# USING FORMIC ACID FOR OXIDE REDUCTION

**ADVANCED TECHNOLOGY FOR RESEARCH & INDUSTRY**

**KNOWLEDGE BASE FACT SHEET**

- SCOPE: Explanation of the process of the flux less 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 is 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 vaporise during the elevated temperatures of the soldering process. This outgassing is the causes for voiding (trapped gas) between two solder surfaces. An example in soldering High Power Semiconductors. During die attach, where heat transfer is crucial to the performance of the die and product. Voiding can lead to localised heat spots on a dies 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. Following process's such as wire bonding require clean and 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 parts.

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 to remove 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 and above 350 degrees Celsius which is not compatible with the lower melting point solders.

A suitable alternative for flux free soldering with lower temperatures is to perform the solder reflow under a formic acid (HCOOH) vapour. The formic acid vapour chemically reacts with the metal oxides at a lower temperature (150-160 degrees Celsius) to create formats, further increasing temperatures decomposes the formats further 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 in the profile 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 degrees Celsius, further ramp upto 220 degrees Celsius with a dwell, provides time for the solder reflow and oxide removal. During the chamber is 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, because the oxide removal properties of formic acid vapour are effective at lower temperature, it is a very flexible process as well as effective.
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 suitable for further diffusion processes such as wire bonding.

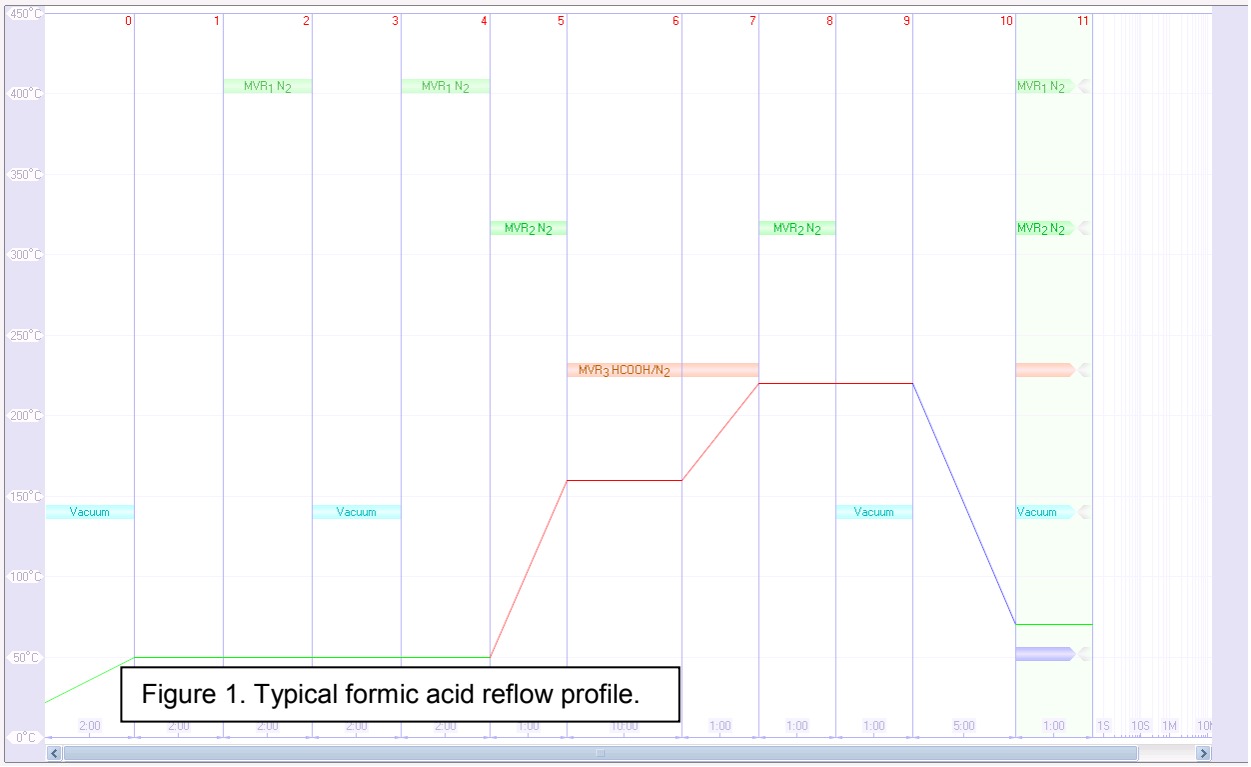


Figure 1. Typical formic acid reflow profile.