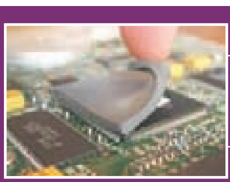

Production Equipment

The evolution of cleaning methods in the pcb reworking process

Why contactless solder cleaning is rapidly replacing manual efforts

By Robert Roush, product engineer & Paul Wood, advanced product applications manager, Metcal, a brand of OK International

Today's manufacturers of printed circuit boards (pcbs) are strongly quality driven, but even among those operations that are able to drive yields near or even above 99%, the huge volumes associated with applications such as smart phones and tablets could still leave them with thousands of boards per week that come off the assembly line damaged and in need of rework.

Since the cost of these pcbs can be well over US$200 each, most manufacturers and OEMs consider it vital to develop an effective process for working to reclaim these boards and minimize scrap pcbs and the resulting losses in their operations.

Indeed, today's environment is a far cry from the days of the limited-feature 'candy bar phone' pcbs, when the value of reworking faulty boards was not overwhelmingly clear. Yet, even as board sophistication and cost escalate, and global consumer demand continues to intensify, it is becoming more difficult for manufacturers to clean faulty boards manually when reworking them. Instead, contact-less cleaning previously a specialized process utilized by only a small segment of the market is fast becoming not only mainstream, but mandatory for most pcb manufacturers, often driven not only by the need to remain competitive, but, for contractors, by the adamant demands of their OEM customers as well.

Traditional manual cleaning process can cause many types of damage

The rework process has long consisted of three steps: removal of the inoperative component, cleaning of residual solder from the ball grid assembly (BGA) pads which held the old component in place and replacement with a new component to create a viable pcb. The first and third steps removal and replacement have long been automated, and are completed on rework machines with operator assistance. Cleaning, the middle step and arguably, the most sensitive and vital step when it comes to reclaiming a damaged board is often done completely manually by a skilled and experienced technician. The cleaning is performed with hand tools, usually a wicking braid and a soldering iron, using standard or specialized tips. Obviously, the effectiveness of the operation is highly dependent on the skills of the individual operator, and, especially with emphasis often placed on speed, board damage is quite common. (See Figure 1.)

For example, one common scenario in manual cleaning is the destruction of a pad due to sticking, when the heat of the soldering iron momentarily dissipates through the board, causing the delicate pad to stick to the wick and be chipped or lifted off the board entirely when the operator pulls the tool back. Overwhelming, destruction to a pad results in a wasted, scrap board.

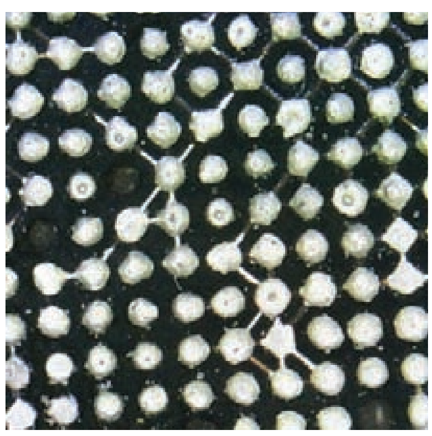

FIG 1: Removed pads.

Today, in the drive to help the smart phone or other ultimate product deliver greater functionality, manufacturers are creating thicker pcbs with multiple inner layers of copper. These, unfortunately, also cause the heat to dissipate more and more quickly when using hand held cleaning tools, ensuring that sticking challenges will become even more problematic going forward. (See Figure 2.)

Other risks to the circuit board assembly when performing a manual BGA cleaning are numerous. To name a few, molten solder can flow into electrical connections and vias, causing shorts in the board. Solder can be removed inconsistently among the dozens or hundreds of pads, resulting in poor adhesion of the new component. And, portions of the solder resist can be inadvertently removed by the wick, causing solder to flow into electrical connections when the board is put back into the rework machine, leading to bridges and shorts.

FIG 2: Open via and solder resist damage.

Another, perhaps even more insidious issue is that, while many manual cleaning problems can be caught in the inspection process and the board, now expensive scrap, kept from getting to market, another common source of damage is not discernible by visible or even x-ray inspection. Pad craters can be created in the fiberglass under the pad due to the stresses caused by the mechanical pressure of operators pressing a little too hard with the soldering iron, or by excessively heated tips held slightly too long against the board. (See Figure 3.)

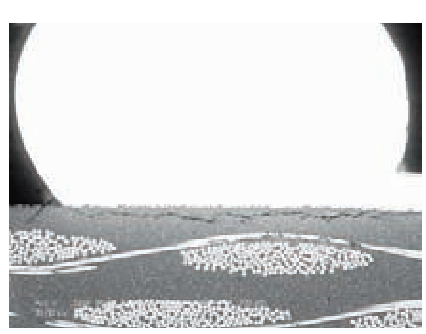

FIG 3: Partial pad crater. (Photo is courtesy of Michael Meilunas, Universal Instruments Corp., Advanced Research in Electronic Assembly (AREA) Consortium)

With this kind of damage, the pad and the solder balls are still connected to each other, but the pad is not fully adhered to the circuit board, leaving it vulnerable to the smallest jolt by the consumer and the end product brand vulnerable to reduced reliability and consumer dissatisfaction. The smaller the pads, the more susceptible they are to this kind of hidden cracking, which means that the situation has been becoming more common and will become even more common in the future as pad size continues to decrease.

Industry trends making manual cleaning even tougher

Indeed, it is vital to realize that, as common as all of these and similar scenarios have been in the past, they are about to become significantly more so. In addition to boards becoming thicker, over the years, pad size and pitch size have also reduced significantly, with many smart phones and other devices now utilizing pad sizes as small as .25mm mils, spaced at intervals of .5mm. It is known in the industry that new chips are scheduled for release in the next two to three years that utilize designs calling for pad sizes as small as .1mm with a .3mm pitch. With adjacent parts so close together, avoiding hitting them with the wick during manual cleaning and creating another round of rework will most likely become impossible for even the most skilled technician.

Further, traditional cleaning methods can be even less effective when it comes to cleaning pcbs incorporating advanced chip technologies. For example, 4th Generation Intel Core Processors technology is providing outstanding improvements in security, making it nearly impossible for criminals to access data stored on the processor. However, due to factors such as differing size pads and uneven solder volumes, manual cleaning can be a significant challenge.

Another technology, ceramic ball grid array, a specialty process used in aerospace, military and other high reliability applications, is another high value case in point. These boards, which use individual components costing tens of thousands of dollars and themselves can cost half a million or more, are notoriously hard to successfully clean manually and rework, and usually have to be scrapped if faulty. The problem stems from the fact that two different types of solder are used in manufacturer, with melting points of 183C and 302C respectively. Improper manual cleaning can change the melting temperature of the solder at the pads, so that when the new component is applied with solder paste, the temperature may not be high enough to form an intermetallic joint, and a dry joint could result at those connections.

In addition, many Package-on-Package chips cannot be confidently cleaned with manual methods due to the threat of melting the bottom package. One highly advanced component, the Invensas BVA POP which promises a fourfold increase in memory and processing speedholds the solder balls on with fishhook shaped connectors 50 microns wide and 90 microns high, barely visible to the unaided eye and spaced at .2mm intervals. Suffice to say that manual cleaning is not an option for this innovation.

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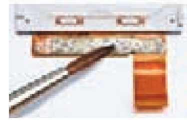
Low viscosity, one component silicone is fast curing



MasterSil 713 easy-to-use one component silicone with low viscosity is suitable for smaller encapsulations and conformal coating applications. The self-leveling system cures rapidly at room temperature and is non-corrosive. Speed of cure depends upon the level of humidity and the thickness of the layer being cured. Product can be cured in thicknesses up to 1/4-inch deep with superb flexibility and elasticity. Product provides improved electrical insulation properties.

MASTER BOND

http://ept.hotims.com/56236-70

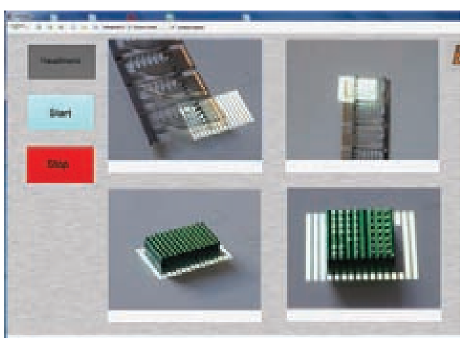
Pcb maker prints prototypes on the spot

V-One electronic circuit board printer enables prototypes within minutes, eliminating the frustrations with traditional fabrication processes and reducing hardware development time. Product eliminates the need for MOQs, setup fees and shipping costs. Prototyping is simplified as Gerber files go in and FR4 boards come out. Product prints two layer pcbs and hand solders components. No stencils are required for small production runs. Pop your fabbed boards in and dispense solder paste in minutes, as a 550W heater reflows components on the spot.

VOLTERA

http://ept.hotims.com/56236-71

3D sensor inspects soldered conductor boards



EyeScan VR 3D sensor works with structured light to inspect soldered conductor boards. In this process the light is projected in stripes onto the object and due to the height structure of the object, creates a light pattern, which is then captured by a camera, which is positioned in a certain angle. This method is extremely fast, making unit suitable for inspection tasks such as shape deviation, completeness, or BGAs and bent IC-pins. 3D-cameras of product series are supported by firmís image processing software. User can put together inspection programs via the drag-and-drop function of the software with the preprogrammed commands for 3D inspection and evaluation.

EVT EYE VISION TECHNOLOGY

http://ept.hotims.com/56236-72

Boundary scan technology software boosts JTAG chain control

Update to boundary scan technology software suite increases the flexibility of JTAG chain control, making it easier for engineers to access the full JTAG capabilities of boards, to achieve maximum test coverage. Dynamic chain profiling simplifies initialization of boards with multiple JTAG chains, in which a device in one JTAG chain controls power supplies or reset lines for JTAG devices in the other chains. During flash programming it is now much easier to set up XJTAG to only clock JTAG data through the chain that is needed for the programming operation, leaving the other chain(s) held in their current state.

XJTAG

http://ept.hotims.com/56236-73

Heatshrink tubing suits low-voltage applications

Amphenol Industrial Products Amphe-HST line of heatshrink tubing is RoHS-compliant and is widely used in low-voltage applications and medium-voltage transmission and distribution as well as insulation protection. Product line comes in a variety of styles including thin wall tubing that protects all types of electronic and electrical applications and dual wall tubing that seals and insulates splices, junctions, Ys and Ts, back shells and terminations where environmental protection is required. Products operate in environments up to 260C. Products provide 2:1 to 6:1 shrink ratios and are comprised of irradiated or cross-linked materials. Chemical and solvent resistant, products come in a choice of standard and custom colors.

XTRONICS

http://ept.hotims.com/56236-74

Electronic Coating Technologies and LPMS-USA align to bring low pressure molding into Canada

LPMS-USA, Lake Zurich IL, a full-service low pressure molding solution provider, has partnered with Brampton ON-based Electronic Coating Technologies (ECT), which will deliver LPMS's technology to Canada.

LPMS-USA's president Michael Cooper formed the company last year to bring the latest in low pressure molding technology to a U.S. market in need of a better solution to encapsulating electronic components, says Tom Charlton, president of Electronic Coating Technologies. Charlton draws from 30 years in the adhesive and coatings industry to understand the impact of LPMS-USA and the latest in low pressure molding technology on overmolding and encapsulating manufacturing.

"We look forward to adding LPMS-USA low pressure molding solutions to our offerings at ECT, the product line is synergistic to our Capital Equipment Representation and Subcontract Encapsulation Services," Charlton says.

Charlton opened ECT in 1997 to bring to the electronics market a company whose staff would bring many years of expertise in conformal coatings, potting compounds, gaskets, adhesives and equipment. His vision was to offer a service to help small to large sub contract assembly houses, OEM's and other manufacturers together to deal with the complex issues of applying chemical compounds to assemblies in a safe, environmentally responsible and repeatable way.

LPMS-USA operates as a full-service low pressure molding solution provider offering in-house machines, mold fabrication services, as well as contract manufacturing services. Research has indicated a need to protect circuit boards, electrical components and batteries from moisture and vibration, as well as provide strength to delicate wire harnesses and connectors. The low pressure molding process requires no housing, uses less material than traditional potting processes and can produce finished parts in seconds.

LPMS-USA has more than 25 custom machine options from R&D prototype units to large production units, the ability to fabricate a mold within 15 business days and a dedicated engineering team to assist with design modifications and recommendations.

For more information on low pressure molding solutions from LPMS-USA, visit www.ElectronicCoating.com

The pcb reworking process

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Automated contact-less cleaning offers safer options

Fortunately, contact-less cleaning or scavenging is an extremely effective method for cleaning BGAs with these chips, as well as substantially alleviating the escalating challenges of manual cleaning described above. With contact-less cleaning, a software-controlled, automated machine process precisely controls temperature and placement of a soldering tip and uses a vacuum to remove the molten solder.

With these features in mind, it becomes easy to understand how contact-less cleaning can alleviate the challenges associated with manual cleaning and will most certainly supplant it entirely in many applications. For example, there is no contact made with the pad or board, reducing the risk of mechanical damage. Precision controlled tips can clean pads too small and too close together for human operators to reasonably attempt. The software and equipment continually control thermal profiles. And, the vacuum collection nozzle automates the task of solder removal, for more consistent and complete removal and less chance of molten solder flowing into undesirable areas.

Stand-alone vs. all-in-one contact-less designs

Until very recently, contact-less cleaning could only be performed on very large, high end machines, and/or as an optional, retrofittable add-on that would allow the cleaning function to be added to the removal and replacement steps on a single rework machine. As demand is growing in the industry for a more cost-effective contact-less solution, 'stand-alone' contact-less cleaning machines are entering the market, offering the need for substantially less capital investment, as well as a host of other potential benefits.

Perhaps most obviously and significantly, stand-alone machines can offer greater throughput. Like 'all-in-one machines,' they can be run by a single operator, but, unlike all-in-one machines, when used side by side with a standard rework machine performing removal and replacement, they offer the opportunity for the establishment of an 'assembly line' operation to increase speed and yields.

In this scenario, the operator begins by placing a pcb on the rework machine. After the machine removes the chip, she transfers it to the adjacent cleaning machine on the desktop for automated cleaning. Meanwhile, she puts a second board on the rework machine to remove that chip, so two boards are in production simultaneously. When they are both complete, she transfers the first board, now clean, from the stand-alone contact-less cleaning machine to the rework machine for chip replacement and transfers the second board, with its chip now removed, to the stand-alone machine for cleaning. This becomes a continuous process.

Compare this to the operation of an all-in-one scavenger, where only one board can be worked on at once, most often completing component removal, cleaning and component replacement in a serial fashion. With a 'stand-alone' scavenger, yields on reworked boards can be increased by 50% or more. Further, since stand-alone scavengers tend to use standard single phase power, whereas the larger machines often utilize 3-phase power, the difference in power consumption and cost can be significant, particularly in a high volume 24/7 operation and should be factored into any ROI equation.

It should also be noted that stand-alone contact-less cleaning machines offer the opportunity for manufacturers to more flexibly, quickly and cost-effectively add contact-less capabilities to their operations. If, for example, they have more recently invested in a standard rework machine lacking a scavenger add-on option, they can readily add a contactless cleaning machine to work side-by-side with their current rework machine, regardless of make or model, without investing in a whole new rework machine. This provides an especially useful option, for example, for contract manufacturers suddenly 'forced' to quickly add contact-less cleaning capabilities by their customers. Similarly, even if their current rework machine does offer a scavenger add-on option, they can choose a stand-alone scavenger instead, and gain the benefit of increased throughput, as discussed above.

Machine features vary

Another advantage to contact-less cleaning over manual cleaning is that many machines all-in-one, retrofittable and stand-alone include a second programmable pre-heater placed under the board in addition to the nozzle heater. This allows the operation to reduce the need for the higher temperatures needed when using a single heat source such as a soldering iron, and helps maintain optimal and consistent temperature throughout, thereby avoiding the heat-related pad and board damage endemic to manual cleaning.

However, different manufacturers use different heating technologies for this dual-heater configuration, mainly differing combinations of convection heating and infrared heating elements, including IR/IR, IR/Convection and Convection/Convection combinations. Further, the machines using IR utilize a number of varying technologies, such as red light IR and white quartz. The bottom line is that the technologies can offer a substantially different level of temperature control precision, and this aspect should be investigated before purchase in order to optimize yields.

Machines also differ in their degree of automation; for example, some require the operator to move the board manually at certain points, which could impact success rates and throughput. Machines can also differ in the size of the BGA matrices that they accept.

Also differing among machines is the quality of the automation itselfhow easy it is for the engineers to effectively program, how many steps are required for the operator to run a rework or cleaning sequence, the ease-of-use of the graphical user interface, how much training is required, and so onall aspects that should be taken into consideration before investment.

For more information on contactless solder cleaning from OK International, go to http://ept.hotims.com/56236-75