High speed and/or high spatial resolution X-ray mapping at low landing voltage using FE-SEM with in-lens gun

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For recent scanning electron microscopes (SEMs), improvement of analytical capability as well as imaging capability is required. For various analyses such as energy dispersive X-ray spectrometry (EDS), electron backscatter diffraction (EBSD), wavelength dispersive X-ray spectrometry (WDS), and newly developed soft X-ray emission spectrometry (SXES) [1], high probe current is required, which usually degrades probe diameter. To achieve high-spatial resolution analysis at high probe current, reducing aberration of condenser lens is also important, while only aberration of objective lens is dominant at low probe current. Here, we studied high spatial resolution X-ray mapping using newly developed JSM-7200F, which has an electron source in magnetic field of condenser lens (in-lens gun) [2]. Aberration of a condenser lens is significantly improved by placing a source in magnetic field of the condenser lens [3].

Fig. 1 shows a backscattered electron (BSE) image and EDS mappings for Sn-Ag solder at landing voltage of 7 kV and probe current of 7 nA. Even at high probe current of 7 nA, high spatial resolution is achieved in short mapping time of 5 minutes.

Fig. 2 shows a BSE image and EDS mappings for the alloy at landing voltage of 3 kV and probe current of 7.8 nA. Here, in addition to reduction in aberration of condenser lens, aberration of objective lens is also decreased by applying -2 kV substrate voltage, since landing voltage is low. Not only clear identification of leaf structure (Fig. 2(d)), but also segregations of aluminum (Fig. 2(b)) and zirconium (Fig. 2(e)) are observed.

As described, high spatial resolution analyses are realized using in-lens gun together with Schottky emitter. Furthermore, the through-the-lens (TTL) detectors with energy selection system, which are installed in JSM-7200F as standards, allows simultaneous capturing of secondary electron (SE) and BSE images even at low landing voltage (for example, Fig. 3). This makes selection of analytical points easy as well as improvement of imaging capability.

References
Fig. 1. a) BSE image and b), c) EDS mappings at high beam current of 7.2 nA at 7 kV for the short time of 5 min. Specimen: Sn-Ag solder.

Fig. 2. a) BSE image and b-d) EDS mappings at landing energy of 3 kV with a 100mm² EDS detector. Specimen: alloy. -2 kV substrate bias was applied. Mapping time was 30 minutes.

Fig. 3 Simultaneous capturing of a) SE and b) BSE images using energy selective system in TTL. Topological and material information can be obtained, respectively. Landing voltage: 1 kV, Specimen: W wire.