving power of conventional energy-dispersive X-ray detectors is insufficient to clearly resolve such soft X-rays. On the other hand, wavelength-dispersive X-ray spectrometer (WDS) can be resolved the soft X-rays because its energy resolution is less than 10 eV. However throughput of the WDSs is very low.
In contrast, energy-dispersive X-ray detectors based on superconducting-tunnel-junctions (STJs) have simultaneously exhibited excellent energy resolution of <10 eV, relatively large detection area of >1 mm^2, and high counting rate capability of >200 kcps for soft X-rays less than 1 keV [2]. We have developed the SEM utilizing STJ array as an EDS analyzer [3], which is abbreviate as SC-SEM hereafter, in order to realize nanometer-scale elemental mapping.
Fig. shows a picture of the SC-SEM. The SC-SEM consisted of a field emission SEM and a 100-pixel STJ array X-ray detector. X-rays emitted from the sample by the electron beam were detected by the STJ array via the polycapillary X-ray lens and two X-ray windows. The enegry resolution for N-Kα of the STJ (12 eV) was about 5 times higher than that of the SDD (60 eV). The throughput for N-Kα of the STJ was about 50 times smaller than that of the SDD. In the future, by improving the X-ray optics, the throughput is expected to be increased about 10 times. The SC-SEM can perform nanometer-scale elemental mapping because the SC-SEM realizes both the high throughputs of SDDs and the excellent energy resolution of WDSs.

Reference
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Fig. Picture of the SC-SEM

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