COPPER DISSOLUTION

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Copper dissolution is the process necessary to form the intermetallics within the solder connection. When molten solder comes into contact with copper plating the copper dissolves into the solder alloy, and it continues until the solder solidifies or until the copper is fully diffused into the solder.

It is a process needed to provide strength to a solder joint, however, it can become an issue if the copper dissolution occurs too rapidly. In lead-free solder alloys the reaction between the tin in the solder alloy and the copper in the PCB substrate occurs at a higher rate than if the tin is alloyed with other elements. The higher soldering temperatures and longer contact times with the solderable surfaces increases the amount of copper dissolution. If the soldering process is not properly controlled, it can lead to excessive copper loss and speed up the degradation of the plated copper connections.

Copper diffusion rates for the solder alloys depend on three main parameters:

- Chemical composition of the solder
- Reflow temperature
- Time above liquidus temperature

Figure 1: Appears to be a cracked solder joint

Such process parameters can and should be controlled to limit the amount of copper dissolution during the assembly processes. Other variables that could impact the total loss of copper are: minimum copper plating thickness and PCB surface finishes used.

Excessive copper dissolution is a major defect and reliability concern. If excessive copper dissolution occurs, it can negatively affect the long term reliability of the electronic hardware. STI's Analytical laboratory recently came upon some customer samples that were previously thought to exhibit solderability issues. When surface evaluation did not immediately provide the required answers, a cross-sectional evaluation was performed. Micro-sectional SEM evaluation of various solder connections revealed the presence of excessive copper dissolution. These examples show the extent in which the plated copper connections can be compromised:

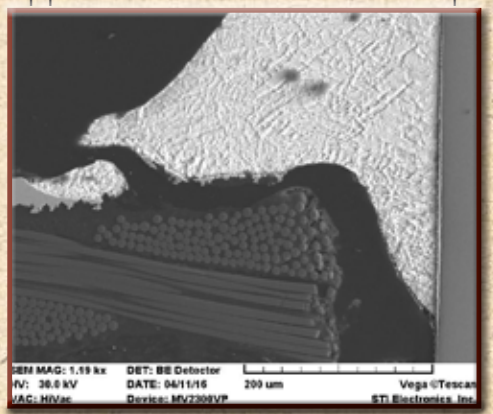

Figure 2: Excessive copper dissolution visible

Visual defects can and are sometimes dewetted in appearances. They can also manifest itself as a lifted pad state where the underlying copper pad adhesive system fails.

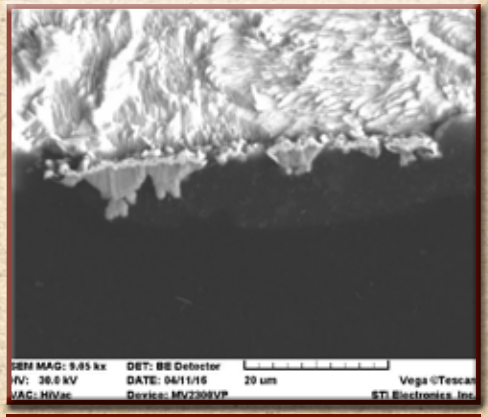

Figure 3: No significant copper layer visible

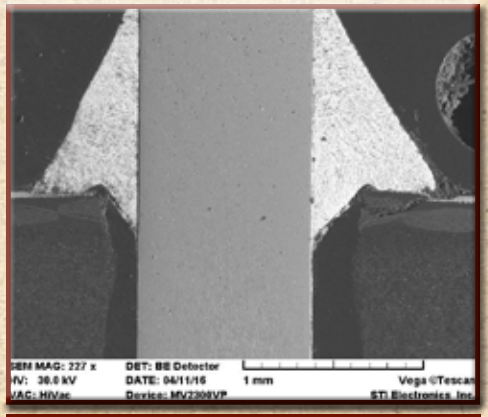

Figure 4: Failed electrical interface

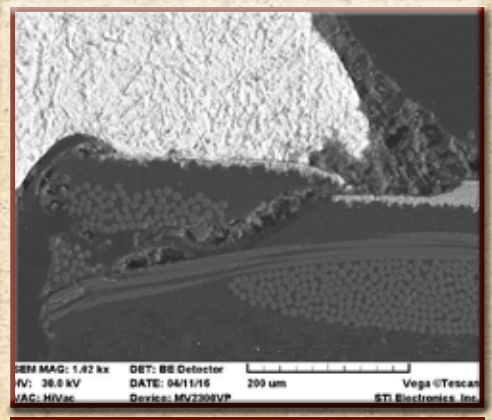

Figure 5: No bulk copper pad present

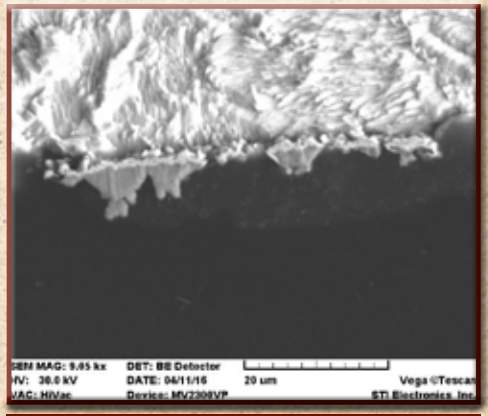

Figure 6: No bulk copper pad present

Figure 7: Dewetting in appearance

Figure 8: Dewetted visual appearance land surface

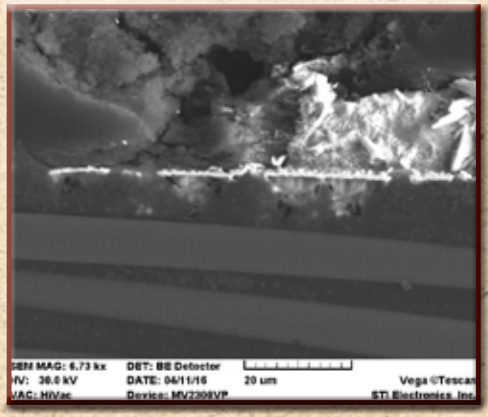

Figure 9: Cross-sectional view of almost completely consumed copper layer at the PCB interface. All one can see is an intermetallic formation with no underlying copper pad support.