Failure Analysis Case Studies for Assembled Boards

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Introduction

- The work was done for product development projects to find out the root causes of the failures that were identified in tests as well as in the first field failure returns.
- Three cases were chosen where the symptoms were similar to each other, and first interpreted as miss function due to CSP failures. The root causes were finally identified to PWB quality problems, and right improvement actions could be chosen comparable easily.
- The products in question are small portable devices integrating different technologies – component technologies, PWB technologies, software, mechanics, as well as production technologies.

- Physical failure analysis is applied in product development projects in connection with reliability design and reliability testing to find knowledge on failures that are potential in the future usage period of the product.
- When the reliability tests are done to find the weak links, it is important to find out the real failure mechanism and root causes as exactly and rapidly as possible to go forward to improved design.
- When the failures are identified but not analysed detailed enough to know the root cause, there will be extra work and unnecessary efforts to solve the problem based on erroneous assumptions.

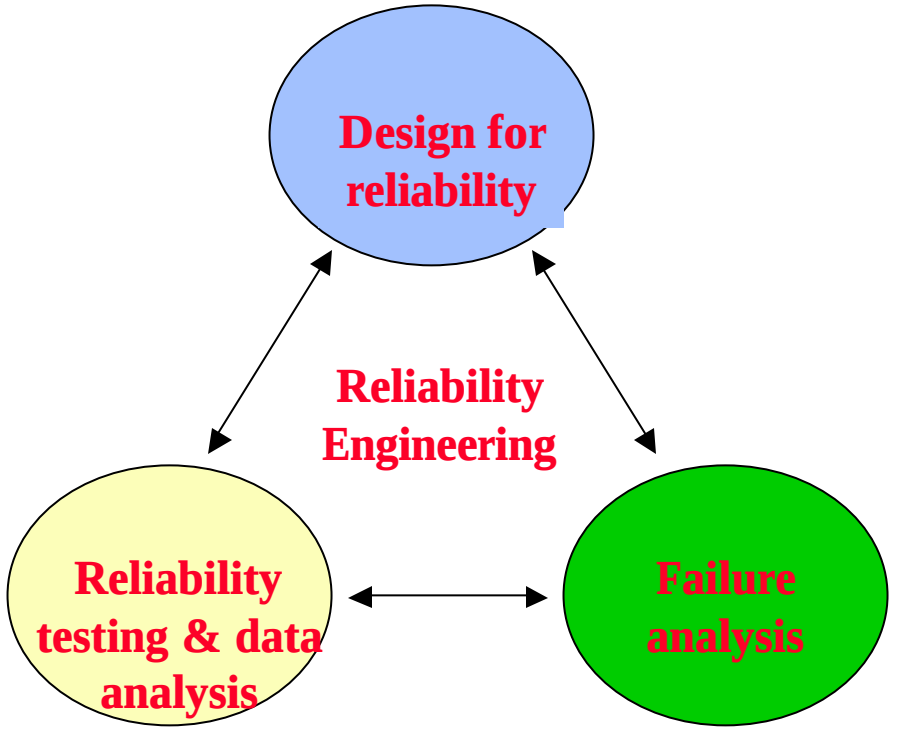

Figure 1. In product development Failure analysis is a part of Reliability Engineering and closely linked to reliability testing and design for reliability.

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Experimental details

The failure analysis work has been done from cross-section samples. The failed location has been determined with electrical measurements. All the studies have been made from fully functional devices.

Analysis Equipment used:

Environmental Scanning Electron Microscope (E-SEM) Philips XL30 + Energy Dispersive Spectroscopy (EDS) Edax DX4

Optical Metallurgical microscope with digital camera, Olympus BX 60

Case 1

- During mechanical testing for product validation, the symptoms for CSP failure were suspected. The failing area and component was determined with electrical measurements and cross section sample was made. The PWB material was FR4 with RCCu build-up layer.
- OSP surface finish was used on the PWB solderable areas.

It was found that the root cause for the failure was actually the PWB. The build up layer was found to be cracked as well as the μ-vias, especially in the component corners. The actual solder joints were found to be without failures and no cracking was detected at the interface between the PWB pad and solder joint.

Actions were done to improve the RCCu layer strength.

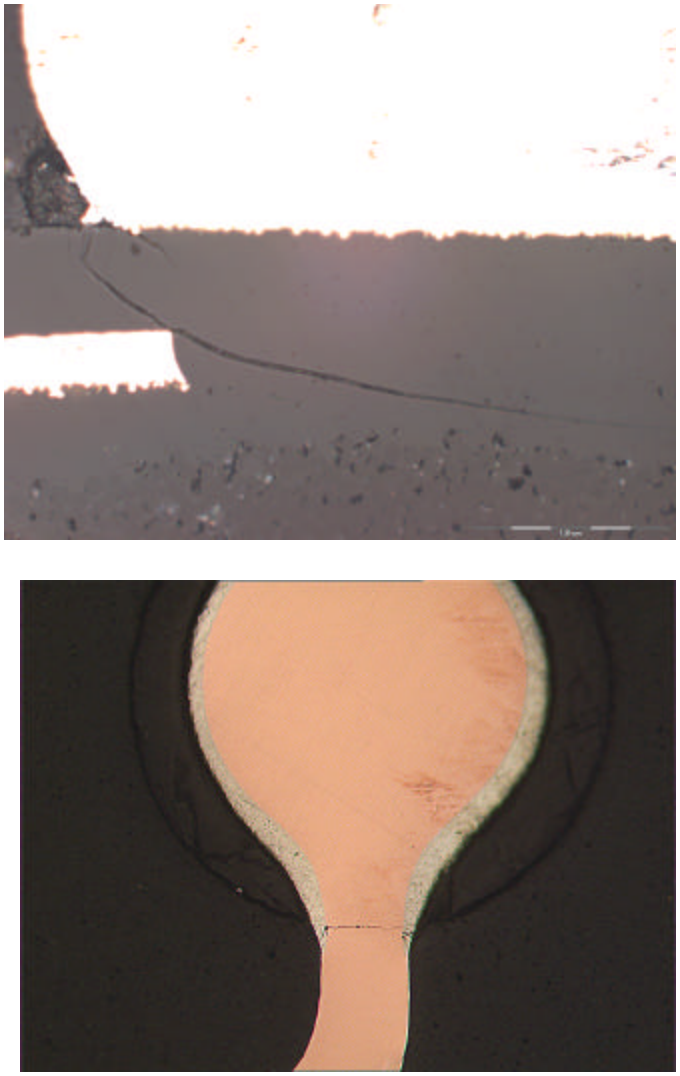

Figure 2. Cross section and overview from the RCCu crack.

Case 2

- The production lines reported an increasing amount of failures in the functionality tests for a CSP component. Electrical measurements indicated a broken connection, and a cross section sample was made. The PWB material was FR4 with RCCu build-up layer.

Result: Root cause for the failure was µ-via crack.

Corrective actions were done together with PWB vendor.

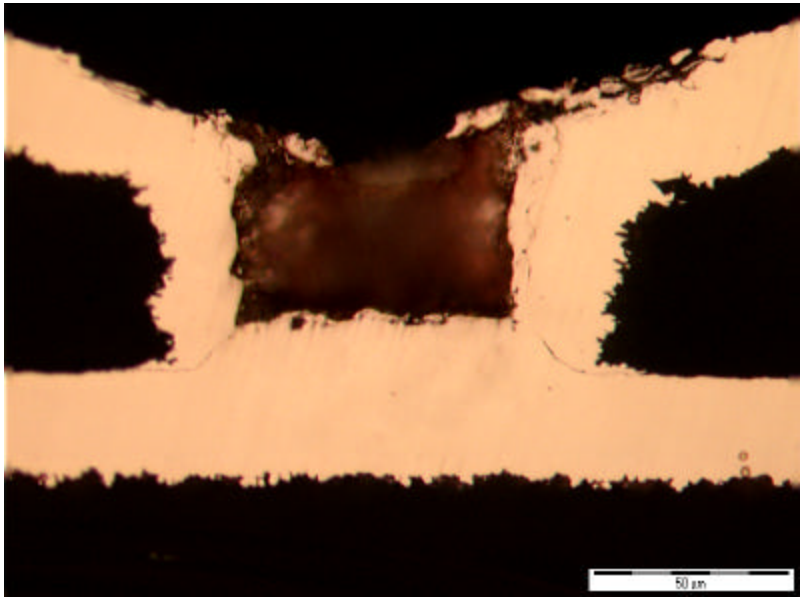

Figure 3. Cross-section from the broken µ-via causing the malfunction in the device.

Case 3

- First field reliability studies at the end of product creation project were performed and more detailed study was done to failed phones. The studied phone failed to function and cross section was made and the location was determined with the electrical measurements. The PWB material was FR4 with RCCu build-up layer.

- Result: The root-cause for the failure was the cracks in the Cu plating in the buried through hole. Root-cause was determined together with vendor and improvements were implemented.

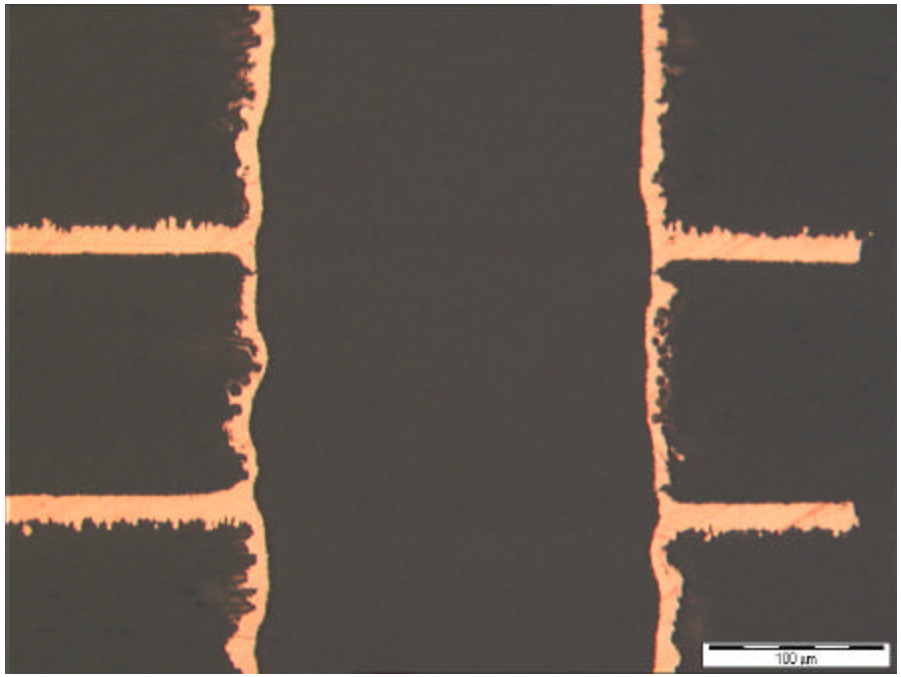

Figure 3. The cracks in the PTH causing the miss function in the device

Conclusions

The cases show the importance of deep enough root cause analysis. It is important not to assume one knows the failure.

Root cause analysis is valuable for improving product creation process. It has high potential to shorten the product creation time by focusing the effort to the real issues, effectively.

The described cases also reveal that PWB should be considered as one of the components in electronic reliability engineering - in design and verification.