Defluxing Déjà vu

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The leading manufacturer of cleaning and cleanliness testing products.

While the origin of the phrase "may you live in interesting times" is widely disputed, the fact that we indeed live in an interesting time is certainly not. While record bank failures and declines in stock values, only rivaled by the Depression era, wreak havoc on consumer confidence, the economic trickle-down effect translates to reductions in production output and ultimately the consolidation of many industries, including electronic assembly.

In the face of budget cuts and the resulting reduction of approvals of new capitol equipment requisitions, at least one industry failed to falter. The cleaning industry, specifically post-reflow defluxing and cleanliness testing equipment, experienced a surge of new business in 2008. So, one asks, who's cleaning boards? The answer is unconventional.

Before the Montreal Protocol (the ban of CFC-based defluxing agents), most electronic assemblers removed the flux from assemblies. With few exceptions (high-solids-content rosin-based fluxes in commercial applications), all boards were cleaned after soldering. The post-Montreal-Protocol era brought no-clean flux and cleaning became the near-exclusive activity of military and a small handful of other high-reliability assemblers. They cleaned because military specifications required them to do so. The cleaning equipment market became highly specialized, with many previously familiar high-speed in-line (conveyorized) defluxing equipment manufacturers either going out of business or merging with surviving companies. Lower-volume, batch-format cleaners replaced larger, faster in-line models due to their suitability and efficiencies in lower-volume/higher-mix applications common in military and other high-reliability applications.

The introduction of lead-free legislation has once again rocked the cleaning industry, this time in an opposite direction. 2008 represented a banner year for many defluxing equipment manufacturers and compatible chemical suppliers. In the midst of an economic downturn, the cleaning industry actually grew. What forces were at work to cause the entire industrialized world to rethink their defluxing strategies? The answer lies between two electrical components mounted on a circuit board. It is a small metal crystal called a dendrite.

A dendrite is a metal crystal that can grow between two electrical points on a circuit board. Because the dendrite is comprised of metal it conducts electricity. Unwanted electrical conductivity on a board between two undesired locations can easily cause a board to fail. A board failure in a cruise missile produces obvious detrimental repercussions, hence the cleaning requirement. But dendrites know no application-based boundaries. The fact is, it only takes three basic ingredients to produce a dendrite: voltage (as low as 1.5 volts); a corrosive material; and moisture.

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Dendrites grow on a board by way of a plating process whereby a conductive and corrosive residue (flux) provides a current path between a cathode and an anode. Voltage travels along the new, unintentional current path and the dendrites begin to grow.

Ok, if only three ingredients are required for dendritic growth, why haven't we seen this before? While it only takes three basic ingredients to grow a dendrite, there are two other factors that aid and abet the dendrite. One is the ever-decreasing distance between the cathode and the anode. We call this miniaturization. Perhaps no other industry is better known for miniaturization than the electronics industry. The other contributing factor is lead-free solder alloys. Lead-free alloys require higher reflow temperatures compared to eutectic alloys. Combine higher reflow temperatures and very-low-solid fluxes and what do you have? You have flux that polymerizes too soon in the reflow process, preventing the encapsulation of metal salts created when metal turns to liquid. Unlike traditional high-solids-content rosin fluxes (more common in days gone by) that capture and encapsulate the metal salts, low-solids no-clean fluxes, when combined with higher heat, can harden, preventing the encapsulation of metal salts. These free metal salts become fertilizer for dendrites.

How can one prevent dendritic growth? The answer is painfully simple. There are three potential methods:

- Remove voltage from the board. Yes, I'm being facetious.
- Prevent contact with moisture and/or humidity. This can be accomplished by either controlling the board's environment (not always possible) or conformal coating the board (which, ironically, requires a clean surface for proper adhesion).
- Remove the conductive residue (flux).

I'll pick door number three Monte, and so did much of the electronic assembly industry. In just the past few years, more assemblers began to clean their assemblies after reflow to remove flux and other conductive residues picked up in board fabrication, from components, and during the assembly process.

Because defluxing is new again, there is a newfound desire among engineers to learn more about modern defluxing alternatives. In October 2008, IPC and SMTA produced the "High Performance Electronics Assembly Cleaning Symposium" to a sold-out crowd. To the surprise of many, commercial and military assemblers alike attended and participated in this event. Board failures due to the lack of proper post-reflow cleaning are no longer exclusively the problem of super-high-reliability manufacturers. Manufacturers of military hardware, medical devices, cell phones, train control equipment, digital signs, and countless more applications traveled from several states and countries and paid a fee to participate in the two day Chicago event.

With cleaning once again part of the EMS vernacular, suppliers of cleaning equipment and chemicals have provided manufacturers with suitable choices to match any cleanliness, throughput, and environmental requirement. With fewer field failures and increased reliability, perhaps our time can be a little less interesting.

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