USING FORMIC ACID FOR OXIDE REDUCTION

ADVANCED TECHNOLOGY FOR RESEARCH & INDUSTRY

KNOWLEDGE BASE FACT SHEET

- SCOPE: Explanation of the process of fluxless solder reflow.

Traditionally solder reflow has been used with a liquid flux additive, to further increase the wetting of solder to metals with high oxide layers. There are, however, flaws or issues that come with using flux in your soldering process.

Voiding
Because all flux has a liquid component it is prone to outgassing and vaporising during the elevated temperatures of the soldering process. This outgassing is the cause for voiding (trapped gas) between two soldered surfaces. An example can be seen when soldering high power semiconductors. During die attach, where heat transfer is crucial to the performance of both the die and the end-product, voiding can cause localised heat spots on a die's surface, leading to stress and fatigue cracks. Although the addition of soldering under vacuum further reduces the voiding, it is still not considered ideal.

Flux Residue
Soldering with flux naturally leaves residue and then you are left with the process of removing and cleaning your part. Follow-on processes such as wire bonding require clean parts, free from contamination, so the cleanliness is critical. Flux residue is also known to react with water vapour to create an acidic solution on the surface of parts. This can affect the long term reliability of your devices.

Flux-Free Reflow:
The ideal solution is to perform the soldering process in a flux-free atmosphere. Soldering in a 100% Hydrogen atmosphere is one method used for flux-free soldering that removes surface oxides. This adds an explosive risk and is dangerous; the equipment needed would need to be ATEX approved. Forming gas (a mix of Nitrogen and Hydrogen, 90% - 10% respectively) is safer, but the effective temperature is equal to and above 350°C, which is not compatible with the lower melting point solders.

Formic Acid Reflow:
A suitable alternative for flux-free soldering with lower temperatures is to perform the solder reflow under a formic acid (HCOOH) vapour. The vapour chemically reacts with the metal oxides at a lower temperature (150 - 160°C) to create formats; increasing the temperature even more decomposes the formats into Hydrogen, Water & Carbon Dioxide. When combined with a vacuum solder reflow, system these gases and vapours can be removed through the vacuum system.

A typical formic acid vacuum solder reflow profile can be seen below. After two vacuum stages with nitrogen refill, the chamber is free from atmosphere and oxygen. The temperature is increased with the introduction of formic acid vapour (nitrogen is used as a carrier for the formic acid vapour) with a dwell at 160°C, and a further ramp up to 220°C with a dwell provides time for the solder reflow and oxide removal. The chamber is then purged with nitrogen and evacuated with the vacuum stage to remove any voiding.

Formic acid solder reflow is a proven method for flux-free soldering, and because the oxide removal properties of formic acid vapour are effective at lower temperatures, it is also a very flexible process. It eliminates the need for pre reflow fluxing and post reflow flux removal. And because of the corrosive properties of formic acid, it leaves bare metallic surfaces suitable for further diffusion processes such as wire bonding.

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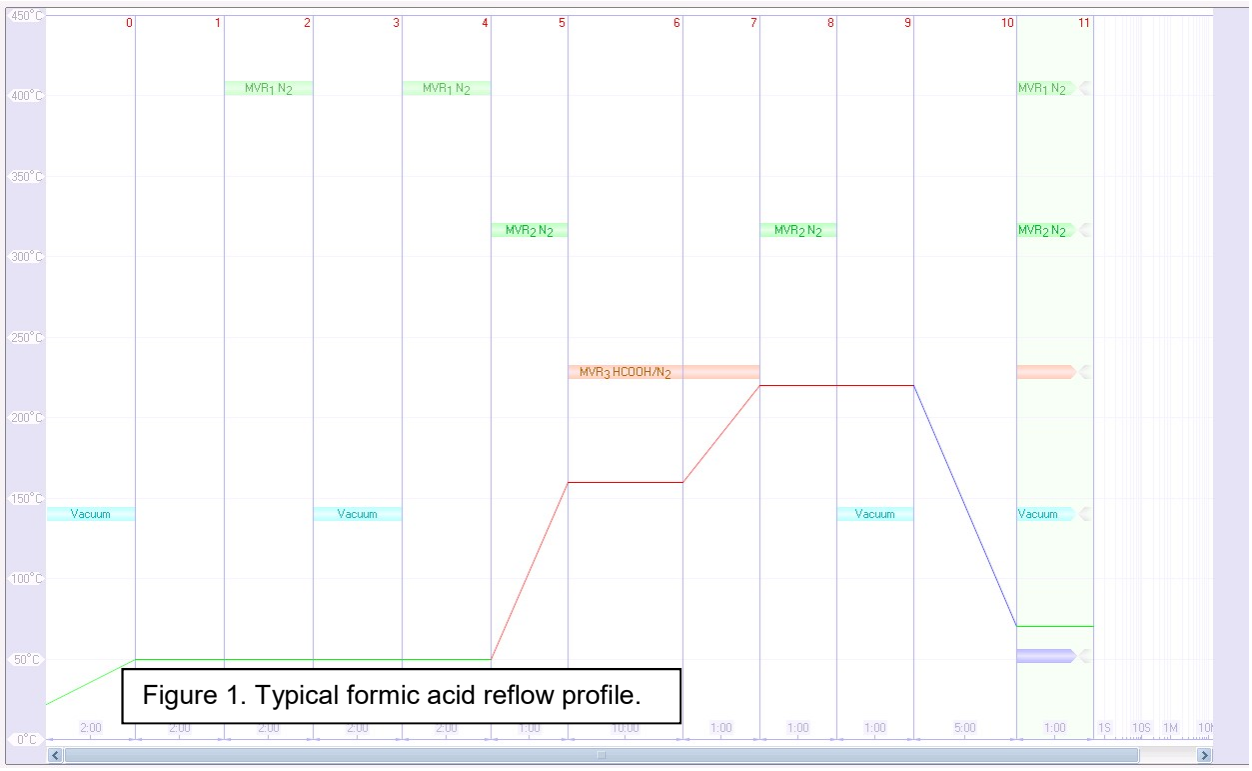

Figure 1. Typical formic acid reflow profile.