Manufacturing Process Improvement & Optimisation

21 - 24 April 2008

SMART Group SA is hosting a seminar - 'Manufacturing process improvement & optimisation' - presented by American and European industry experts, aimed at those involved in manufacturing processes.

Topics

- Components & Process Materials
- Screen Printing Process & Stencil Design
- Board Handling
- Assembly Process for SMT & Thru-Hole
- Wave Soldering & Reflow
- Equipment Evaluation

If you need to analyse manufacturing problems, improve production yields, increase profitability and make your company stronger, then YOU need to attend !

Monday 21April 2008
Protea Hotel, Stellenbosch

Tuesday 22 April 2008
Protea Hotel, Midrand

Wednesday 23 April 2008
ProteaHotel, Midrand

Thursday 24 April 2008
Riverside Hotel, Durban

Who should Attend?

All managers, production engineers, NPI engineers, process engineers, quality engineers, supervisors, and anyone who inferfaces or is involved in manufacture.

About the Presenters:

RICHARD BOYLE

After finishing his 'A' levels Richard took a job at a local laboratory to earn some extra cash before going to University. Having spent over 20 years at Multicore Solders Ltd (now Henkel) in various departments he now thinks that he may not be going to University. But he achieved the qualifications he required, through day release and also got over 20 years' experience with Multicore, he is now the European Technical Services Manager for the Multicore Solder and Loctite Electronics Materials product ranges. Although involved in many projects with customers around the world, much of his focus at present is with lead free process implementation within Europe.

PHIL ZARROW

Phil Zarrow has been involved with PCB fabrication and assembly for thirty years. His expertise includes the manufacture of equipment for circuit board fabrication and assembly of through-hole and surface mount technologies. In addition to his background in automated assembly, Mr. Zarrow is recognized for his expertise in surface mount technology processes and methodologies, particularly, printing, placement, reflow and wave soldering, design for manufacturability and assembly, as well as material issues including lead-free implementation. Having held key technical and management positions with Vitronics Corporation, Excellon-Micronetics and Universal Instruments Corporation, GSS/Array Technology, and ITM Consulting, he has extensive hands-on experience with set-up and troubleshooting through-hole and SMT processes throughout the world.
Phil is a member of IPC, SME, IMAPS, a co-founder of ITM Incorporated, and is a past national level officer and national director of the Surface Mount Technology Association (SMTA). He was also Chairman of the Reflow Committee for SMEMA. He was the recipient of the SMTA's *Member of Distinction Award* (1995) and *Founders' Award* (2000). Mr. Zarrow has served on the Editorial Advisory Board for *Circuits Assembly* Magazine and is the author of the award winning "*On the Forefront*" and "*Better Manufacturing*"columns.

KEITH BRYANT

A qualified Production Engineer, Keith is a Director of the UK SMART Group and sits on its Technical Committee, a mentor of the SMTA, and the ICT. Currently, he is the European Sales Manager of Dage X-Ray Systems. Keith has presented technical papers on many subjects including Lead-Free Materials and Process, throughout Europe, Asia and the USA.

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Reflow profiling for fun and profit

By Phil Zarrow

Profiling is the process by which we determine the proper time-temperature durations a PCB assembly must sustain throughout the reflow cycle. Reflow soldering is not a matter of "the board goes in the oven, heats up, the solder melts, the board comes out, the solder cools," but it is not rocket science either. The aforementioned time-temperature duration information is supplied by the solder paste manufacturer for the specific formulation being used and can, hopefully, be found on the data sheet.

Of course the maximum temperature the assembly can see is dictated by the component (or material) on the assembly with the lowest thermal threshold of pain. Subtract a "buffer" of 5°C from this temperature to determine the maximum temperature of the Most Vulnerable Component (MVC) and do not exceed this temperature; thus the maximum gradient across the assembly is defined by subtracting from the MVC value the temperature at which the liquidicity of the molten alloy is ideal for wetting which is usually 15 to 20°C above the melting point of the solder alloy. With Sn63/Pb37 and Sn62/Pb36/Ag2 alloys this is typically between 205 and 210°C. With the current vogue lead-free alloy, SnAgCu, it is around 235°C. And don't forget to attain the shortest time above liquidus (melting point) too.

You really have to profile each application that you are going to reflow. That's right, take a sample board, instrument it up with thermocouples and obtain the proper profile for that application. If you have PCBA applications that are very similar (in size, mass, and surface geometry) you can likely get away with using the same profile. But no matter how heat-transfer-efficient the reflow oven is (or the salesman says it is) one profile does not fit all.

While profiling each application is necessary, it is not all that difficult. Of course there is a downside – as mentioned at the outset, reflow profiling is a monotonous procedure. Reflowing in a convection oven is a very unexciting process. With printing and component placement, at least there are the dynamics of mechanical motion. In reflow, the assembly disappears down a dark tunnel and emerges about four minutes later.

Most important is the proper attachment of the thermocouple to the assembly. Don't attach the thermocouple with Kapton tape – you are not making consistent contact with the solder joint you think you are monitoring. You are likely measuring a combination of air temperature, tape temperature and sometimes (maybe) joint temperature but this is highly inaccurate. Attach the thermocouples with either a high-temperature solder alloy or a conductive epoxy. This may mean sacrificing an assembly to the "profile gods" but now you have a tool with which you can periodically check the accuracy and repeatability of the profile for that board in your oven. If you have very low quantities and a high mix of boards, there are non-destructive, re-usable contacting probes available as well (such as *ECD's* TemProbes).

Use an assembly that is populated with the components as it will be passing through the oven. Unless you are reflow soldering a bare board, do not profile with an unpopulated board. Thermocouples will be attached at interconnections (lead to pad junctions) that represent, at least, the warmest and coolest points on the board. Place other thermocouples at heat sensitive components (i.e. the MVC) and other high-mass components to ensure they are seeing sufficient heat.

Since you are using a previously soldered assembly, it is essential to remove the solder from the interconnects where you will be attaching thermocouples. As the board was likely soldered with Sn63/Pb37 and you will be using, perhaps Sn10/Pb90, if you were to simply solder the thermocouple with the latter, you would wind up with a "mystery" alloy and one that will not sustain the multiple thermal excursions required of the test board. It is therefore mandatory that the existing solder at the interconnect be removed using solder-wick. This should also be done if you are using conductive adhesive to attach the thermocouple. Otherwise the Sn63/Pb37 will reflow underneath the adhesive.

As stated earlier, profiling is a tedious process and there is nothing worse than losing a thermocouple during a run as this means having to do it over again. Hence, this step is very important. I have an assembly

that I used for evaluating reflow systems that was instrumented in this fashion. This assembly has seen at least 150 reflow cycles and has not yet lost a thermocouple attachment. The rest of the board doesn't look too hot but the thermocouples are intact. After removing the old solder, apply a small amount of flux and then, using a soldering iron, use a small but sufficient amount of the high-temperature solder.

Use Type K, 30 AWG thermocouple wires, preferably pre-welded. After attachment, route the thermocouple leads towards the rear (in terms of direction of travel) of the PCB assembly. Some people prefer to terminate the thermocouple lead at the trailing edge of the PCB with a connector. The lead from the measuring device can then be quickly connected and disconnected at this point. Use Kapton tape to provide hold-down and strain relief to the thermocouple leads at appropriate locations on the PCB.

"Phil Zarrow used to hallucinate reflow profiles before becoming President and SMT process consultant for ITM (www.ITMConsulting.org)"

Most reflow machines are equipped with on-board profiling software. This allows for the thermocouple leads to be plugged into ports on the oven and tracked on the system monitor screen in real-time. Many people prefer to use a data-recorder device that travels through the oven with the test assembly and records the temperature from multiple thermocouples at programmable time intervals. These systems are offered as "run-and-read" or as transmitting units that allow observation of the profile in real-time.

Now that you have established the proper profile for the application, use it. Conscientious practitioners confirm the profile by running the instrumented PCBA and data recorder through the oven before committing the oven to production each time a set-up occurs. Other world-class operators, such as those doing high-volume, low-mix, confirm that the oven is set-up with a profile confirmation check at the beginning of the production day. The best of the best log in the profiles on a control chart.