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Application News

No. P109

Electron Probe Microanalyzer

Analysis of Micro Ag Particles of Lead-Free Solder

In the electronics industry of recent years, solder joining technology has become increasingly important due to the miniaturization of electronic components and popularization of lead-free (Pb-free) solder. This article introduces the high resolution X-ray images which are possible only with FE-EPMA™ and the difference in the distribution of microparticles when the accelerating voltage is changed based on an example in which a solder joint on a printed circuit board implemented with a lead-free solder (Sn-3.0Ag-0.5Cu) was analyzed using an EPMA-8050G EPMA electron probe microanalyzer.

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Analysis of Micro Ag Particles of Solder

Fig. 1 shows the result of a mapping analysis of the solder in a joint between the lead of an electronic component and a printed circuit board. The measurement was done under a low accelerating voltage condition (7 kV) to prevent spread of spatial resolution. The joint has an element distribution in which Ag and Cu have precipitated in a particulate form. In Fig. 2, Ag and Sn were analyzed by enlarging Fig. 1. The Ag particles are captured clearly, and the spacing between the Ag particles shows spatial resolution of 100 nm or less.

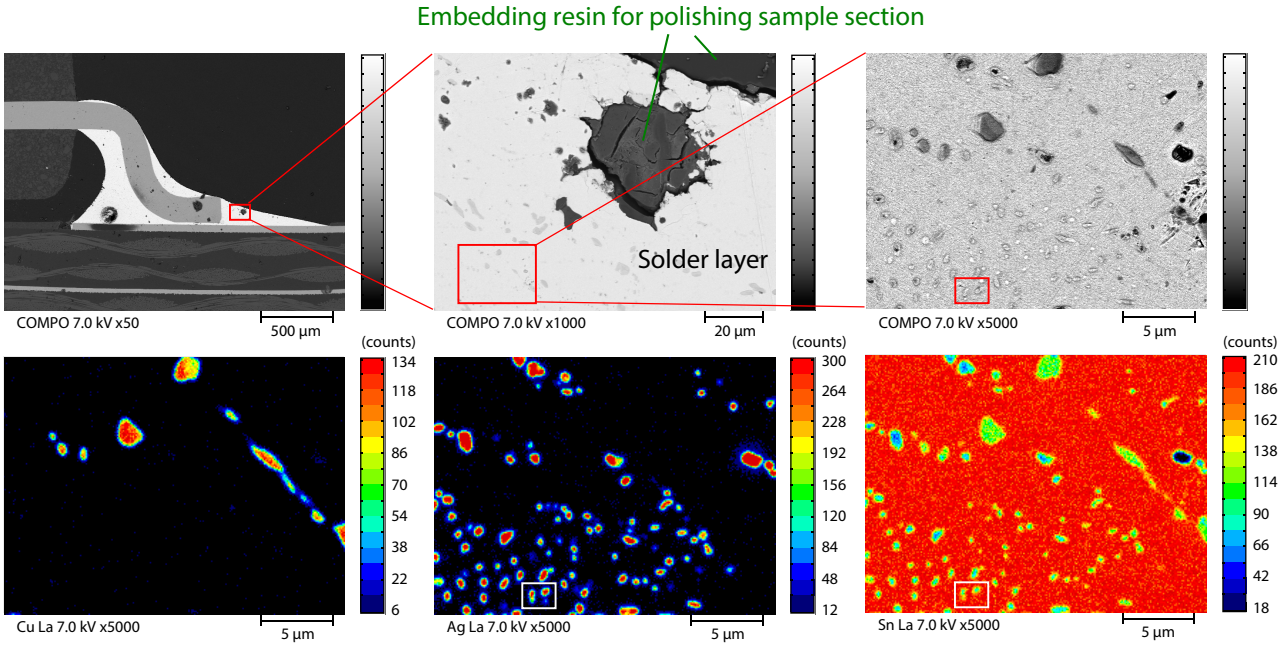

Fig. 1 Mapping Analysis of Solder

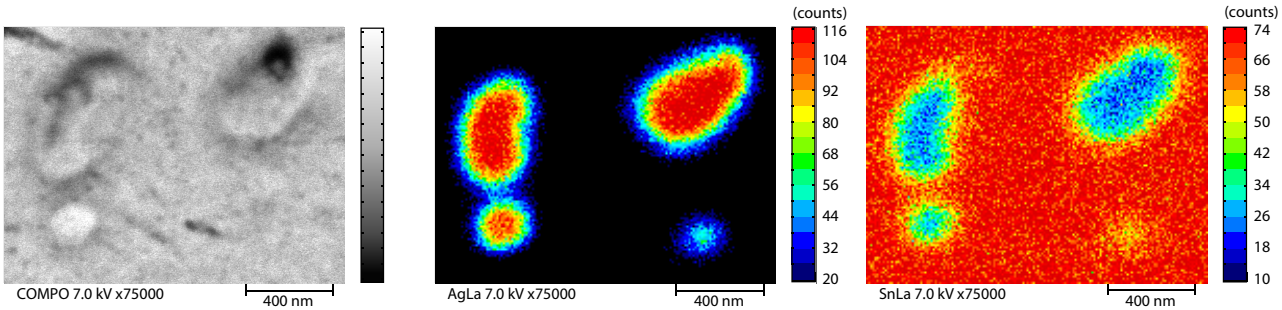

Fig. 2 Mapping Analysis of Micro Ag Particles of Solder

Comparison of Ag Particle Distribution Depending on Accelerating Voltage

The mapping analysis of micro Ag particles in a solder joint on the printed circuit board was compared at accelerating voltages of 7 kV and 25 kV. Fig. 3 shows the mapping analysis results for 7 kV, and Fig. 4 shows the COMPO (BSE) images and element distribution images of Ag at the accelerating voltages of 7 kV and 25 kV. Line profiles of Ag intensity are expressed by drawing designated lines from the mapping analysis results on the element distribution images of Ag. Comparing the data for 7 kV and 25 kV, it can be understood that the distributions of Ag are different. Fig. 5 shows the results of a calculation of the electron scatter volume (red) and the primary X-ray emission volume (green). When the COMPO images and Ag element distribution images on the line profiles are compared, at 7 kV, the distribution is limited to particles A and B, whereas at 25 kV, it is also possible to detect particles C and D, which are located at greater depths. This difference is attributed to the difference in the primary X-ray emission volume due to the difference in the accelerating voltages. If a cross section of the line profiles in Fig. 4 is drawn in the depth direction, the distribution of particles is estimated to be as shown in Fig. 6. Thus, information on the distribution of elements in the depth direction can be acquired by changing the accelerating voltage. For example, it is possible to obtain a specialized distribution for the shallow region of the sample surface by setting a low accelerating voltage.

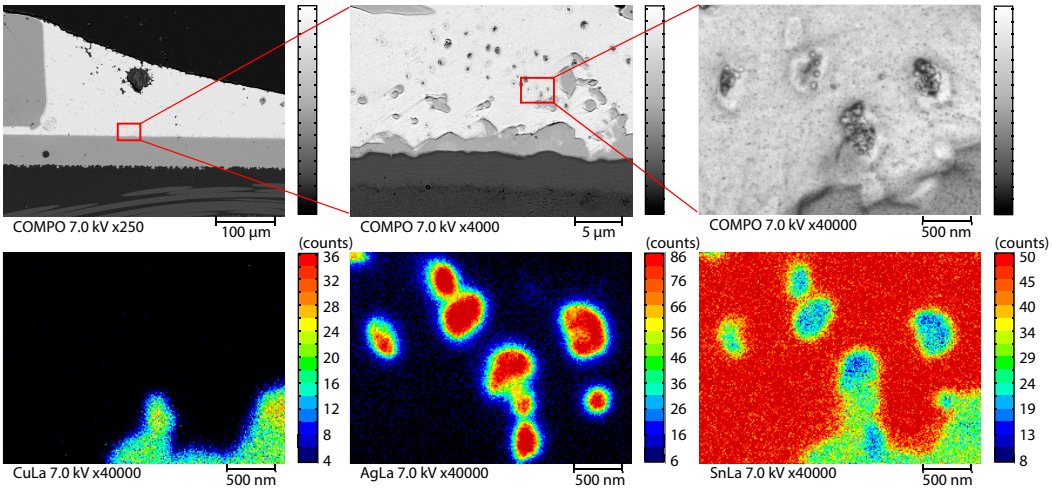

Fig. 3 Mapping Analysis of Solder (7 kV)

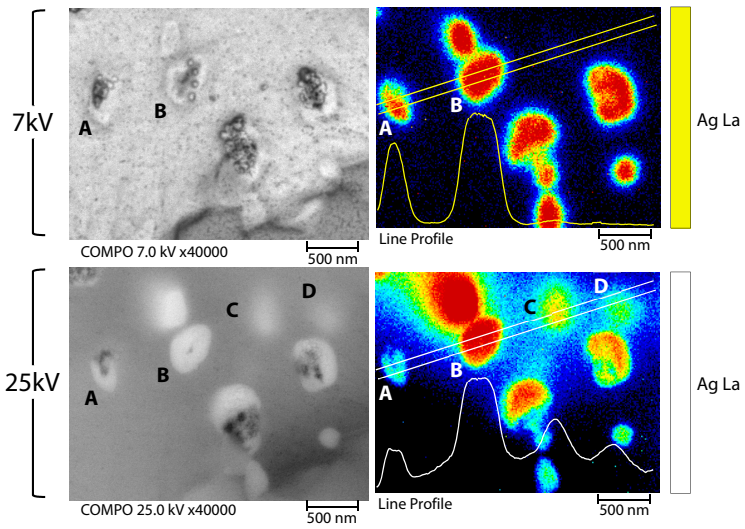

Fig. 4 Element Distribution Images and Line Profiles of Ag (7 kV and 25 kV)

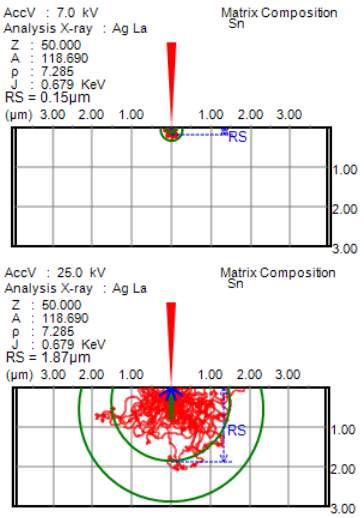

Fig. 5 Electron Scatter Volume and Primary X-ray Emission Volume
(RS: Maximum Effective Depth of Effective Scatter Volume)

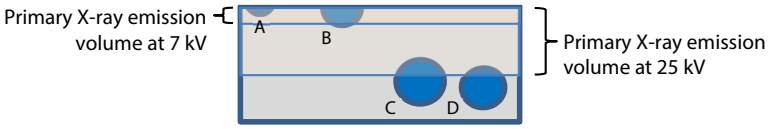

Fig. 6 Estimated Depth-Direction Cross Section of Line Profile of Ag Particles

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