Tech Article

Tackling Difficult PCBA Cleaning Challenges

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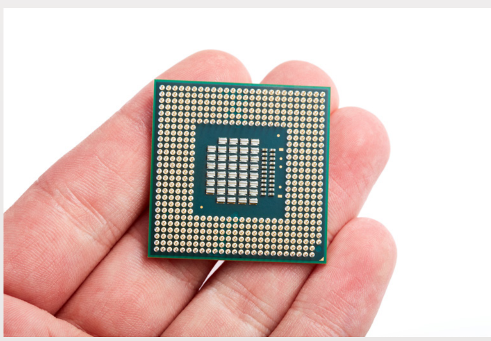

BGA components have stand-offs measured in microns.

Modern electronics are everywhere in our world, making life better for nearly every person on the planet. And today's electronic components are smaller and more complex than ever. PCBA (printed circuit board assembly) designers squeeze micro components like CSP, flip chip, micro BGA and QFN packages into tighter spaces on the PCBAs. Low standoff components like MOSFETs and zero-clearance components are now routine. I /O (input/output) counts are increasing and circuit boards are becoming multi-functional. But, as PCBAs continue to shrink in size and grow in complexity, cleaning the contamination from them becomes more challenging. Dirty PCBAs are vulnerable to many long-term performance and reliability problems. These include parasitic leakage, electrochemical migration, delamination, shorting and dendrite growth. So, it is important to understand the PCBA construction, what the contamination is and how to best remove it.

The Electronics Evolution

Until the 1970s, almost all electronics were built from individual components, using labor-intensive assembly of thousands of separate diodes and transistors. The miniaturization demanded by the space race led to the first computer chips called "through-hole" circuit board designs. The first through-hole components made their commercial application introduction in the late 1960s. The integrated circuits were embedded in the black plastic housings of the "chips" and the circuits were connected using their long metal legs. The defining physical feature of a through-hole PCBA are the "legs" that protrude from the sides of the components and go through the actual circuit board. During assembly, a technician solders the legs (16 to 20) into place, creating the hun¬dreds of electrical connections that make the device "smart". The chips have a high "stand-off" from the board allowing heat to escape. The high stand-off also allows better cleaning since the cleaning fluid flows under the high-mounted components to dissolve and rinse away contaminants.

SMT Designs

The late 1980s saw the evolution to the first "surface mount" components. These designs retained the legs along the perimeter of the earlier generation chips. But they were smaller and more numerous. They also eliminated the space-wasting holes going through the actual PCBA. Surface mount technology (SMT) kept the same basic design as through-hole chips, but it miniaturized all the components. By miniaturizing the legs and using all four sides of the chips, the number of electrical connections increased to 200 or more on the densest designs. This made them extremely powerful. Shorter legs with tighter stand-offs were more vibration resistant. It also enabled more chips per-square inch. However, their lower clearance makes cleaning more challenging since it's more difficult for the cleaning fluid to flow under the components, and even more importantly, out from under the components to wash the contaminants away.

Ball Grid Arrays

By the end of the 1990s, ball grid array (BGA) components became commonplace. BGA components evolved away from space-wasting legs. All electrical connections are under the chip, using micron-sized points of solder to complete the circuits. BGA designs also increase exponentially the number of

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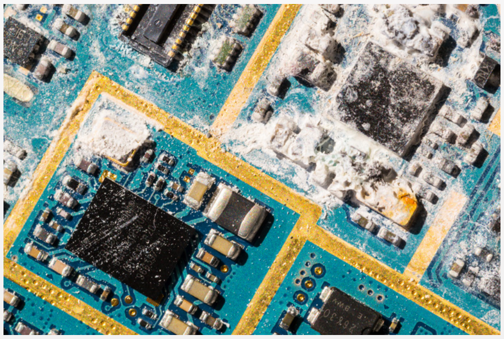

White salt residue can corrode the solder joints causing the PCBA to fail.

connections made, since the number of possible connections is limited only by the area of the chip, not the perimeter.

Initially seen as microprocessors in computers, BGA components packed still more transistors into the smallest possible package. Each chip supported thousands of tiny solder connections. This made them rugged, even in harsh environments. BGA designs make for smarter electronics, but their stand-offs are measured in microns, making cleaning under them difficult.

Fiber Optics

In the 2000s, fiber optic components started to appear on PCBAs. Almost every fiber network running to a home or business is connected at each end to printed circuit boards using fiber optic transceivers. These are tiny devices mounted on the PCBA. They take the optical signal and convert it to an electrical pulse. Fiber optic components are vulnerable to many types of contaminants. These include dust and fingerprints that must be cleaned with specialty tools using special care.

3D Printed PCBAs

Today, 3D printed components are gaining popularity. They offer flexibility and versatility in PCB designs that were not possible before. Ideal for quick PCBA prototyping or for producing custom circuit boards, 3D printing allows engineers to create curved circuit boards or shapes other than a flat surface. A 3D printed circuit board typically uses a mixture of materials for construction. One material, such as plastic, to 3D print or extrude the board itself. And another material, such as copper or silver paint to serve as an electrical conductor. Mixed materials boards are a challenge to PCB fabricators because materials compatibility is a concern. A cleaner too weak will not clean properly, one too strong could damage delicate components.

Changing Regulatory Requirements

Regulatory and safety requirements are also changing PCBA manufacturing and cleaning methods. Many countries have federal, state and local environmental rules limiting the use of ozone-depleting and global warming substances. Also, low toxicity and worker safety are of utmost importance. PCBA cleaner formulations must evolve to meet these requirements. They must clean well, meet emerging regulations and be safe for both workers and the environment.

Modern Benchtop Cleaning for Modern PCBAs

PCBAs have gone through many changes over the decades. And cleaning fluids and methods needed to keep pace with their cleanability requirements. The increasing packaging density, the introduction of new materials and more stringent environmental and safety requirements makes benchtop cleaning modern PCBAs a challenge. Fortunately, there are cleaning fluids and methods to help. Here are some examples.

Low Clearance Components

During soldering, salts are produced as the flux activators are heated. This leaves microscopic crystals behind. These salt crystals sometimes appear on the PCBA as a white residue which can be difficult to remove. But if the salts are not cleaned from the PCBA, they can corrode the solder joints causing the

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Fiber optic components require specialty cleaning tools and fluids.

PCBA to fail. Making matters worse is that today's densely packed PCBAs run very hot. This extra heat speeds the corrosive activity, resulting in even more PCBA damage. The stubborn white residue usually requires an aggressive flux remover or cleaning fluid to eliminate it. The best flux remover for densely-packed PCBAs should be very strong, like the MicroCare PowerClean™ Lead-Free Flux Remover to clean away the salts and other contamination.

The fluid should also have certain physical properties to enhance cleaning. These include a low surface tension and being fast-to-dry. Low surface tension means the cleaner penetrates tight areas such as under BGA components. But, because the fluid is fast-drying, it doesn't stay under the components after cleaning and dries without residue.

Fiber Optic Components

The fiber optic components on a PCBA can't be cleaned with a the same products used on the PCBA itself. A fiber optic strand is smaller than a human hair and the signal it carries is astoundingly fragile. So, cleaning the fiber components must be careful to ensure the speed and the long-term reliability of the entire fiber network.

To clean the fiber components, use Sticklers™ brand lint-free wipes and Cleanstixx™ Cleaning Sticks that do not leave glue residue or lint on the fiber connectors. For the very best results, use the Stickers™ Fiber Optic Splice and Connector Cleaner Fluid. It is an ultra-pure, water-free cleaning fluid specifically engineered for fiber optic cleaning. The fast-drying fluid ensures the wipes or sticks do not leave excessive moisture or residue on the fiber components.

3D Printed or Multi-Material PCBAs

When cleaning 3D printed PCBAs it is important to take materials compatibility into account. 3D printed PCBAs are typically made of at least two or more different materials including plastics and metals. Typically, the stronger the cleaning fluid, the higher the risk that it may damage the PCBA, especially plastics.

Test Before You Clean

A good method to ensure the chosen PCBA cleaner or flux remover works without damaging a PCBA is to conduct a 'cleaning trial' on sacrificial or test circuit boards. Start with a milder cleaner first and try stronger ones until you achieve the optimal cleaning result. Perform tests in more than one area on the PCBA to ensure it is safe for all the materials the cleaner may contact.
Some PCBA designers conduct their own in-house cleaning trials. But in some instances, you can send your test circuit boards to the MicroCare Critical Cleaning Lab for an in-lab cleaning assessment. Through cleaning experiments on your PCBAs and specific contamination, they can ensure you are cleaning with the fewest risks to the circuit boards. They may also suggest changes in your cleaning processes to boost PCBA cleanliness, regulatory compliance and worker safety.

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The MicroCare Critical Cleaning Lab can perform cleaning trials and provide recommendations.

Conclusion

The electronics components from the 1970s have little in common with the advanced microelectronics used today. Changes in layout, materials and safety regulations make modern PCBA cleaning more complex. So, it makes sense that cleaning fluids and methods have also evolved and improved over time. There is a vast array of PCBA cleaners on the market. But it is important to choose one that helps you overcome your particular PCBA cleaning challenges. The cleaning fluid or flux remover must have the right physical properties to clean well. But it should also be formulated to help protect air quality and ensure worker safety.

For help in choosing a PCBA cleaning fluid, partner with MicroCare. Our Applications Specialists can recommend the best cleaning fluid and process improvements to achieve optimal PCBA cleaning results.

About the Author:
Emily Peck is a Senior Chemist at MicroCare which offers benchtop and vapor degreasing critical cleaning solutions. She has been in the industry more than 6 years and holds a MS in Chemistry from Tufts University. Peck researches, develops and tests cleaning-related products that are used on a daily basis in electronics, medical, fiber optic and precision cleaning applications.
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