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Application Note

Stress Voids: Distorted Internal Pads After HASL

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Stress voids are a widespread condition not always recognized for what they are, how they are formed and how you eliminate them. The condition is more likely to be present on thicker boards but is also common on panels with a thickness of 0.062.

Often identified incorrectly as air entrapment near an internal pad or other internal feature the condition typically (but not always) appears as an elliptical or cigar shaped void with one end near an internal pad or feature and angled about 45 degrees from the horizontal. A typical signature pattern that will absolutely identify any void as a stress void without regard to size shape of location will be the extension of any single void from either a prepreg layer or a laminate layer through the plane of transition between those two layers. That transition is not always apparent because those areas that form stress voids are usually where the bare laminate bonds to the prepreg layer. A void that extends from a prepreg layer into a laminate layer is a stress void absolutely and without doubt.

Cross sections taken in a horizontal plane will often show these "voids" as a space around an internal pad or a space inside a clearance area around the plated barrel – it in not unusual to see a complete "ring" around the feature made of several voids nearly connected to each other. Cross sections of an internal pad showing one side of that pad to have "pulled away" from the resin is probably a "stress void," particularly if that happened near the center plane of a thicker board.

The condition is almost always associated with HASL processed boards, not really caused by the HASL process itself but by the combined solder dip heating the area around plated holes to a point where the resin becomes soft then a rapid cool down (usually by immersion in water) causing. The dramatic differences in expansion and contraction of the plated copper in the hole while the resin is softer can cause the resin near internal features to pull apart.

Thick boards are more likely to exhibit the condition because the dwell time in the molten solder bath is often increased to achieve good coverage in plated holes, the total expansion is greater based on the total thickness and the differential in contraction rates when seeing the rapid cool down is greater.

Depending of the process in place at any given shop with any given board design the stress voids might be concentrated in the outer layers or near the center plane of the panel. Usually when voids near the outer layer are predominate that is an indication of that the dwell time for air cool and equalization after HASL is way too short. When voids are concentrated near the center of the panel or when resin appears to be pulled away from one edge of an internal pad or feature that usually indicates a less sever condition but one that still needs the air cool time to be increased.

A stress void condition can usually be eliminated by increasing the dwell time for cool down and equalization prior to water immersion where very rapid cool down will take place. The only functional down side to increasing the time for air cool prior to a water immersion is the potential for oxidation to begin forming on the solder surface – that usually won't be a concern unless you hold the panel for more than 90 seconds.

Older systems where the hold time can be controlled by an operator is easier to deal with but some of the newer horizontal systems that limit the time available for air cool down prior to water immersion might require conveyer extensions or some other strategy to increase the hold time prior to water immersion.

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