

Application News

No. P107

Electron Probe Microanalyzer

Analysis of Lead-Free Solder Joint Interface

Solder joining technologies have become increasingly important in the electronics industry in recent years from the viewpoints of miniaturization of electronic components and wide adoption of lead-free solder alloys. This article introduces an example of analysis of the solder joint interface of a printed wiring board on which components were mounted with a lead-free solder alloy (Sn-3.0Ag-0.5Cu) and a crack in the solder using a Shimadzu EPMA™ electron probe microanalyzer (EPMA-8050G, hereinafter, EPMA).

T. Ono

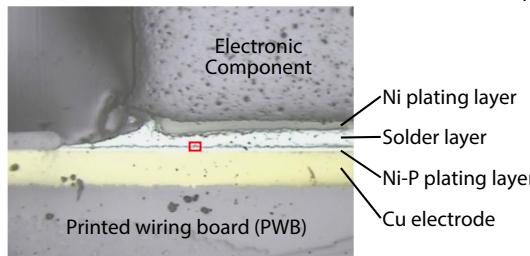


Fig. 1 Optical Micrograph of Solder/Electroless Ni-P Plating Joint Interface

Solder/Electroless Ni-P Plating Joint Interface

In solder joints on printed wiring boards (PWB), an electroless Ni-P plating is applied on Cu electrodes. Fig. 1 shows the composition of each layer between the PWB and the electronic components mounted on the board. Fig. 2 shows the enlarged mapping results of the region in the red box in Fig. 1. This figure shows the joint interface between the solder and the electroless Ni-P plating. It can be understood that heterogenous dendritic intermetallic compounds of Ni, Cu, and Sn and a P-rich layer have formed in this region. Fig. 3 shows the enlarged mapping results for the areas in the red boxes in Fig. 2. The condition of P concentration with a thickness of several 100 nm and the distribution of fine Ag particles with size of approximately 100 nm can be captured clearly by measurement under a low accelerating voltage condition (7 kV) to reduce the spread of X-ray spatial resolution. As this example demonstrates, useful information for investigation of decreased solder joint strength and analysis of the interfacial deposition reaction process can be acquired by EPMA analysis.

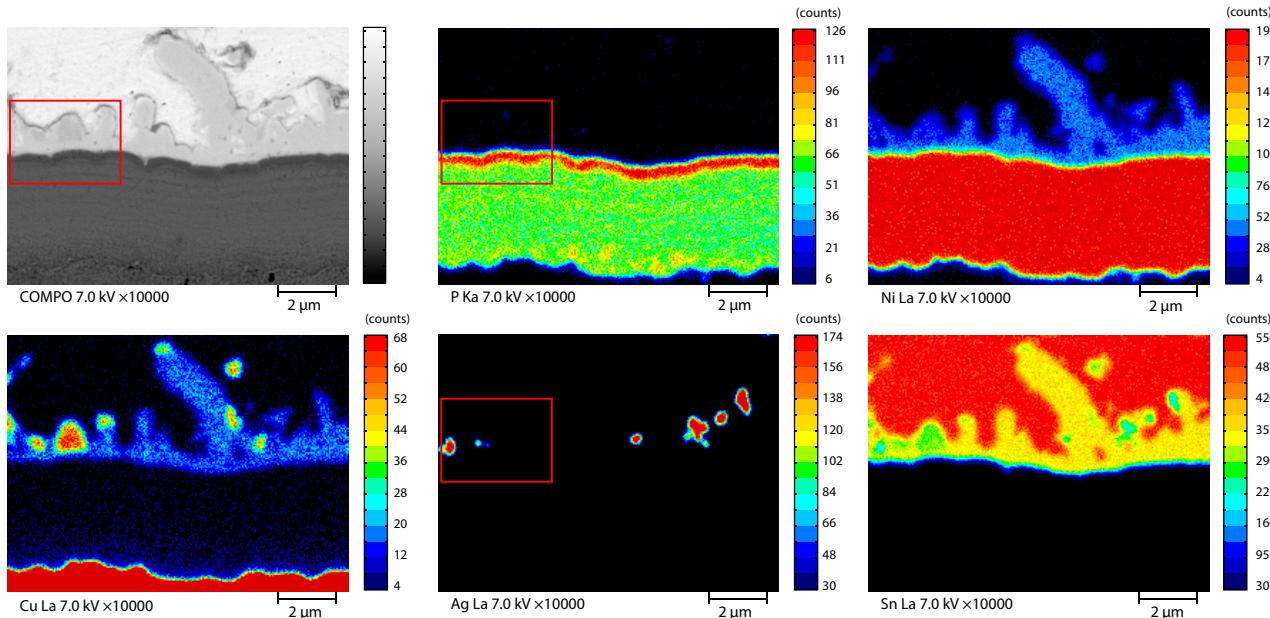


Fig. 2 Mapping Analysis of Solder/Electroless Ni-P Plating Joint Interface

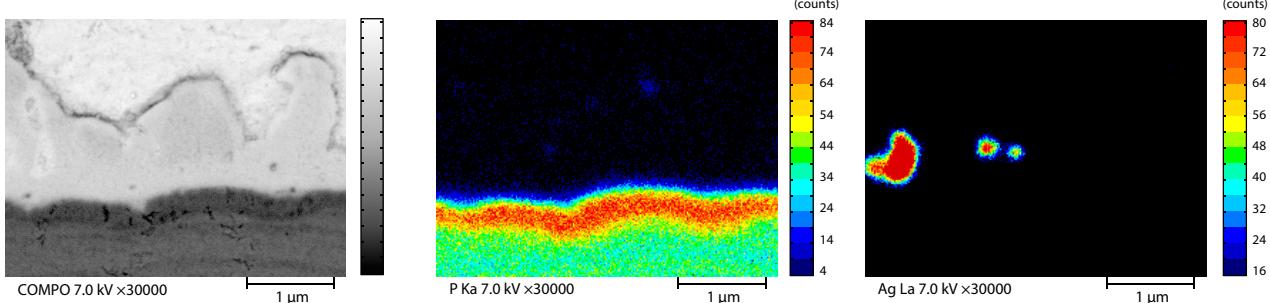


Fig. 3 Enlarged Images of Mapping Analysis of Solder/Electroless Ni-P Plating Joint Interface

Analysis of Solder Crack

Next, a mapping analysis of an area where a crack occurred in a PWB solder joint was conducted. Fig. 4 shows the mapping analysis results. The overlay image (lower right) shows the distribution when 4 elements (Ni, Cu, Ag, Sn) were overlaid, and indicates that an intermetallic compound layer consisting of mainly Ni, Cu, and Sn has formed at the interface between the solder and the Ni plating.

Focusing on the region between the intermetallic compound layer and the crack (region outlined by the red dotted line in the COMPO image at upper right in Fig. 4), it can be understood that depletion of Cu and Ag has occurred (as

shown by the white dotted lines in the element distribution images for Cu and Ag in Fig. 4).

Based on these results, it can be inferred that Cu and Ag, which are originally components of the solder, dispersed and concentrated at the interface with the Ni plating layer, and the crack occurred due to the deterioration of solder strength accompanying the formation of this Cu- and Ag-depleted layer.

This experiment shows that valuable information for analysis of the cause of cracks in solder joints can also be obtained by EPMA.

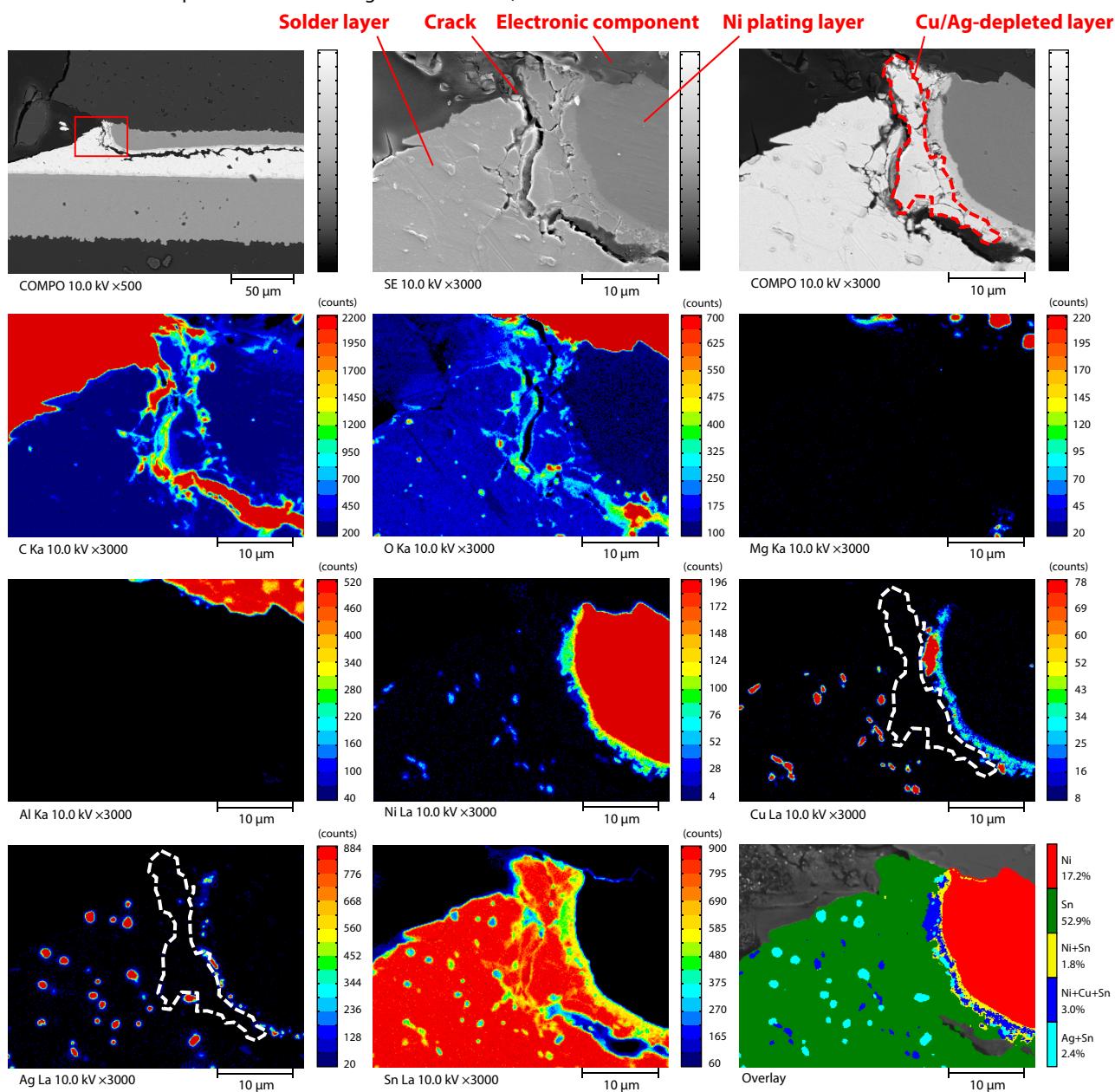


Fig. 4 Mapping Analysis of Solder Crack

EPMA is a trademark of Shimadzu Corporation in Japan and/or other countries.

First Edition: Jan. 2020



Shimadzu Corporation

www.shimadzu.com/an/

For Research Use Only. Not for use in diagnostic procedure.

This publication may contain references to products that are not available in your country. Please contact us to check the availability of these products in your country.

The content of this publication shall not be reproduced, altered or sold for any commercial purpose without the written approval of Shimadzu. Shimadzu disclaims any proprietary interest in trademarks and trade names used in this publication other than its own. See <http://www.shimadzu.com/about/trademarks/index.html> for details.

The information contained herein is provided to you "as is" without warranty of any kind including without limitation warranties as to its accuracy or completeness. Shimadzu does not assume any responsibility or liability for any damage, whether direct or indirect, relating to the use of this publication. This publication is based upon the information available to Shimadzu on or before the date of publication, and subject to change without notice.

© Shimadzu Corporation, 2020