Structural changes in IR/C vs. VPS SAC305 lead free solder joints

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The studies presented in the paper are focused on Surface Mount Technology (SMT) using two soldering processes, **I**nfra**R**ed/**C**onvection (IR/C) and **V**apor **P**hase **S**oldering (VPS) characterized by different thermal profiles with variation in practical range. During experiments, the same types of elements of the trinomial solder paste, electronic components terminals and metallic substrate on PCBs were involved in the soldering process, in order to characterize the solder joints microstructures and parameters depending only on process thermal profile for each type of PCBs pad finishes. In the experiments, five types of identical pairs of PCB (one for VPS, one for IR/C) were used, according to the type of the pads finishes: Electroless Nickel Immersion Gold (NiAu); Immersion Tin (ImmSn); Hot Air Surface Leveling (HASL-Sn-Cu-Ni); Organic Solderability Preservative (OSP) and Immersion Silver (ImmAg). On each of the experimental PCBs, the same surface mounted components (SMT) were soldered in the same positions using solder paste SAC305 (Sn96.5 Ag3.0 Cu0.5) type 4, deposited with the same stencil with 150µ thickness. In consequence five types of identical PCBs were used from pad finishes, component and solder paste deposit volume points of view, for a minimum of three different thermal profile for each of the soldering process (VPS & IR/C), in order to emphasize the influences of reflow soldering process thermal profile in solder joint reliability, quality and electrical parameters depending on its microstructures.

The alloy used for pasting the components to the support is from the Sn-Ag-Cu system, having the standard chemical composition – SAC305 (Sn96.5 Ag3.0 Cu0.5). This ternary alloy is close to the eutectic composition of the binary system Cu-Sn, respectively at 99.3 % Sn, its melting/solidification temperature being of 231.9°C. The presence of Cu and even of other micro alloy elements such as Bi, Zn, Ca, MM (Misch-Metal) slowly turn the eutectic composition to a hipereutectic one, having a favorable effect on the separation of the free components within the structure, or towards a hipoetectic, favoring the apparition of the Sn's solid solution. The micro alloy elements have, first of all, the purpose of forming an oxide thin coating when the alloy is melting, having the role of ensuring its protection and also of modifying the superficial tension at solidification. Moreover, the elements with a higher atomic radius favor the creation of viable crystallization centers having the effect of finishing the structure at solidification and of growing dim or removing the dendritic structure.

Studying the interface between paste alloy and component, it can be noticed that when using the VPS technique, a diffusion zone appears, due to the fact that the heating speed is lower in comparison to the IR technique. This low speed favors the diffusion process, thus

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growing the chances that intermetallic components, containing the add-on elements from the PAD (Sn, Ni, Au, Ag), may appear.

When using the IR technique, the paste suffers a more severe thermal shock, the elements with higher thermal conductivity having a bigger temperature gain. This explains the fact that the pastes which contain Ni, Au, Ag are superior in quality.

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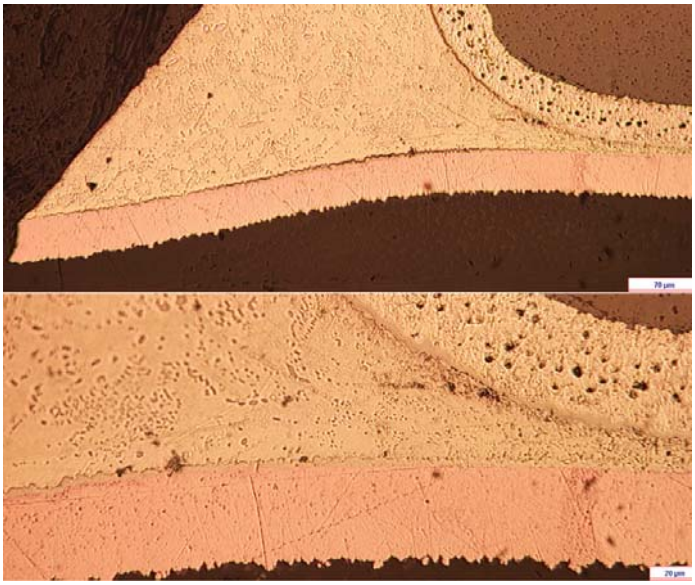

Figure 1. Microstructure of IR/C SAC305 soldering on Ni-Au substrate.

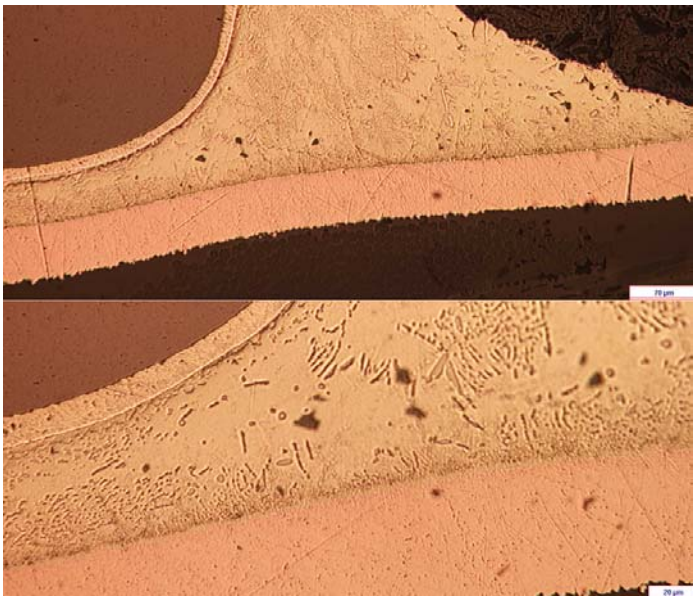

Figure 2. Microstructure of VPS SAC305 soldering on Ni-Au substrate.

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