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Dear Customer,

Tin Discoloration – Summary

Tin discoloration is a natural phenomenon that happens to pure tin plating finishes during soldering at certain temperatures and in certain processes. This color change will not adversely affect the solder or the long-term reliability of the product – **no effect on fit, form or function**.

Background information

Many electroplating solutions (including Nickel and Tin) include organic chemical additives to create a high-quality bright finish as expected by the electronics industry.

During normal use, organic brighteners and wetting agents break down and start to build up in the electroplating solution. These organics are very difficult to analyze so levels are unknown. Visual and functional inspection of the plated components is a good measure of the integrity of a plating solution. Functional inspection includes solderability & hotplate tests of all plated components. Before and after ageing is also carried out during normal inspection processes.

Harwin has a highly capable electroplating chemical laboratory with facilities for Titration and Hull Cell testing, X-ray Fluorescence, Atomic Emission Spectroscopy, Artificial Ageing, and Solderability testing. This laboratory analyzes, tests, and maintains all solutions to a high standard, ensuring high quality plated finishes. Our chemical suppliers work closely with Harwin and analyze the plating solutions to back-up our in-house analysis.

Cause of discoloration

The discoloration is Tin Oxide – just 0.5% oxygen present can cause the development of oxide in molten Tin. Tests have confirmed that this surface oxidization and discoloration are related to time and temperature but, importantly, a naturally occurring phenomenon with pure Tin. This is why plating solutions include oxide resisting additives (also an organic).

Extensive testing performed by Harwin has proved that **the surface oxide discoloration does not affect solderability or electrical conductivity and is purely cosmetic**.

After subjecting discolored components to a steam ageing process to simulate 3 years of normal storage, no further deterioration of electrical conductivity (increased resistance) was detected. This confirms **there are no long-term reliability concerns**.

The results also proved that a build-up of the solution organics does reduce the effectiveness of the additive that is added to resist the oxide & discoloration at higher reflow temperatures.

Ongoing project at Harwin

Harwin continues to work on improving the levels and detection of solution organics to acceptable levels with additional equipment purchases and continuous improvement in procedures and methodologies. However, there may still be instances where this discoloration will appear, as there are a number of factors outside our control that can still cause this effect.

Reflow oven profiles and methodologies, and actual component temperatures within the process can be significantly different. The thin material gauge of some components can cause them to heat up faster and keep absorbing the heat for longer than other components on the PCB.

Process considerations

- **Solder Preheat** – Heat should be applied at a gradual rate of no more than 1°C/sec from ambient. If possible, parts should be held at Preheat Temperature for a short period to allow all components and laminates to equalize to the same temperature.

- **Solder temperature** – for ideal conditions, soldering should be carried out at 240°C ±5°C. Regardless of oven temperature, component temperature should be checked using a "mole" probe which measures temperature at the PCB surface. Exposure time for the highest soldering temperatures should be kept to the minimum that will ensure a good solder joint.

- **Solder oven** – Convection ovens give the greatest control of temperature gradients and steady temperatures, and even heating across the PCB surface. Infra-Red (IR) ovens are not recommended – process control is difficult, and surface temperatures can vary by as much as 40°C.

Extensive investigations have shown that discoloration is not evident until soldering temperatures exceed 260°C. The discoloration is Tin oxide, which forms in the presence of oxygen, and generally presents as a straw color on the surface. This effect can be avoided above 260°C by soldering under pure Nitrogen.

If you have any further questions regarding this letter, please do not hesitate to contact our Technical Experts at technical@harwin.com.

Yours faithfully,

Mrs Wendy Jane Preston, BEng (Hons)
Senior Technical Sales Engineer