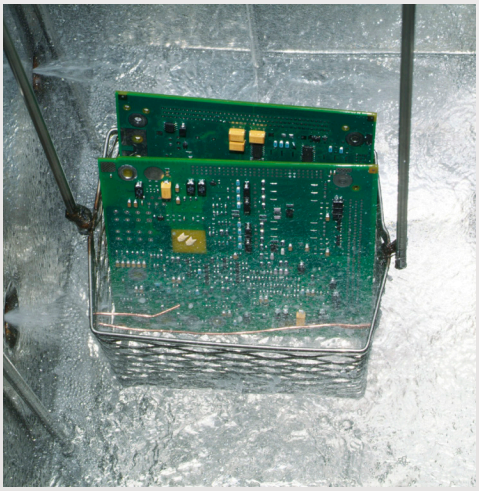
Tech Article

4 Types of PCB Contamination and How to Remove Them

Author:
Emily Peck, MicroCare Senior Chemist

Industry:
Electronics

Published:
EPP Germany



Water and water spots are removed using cleaning fluid inside a vapor degreaser.

MicroCare™

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 before. Manufacturers are squeezing 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. But, as PCBAs continue to shrink in size and grow in density, cleaning the contamination from them becomes more challenging. Dirty PCBAs can be vulnerable to many types of problems including parasitic leakage, electrochemical migration, delamination, shorting and dendrite growth. Therefore, it is important to understand what the contamination is on PCBAs and how to best remove it.

Four Types of Contamination

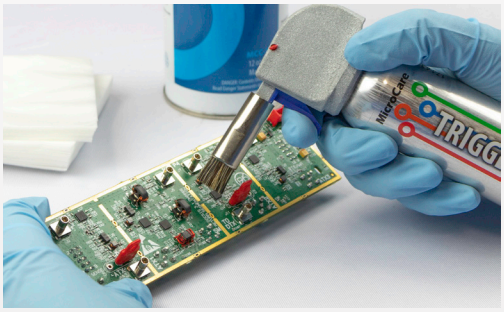
PCBAs are exposed to a variety of different contaminants depending on the manufacturing, storage, shipping and handling of the boards. Therefore, uncured solder paste, fingerprint oils, marking inks, glues and conformal coatings must be removed. In addition, other ionics (a residue with conductive properties), organics and particulates must be cleaned down to the micron or submicron range to allow the PCBAs to perform flawlessly.

There are four major types of PCBA contamination – organics, inorganics, water and insoluble particulate. Each one of these contaminants requires a different cleaning solution.

Organics: Organic contaminants include rosin solder pastes and fluxes that come in grades of activation including R (Rosin), RA (Rosin Activated), RMA (Rosin Mildly Activated) and SA (Synthetic) and create bright, strong solder joints. The pastes and fluxes are typically a mix of solvents, resins and rheological additives. The resins are highly hygroscopic polar compounds or non-polar resins. Organic contaminants can also include non-polar oils and greases. Organic contamination is dissolved and removed with specialty cleaning fluids or flux removers. A mild to medium strength cleaning fluid or flux remover typically works best on organic contaminants.

Inorganics: Inorganics are usually flux and solder paste activators that include acids, bases and halogens. Inorganic contamination typically comes from the polar residue left by lead free and no clean fluxes and solder pastes. The activators in these high-temperature reflow fluxes and solder pastes are commonly chlorides or corrosive salts, including plating salts. Inorganic contamination sometimes appears on PCBAs as white residue which can be extremely difficult to remove. Inorganic contaminants usually require more aggressive cleaning fluids to remove contaminants, especially the stubborn white residue. Therefore, it is important to test the chosen flux remover or cleaner prior to use to ensure it won't damage the PCBA's plastic components.

Water: Water is a subset of inorganic contamination and creates some special PCBA cleaning situations. Some manufacturers clean PCBAs with water and dry them with air knives or heat. However, water could still be trapped in small areas on the boards, such as under tight-fitting PCBA components.



Specialty cleaning fluids remove flux residue, uncured solder paste, fingerprint oils, marking inks, glues and more.

This water contamination is often removed from PCBAs using batch drying in a vapor degreaser outfitted with a water separator. There are two types of drying fluid methods available. The one to use depends on the quantity of water to be removed.

Absorption drying removes small quantities of water. The drying fluid is a fluorinated solvent and alcohol mix. It is hydrophilic so it absorbs water off the PCBAs and prevents water spots from forming.

For very wet applications, displacement drying is the best option. Displacement drying fluids contain a surfactant that moves water droplets off the surface of the PCBAs. The solvent used is hydrophobic or immiscible and is dense enough that it displaces the water on the PCBAs. The water floats to the surface of the drying fluid and is removed to properly dry the PCBA.

Particulate: Particulate is a polar contaminant commonly found on PCBAs. It is insoluble and cannot be dissolved in either water or a cleaning fluid. Particulate ranges in size from submicroscopic to large enough to be seen with the naked eye. As a general rule, the bigger the particulate, the more difficult it is to remove. Some of the more common particulates found on PCBAs include dust, dirt, cloth fibers and metal chips.

Particulates bond electrostatically to PCBA surfaces and require an electrostatic polar cleaning fluid to break that bond. A dense cleaning fluid that contains slightly conductive molecules will break the static bond of the contaminant and displace, or float, the particulate off the PCBA substrate.

When removing insoluble contamination, providing agitation in addition to the cleaning fluid is helpful. For benchtop cleaning, using the mechanical action of a brush helps scrub and dislodge the particulate from the PCBAs. For bulk cleaning, there are a number of methods to add agitation. Leveraging the boiling action of the cleaning fluid, adding vibrating ultrasonic energy or using a spray wand to help to loosen the particulate off the PCBA are all good ways to enhance the cleaning fluid's effectiveness.

Choosing a Cleaner

There is a vast array of PCBA cleaners and flux removers on the market, so it is important to choose one that cleans effectively and leaves no residue. It should also be fast drying to improve board cleaning time and also be materials compatible, generally plastic-safe, to prevent PCBA damage. It should be low odor and, if possible, nonflammable for worker safety. Also, do not overlook price point, the cleaner or flux remover has to work within the budget. If using aerosol cans of cleaning fluid on the benchtop, perhaps consider using a controlled dispensing system that attaches to the flux remover or cleaner can. This method delivers faster and better cleaning, with less waste, driving down the overall cost-per-part cleaned.

MicroCare™

Lab cleaning trials are performed to determine the best PCBA cleaning fluid and method.

Cleaning Trials

Although the capability of the cleaner is important, so is its compatibility with the substrate being cleaned. If you are unsure about the materials of the PCBA construction, it is important to test before the widespread deployment of a cleaner or flux remover.

A good method of ensuring the chosen PCBA cleaner or flux remover will work effectively without damaging a PCBA is to conduct a 'cleaning trial' on sacrificial or test boards. Start with a milder cleaner first and progressively 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, either directly or indirectly. Leading suppliers of critical cleaning solutions have field engineers who can provide guidance on testing the cleaning fluids and how to select the best one for the PCBA material and the specific contamination.

Many companies will conduct their own in-house cleaning trials, but in some instances, companies may send their sacrificial test boards to the cleaning fluid manufacturer for an in-lab cleaning assessment. Cleaning experiments are conducted on their boards and specific contamination to ensure effective cleaning with the fewest risks to their circuit boards. The lab will typically present the company with a written report, including detailed recommendations on the best cleaning fluid or flux remover to use. They may also recommend a change or upgrade in cleaning processes to ensure both PCBA cleanliness and worker safety.

Partner with a critical cleaning expert who will help in selecting the right flux remover or cleaning fluid, ensuring it cleans effectively and is compatible with all PCBA materials. They can recommend the best cleaning fluid and process improvements to achieve optimal 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. For more information, visit www.microcare.com.

MicroCare™

Follow Us!