PCB West Program, pp. 25-28

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July 2012

ELECTROMECHANICAL DESIGN

A NEW METHOD FOR MERGING THE TWO

PCB Surface Roughness

Thermal Profiling

QFN Soldering

Flexible Circuit Failure Sleuthing

Start at the finish: the event that signaled the failure.

QUESTION: I HAVE a product that has failed, and we have traced the failure to an open in the flexible circuit. The flex circuit shows no obvious visible indications of the failure. We would like to further understand why the flex circuit has failed. What steps should we take in our failure analysis of the flex circuit?

Answer: Surely you jest! Flex circuits never fail!

OK, you got me. As much as I would like to say that flex circuits are immune to failure, they are in reality prone to many of the same problems that can cause issues on rigid PCBs. In addition, the very nature of a flex circuit being required to bend and flex introduces a host of other mechanical issues that can cause problems. So where do you start?

First, ask if the part failed after a particular event, such as being exposed to highly elevated temperatures, thermal cycling, shock and vibe, or repeated flexing. The event that signaled the failure usually will give a good indication of where to look for the assignable cause of the failure. For instance, if the failure occurred after any type of thermal excursion or cycling, first examine the plated-through holes or blind vias for barrel cracks or plating separation from the hole wall (through holes) or landing pad (blind vias). Barrel cracks are typically the result of insufficient copper plating thickness, or poor copper plating ductility and/or tensile strength. Separation is usually caused by inadequate etch back (smear removal) from the drilling processes. Isolate the plated holes on the faulty net and perform a cross-sectional analysis of these holes. Always ensure that you thoroughly polish *and micro-etch* the sample mount prior to examination. The cracks or separation you are looking for may be only 0.0001" wide and easily smeared over by the soft copper during polishing. If the sample mount is not properly micro-etched, the cracks or separation will not be visible. In a properly polished and micro-etched mount, the copper should have a dull, grainy appearance (*not* shiny), and there should be a clear line between the base copper and copper plating on the top and bottom surfaces. If the failure seemed to be a direct result of thermal activity, there likely will be visible cracks (FIGURE 1) or separation (FIGURE 2).

If the event that triggered the failure was a flexing operation, start with a thorough visual examination using a microscope on the areas that are flexing. Look for anomalies in the cover material (such as ripples) that can indicate a potential problem with the conductors

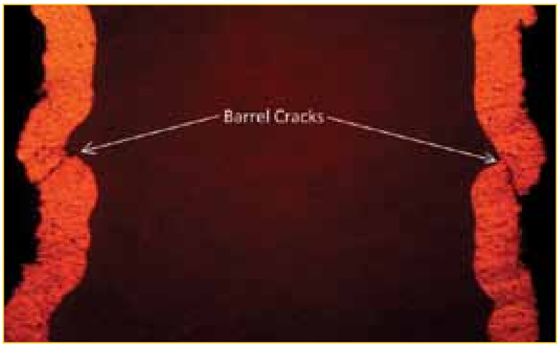

FIGURE 1. Barrel cracks most likely caused by low ductility copper plating.

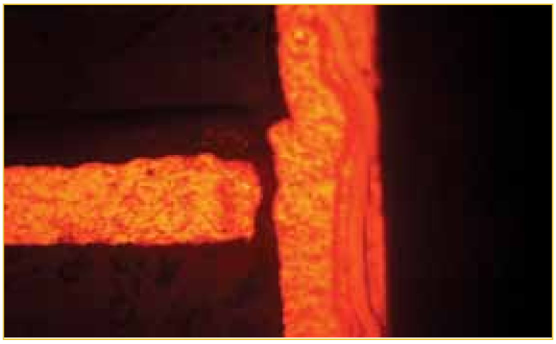

FIGURE 2. Copper plating separation from internal pad usually caused by insufficient de-smear after drilling.

FIGURE 3. Conductor crack caused by stress concentration point.

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below. Also, look carefully at the flexing area for features that could be stress concentration points (e.g., conductor width or directional changes, openings in the cover material, or terminations of platings or coatings). Any of these features in a flexing area can be a recipe for disaster. Once suspect areas have been identified, increase the microscope magnification and carefully inspect for cracks. Again, the cracks you seek will usually be very small and may appear to just be a line across the conductor. **FIGURE 3** illustrates an excellent example of what *not* to do in your design. Notice how the narrow conductor is exposed for a very short length. This conductor was also plated with nickel/gold, which is another no-no in an area that may flex. Nickel plating is very brittle, and even a small amount of flexing can cause a crack, which will then propagate through the entire conductor thickness.

If the circuit has soldered connectors, sockets, or pins and failed after shock or high vibration, carefully inspect the solder joints. This inspection should be performed using a microscope at moderate magnification. Start by looking for any solder joints that may have been questionable to begin with, and expand to other solder joints if the initial search does not reveal anything. Look particularly for cracks or separation between the solder and the pin or pad.

Virtually all flexible circuit failures are a result of either thermal or mechanical stresses. Once the type of stress that triggered the failure is identified, focus the investigation on the circuit features that would be the most affected by that type of stress. And as always, if you "hit the wall" in the failure analysis, do not hesitate to contact the flexible circuit manufacturer for guidance. Chances are they have seen it before and can save you some sleuthing time. **PCD&F**

Final Finishes, continued from page 30

performance. The downside is smoother copper surfaces can result in solder mask adhesion issues.

Some etching chemistry suppliers will discuss a desired roughness prior to solder mask application, but this is specific to their adhesion promoters. Setting a roughness target for those using pumice or brushing is not common. As a surface finish supplier, I offer a rule-of-thumb for desired roughness before final plating, but again, this is not a standard accepted number in the industry. A proper balance between significant roughness for good solder mask adhesion and a smooth surface for quality surface finishing can be a challenge. Some have instituted a light mechanical or pumice step post-solder mask, but prior to surface to help achieve this balance. **PCD&F**