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SELECTION OF WAVE SOLDERING FLUXES FOR LEAD-FREE ASSEMBLY

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Abstract
The process challenges of lead-free wave soldering often require the use of new flux chemistries when compared with the relatively tolerant tin-lead wave soldering process. In some cases, the fluxes used in tin-lead soldering work well in lead-free assembly. In other cases, however, the complexity of the assemblies dictate more active, heat-sustainable products formulated specifically for lead-free applications.

This paper reviews the J-STD-004 and how it is used in flux categorization and selection. It also discusses the major types of flux formulations available, and the design, process and reliability implications of using each type. The purpose of the paper is to help the reader make an informed choice when selecting wave solder fluxes for lead-free processing.

Introduction
When selecting a flux for wave soldering, many factors must be considered. They include the electronic product's performance environment, the complexity of the assembly, and the flux's residues and their associated cosmetics. These relate respectively to flux formulations in terms of their reliability requirements, activity and allowable activators, and their pin testability and appearance. Tradeoffs exist in the selection process. Fluxes that offer higher reliability may have lower activity or lower pin testability. Fluxes with lower reliability may possess higher activity and better yields. The word "may" is used because there are a myriad of formulation combinations to choose from, and each option has its own benefits and drawbacks.

Wave solder flux is potentially the highest risk of the fluxes when compared to fluxes used in other steps of the PWB assembly process. Consider solder paste: the flux is evenly applied only where needed during the stencil printing process, and if an acceptable solder joint is formed during reflow, the no-clean material has seen sufficient heat to render its residues non-corrosive in the localized areas where it was deposited. Similarly, in hand or automated point-to-point soldering with cored wire, the flux in the solder wire is directly exposed to heat in the process and must have seen sufficient heat to actually flow from the solder wire to form the single joint. The risks inherent to the fluxes used in wave soldering are due to the mechanics of the soldering process itself.

Whether wave solder flux is sprayed, foamed, or waved, it is applied to the entire bottom side of the PWB, and some amount of material is deposited on the top surface of the PWB. In fact, it is highly desirable to deliver flux all the way up the plated through holes of the assembly in order to facilitate hole fill of the molten solder. But in the wave soldering process, the thermal exposures of the bottom and top sides of the PWB are not equal. While it may be safe to assume that larger deposits of flux on the solder side of the PWB are rendered benign by their exposure to the solder wave, it may not be safe to make the same assumption about small deposits on the top side of the PWB because they did not experience the same thermal exposure. This is particularly true for high density, complex assemblies.

The transition to lead-free wave soldering is driving many assemblers to select new fluxes for their processes. The following information is provided to help guide the reader through the classification and categorization methods associated with fluxes. J-STD-004A, the Joint Industry Standard for Requirements for Soldering Fluxes[1] which classifies fluxes on the basis of their composition and activity levels, is reviewed. It is important to understand because it applies to all soldering fluxes used in electronics assembly. When selecting a flux specifically for wave

soldering, however, the user must also understand the basic product formulation approaches and how they affect processing and reliability. A method of categorizing wave fluxes based on formulation approaches for various applications is presented.

Flux Classification

J-STD-004A addresses all forms of fluxes used in PWB assembly: paste, liquid, flux-cored solder wire, and flux-cored or flux-coated preforms. It divides all fluxes into one of four classes based on their composition.

As originally described by Alvin Schneider in 1997[2], the flux composition categories and their symbols are:

Rosin	(RO)
Resin	(RE)
Organic	(OR)
Inorganic	(IN)

Each composition category is then subdivided into six flux activity levels according to the corrosive or conductive properties of the flux and its residues.

Flux activity levels are determined by results for copper mirror testing, corrosion testing, surface insulation resistance (SIR), electrochemical migration (ECM) and halide content. The three main activity levels are:

L	Low or no flux/flux residue activity
M	Moderate flux/flux residue activity
H	High flux/flux residue activity

These three activity levels are further characterized by using a 0 or 1 to indicate the absence (0) or presence(1) of halides in the flux. This results in six classifications.

L0
L1
M0
M1
H0
H1

When the 4 composition classes and 6 activity levels are taken together, the result is 24 classifications. Table 1, taken from J-STD-004A lists the 4 composition categories in the first column and the 6 flux activity levels/flux types in the second column, and their resulting 24 classifications with their “flux designator” symbols in the fifth column.

Flux Materials of Composition	Flux/Flux Residue Activity Levels	% Halide (by weight)	Flux Type	Flux Designator
ROSIN (RO)	Low	0.0%*	L0	ROL0
		< 0.5%	L1	ROL1
	Moderate	0.0%	M0	ROM0
		0.5-2.0%	M1	ROM1
	High	0.0%	H0	ROH0
		>2.0%	H1	ROH1
RESIN (RE)	Low	0.0%	L0	REL0
		< 0.5%	L1	REL1
	Moderate	0.0%	M0	REM0
		0.5-2.0%	M1	REM1
	High	0.0%	H0	REH0
		>2.0%	H1	REH1
ORGANIC (OR)	Low	0.0%	L0	ORL0
		< 0.5%	L1	ORL1
	Moderate	0.0%	M0	ORM0
		0.5-2.0%	M1	ORM1
	High	0.0%	H0	ORH0
		>2.0%	H1	ORH1
INORGANIC (IN)	Low	0.0%	L0	INL0
		< 0.5%	L1	INL1
	Moderate	0.0%	M0	INM0
		0.5-2.0%	M1	INM1
	High	0.0%	H0	INH0
		>2.0%	H1	INH1

** 0.0% is defined as <0.05% by weight*

Table 1. Flux Classification as described in J-STD-004A. Note that inorganic fluxes are not used in electronics assembly.

The second and third columns of Table 1 relate to activity levels, which are determined with the following tests:

Copper Mirror Test: This test checks the removal effect of the flux on a 50 nm film of copper that has been vacuum deposited on glass. A drop of test flux and a drop of control flux are placed on the copper mirror and conditioned at 23°C and 50% RH for 24 hours. The results are observed and reported as shown below in figure 1.[3]

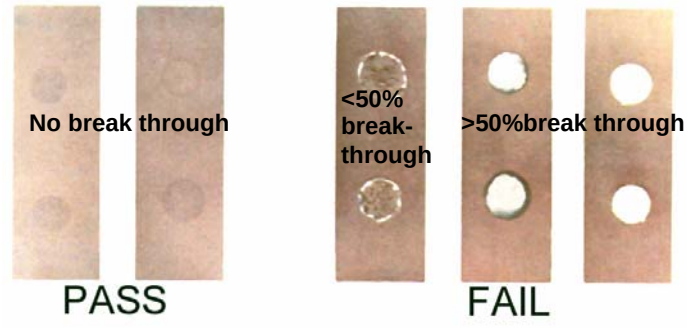

Figure 1. Copper Mirror Test results

Qualitative Halide: Qualitative halide tests indicate absence or presence of halides. If no halides are detected, the quantitative halide tests are not necessary.

- **Silver Chromate:** A drop of the test flux is applied to paper treated with silver chromate. If chlorides or bromides are present in the sample, the paper changes from a reddish color to an off-white, as shown in figure 2.[4]

Figure 2. Silver chromate test results

- **Spot Test:** A drop of test flux is placed in a zirconium-alizarin liquid, which has a purple color. If fluorides are present in the sample, the liquid changes color from purple to yellow. [5]

Quantitative Halide: Quantitative amounts of chlorides, bromides, or fluorides can be determined by ion chromatography.

Corrosion Test: This test checks the corrosiveness of the flux's residue under extreme environmental conditions. A pellet of solder is melted on a copper test panel with the test flux. It is then exposed to 40^{o}C and 100% RH for ten days and visually examined for signs of corrosion.[6]

100 Megohm SIR: The Surface Insulation Resistance test checks the resistance of the flux or its residues when exposed to high heat and humidity. Test flux is applied to copper patterns on FR-4 test coupons, processed, and placed in an 85^{o}C and 85% RH environment where they are exposed to a -48V voltage bias for 7 days. Resistance measurements must be over $1x10^{8}$ ohms on measurements taken on day 4 and day 7. Specimens are processed in accordance with the test standards, depending on the intended end use of the flux.[7]

ECM: The electrochemical migration test checks the propensity of flux residues to allow electrochemical migration, such as dendritic growth which can cause shorts, under severe service conditions. Test flux is applied to copper patterns on FR-4 test coupons (different from SIR coupons) and exposed to 65^{o}C and 85% RH for 4 days without a voltage bias. Surface insulation resistance is measured. The test coupons remain in the 65/85 environment with a 10V bias applied for 500 hours and SIR is again measured. The geometric means of the SIR readings are calculated and compared. A "pass" condition is met if the final reading is greater than or equal to 10 % of the initial reading.[8]

The description of the tests for flux activity levels is intentionally brief. The reader should consult the prevailing documents, which are noted in the "References" section of this paper, for complete test methods and details.

The results of these tests are applied to fluxes as shown below in Table 2.

FLUX TYPE	COPPER MIRROR	QUALITATIVE HALIDE		QUANTITATIVE HALIDE	CORROSION TEST	CONDITIONS FOR PASSING 100 MEGOHM SIR REQUIREMENTS	CONDITIONS FOR PASSING ECM REQUIREMENTS
		SILVER CHROMATE (Cl, Br)	SPOT TEST (F)	(Cl, Br, F)			
L0	*No evidence of mirror breakthrough*	*Pass*	*Pass*	*0.0%*	*No evidence of corrosion*	*Uncleaned*	*Uncleaned*
L1		*Pass*	*Pass*	*<0.5%*			
M0	*Breakthrough in < 50% of test area*	*Pass*	*Pass*	*0.0%*	*Minor corrosion accpetable*	*Cleaned or Uncleaned*	*Cleaned or Uncleaned*
M1		*Fail*	*Fail*	*0.5 to 2.0%*			
H0	*Breakthrough in > 50% of test area*	*Pass*	*Pass*	*0.0%*	*Major corrosion acceptable*	*Cleaned*	*Cleaned*
H1		*Fail*	*Fail*	*> 2.0%*			

Table 2. Requirements for establishing flux activity levels/flux types. The actual table in J-STD-004A has eight footnotes that should be consulted for additional information.

J-STD-004A describes how fluxes are classified by their composition and activity type. Although it offers guidance on activity and reliability tests, it does not offer guidance on how to select the proper material for particular applications. The authors propose a system of categorizing wave solder fluxes based on their formulation characteristics, with a perspective on processing, end-use, and reliability.

Flux Categorization Based on Formulation

From a formulation perspective, fluxes can be categorized in the following order: carrier type, rosin presence, activity, and halide content. Figure 3 depicts the suggested breakdown:

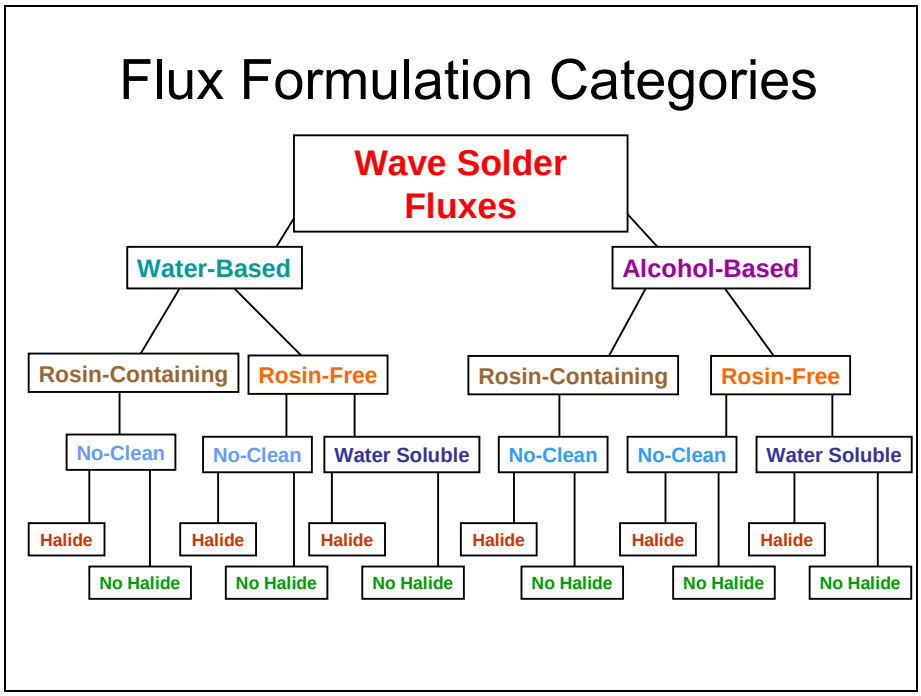

Figure 3. Wave solder flux types categorized by formulation

The carriers or solvents, the materials which hold all the other active flux constituents in solution, are primarily alcohol or water. Alcohol-based fluxes have the advantages of being able to easily dissolve ingredients, exhibit low surface tension which facilitates wetting, and are easy to dry in the preheat portion of the process, but they also carry the drawbacks of flammability and high Volatile Organic Compound (VOC) emissions. To the contrary, water-based fluxes do not bear flammability risks nor emit large quantities of VOC's, but they have lower solvency, higher surface tension, and are more difficult to dry off in preheat. Furthermore, the post-soldering residues from water based fluxes can be hygroscopic and therefore exhibit lower reliability.

Rosin (or resin) presence is the second tier of categorization, and it applies to both alcohol- and water-based fluxes. The inclusion of rosin in a flux formulation determines the nature of its residue from both electrochemical and cosmetic perspectives. Rosin permits greater activity in a flux because it encapsulates and renders harmless any ionic materials such as chlorides, bromides, or unreacted acids left in the residues that may otherwise cause reliability concerns. Rosin itself is an activator at soldering temperatures, as it is a mixture of various long chain high molecular weight acids which react with metal oxides. It is dissolved into the carrier solvent along with other active materials during flux manufacture. When heated in the soldering process it becomes molten and acts as a thermally stable aid to the soldering process, and when cooled it solidifies to act as a hydrophobic encapsulant to any ionically active ingredients which may not have volatilized during the soldering cycle. This encapsulating action allows formulators to produce relatively aggressive fluxes for high soldering yields, without compromising on post soldering reliability. Rosin-bearing fluxes are preferred for low-cost, paper-based laminates that tend to absorb fluxes into the PWB substrates.

A note on the terminology of rosin and resin: rosins are a subset of a larger chemical family of resins. Rosins are substances that occur naturally (in pine trees and other plant material) and have been extracted and refined. Resins are similar compounds that are either completely synthesised, or are highly processed rosins. Although the J-STD-004A classification system differentiates rosin-containing fluxes from resin-containing ones, when categorizing flux product families and end-uses in the remainder of this discussion, both rosin and resin fluxes are grouped together and collectively referred to as "rosin-containing" or "rosin-bearing."

Common issues associated with rosin-containing fluxes are related to the physical appearance of the residue which gets left on the board surface - it can create handling issues and hamper pin testability of the final assembly. There are several ways to proactively address these potential pitfalls. Residues from fluxes that contain rosin are often perceived as sticky or tacky. When using modern rosin-bearing formulations, the assembly should not feel sticky or tacky after it has cooled to room temperature. If it does feel tacky, that is an indicator that either a) too much flux is being applied, or b) the wave soldering process is being run "cool." Flux deposition rates should be determined by process engineering, and controlled by regular checks during production. Of all the processes involved in PWB assembly, wave solder fluxing is one of the most critical to maintain control over, as it can present the greatest reliability hazards if it gets out of control.

Poor pin testability can also be the result of too much flux on the board. Rosin-bearing flux products are specifically measured for pin testability during their development and are designed to meet certain pin testability standards as a requirement for their commercialization. If extremely poor probe contact is experienced at in-circuit test, it is often the result of too much flux applied during the wave soldering process. Again, proper process control can prevent this loss. To maintain low ambient levels of false failures on a regular basis when using rosin-bearing fluxes, best practices should be employed at in-circuit test. Test probes should be shaped appropriately for their corresponding test points, and probe/fixture cleaning and maintenance schedules should be adhered to.

Fluxes without rosins produce very minimal residues, excellent cosmetics and improved pin testability, but they must be applied under well controlled processes. In the preheat and soldering process, fluxes are activated and then deactivated by the thermal excursion to which they are exposed. If flux is applied where it may not get fully activated and deactivated, e.g. overspray that lands on the top surface of the PWB, the underprocessed (activated but *not* deactivated) flux residues can cause reliability problems in the end use environment. Laminate material must be considered when selecting a rosin-free flux, as it is generally not recommended for porous, paper-based products.

Electrochemical activity of the flux's residue determines the third tier of categorization: water washable or no-clean. A flux categorized as "water washable" is corrosive and must be fully cleaned off after soldering. Most water washable fluxes contain halides and strong organic acids

that are active at room temperature and do not get fully depleted during wave solder processing. If they were to remain on the assembly after soldering, they would continue to act on the metals in the circuits, ultimately causing failure. Because the fluxes are fully cleaned after soldering, options for the formulator are not as limited as they are in no-clean products, and water washable fluxes are usually the most highly active, effective ones available. The obvious drawbacks of water washable fluxes are that they do need to be washed, which adds cost to the assembly process, and that if they are not properly washed, reliability concerns will abound.

While no-clean fluxes reduce cost by minimizing process steps, their activity levels are limited by the need for post-soldering reliability. They must be formulated to become deactivated in the wave soldering process so that their residues will be electrically acceptable. Because they are designed to fully activate and deactivate in typical soldering cycles, a cycle that is too short may not render the residues benign, and one that is too long may spend all the activators before the assembly reaches the wave. If the activators are spent during preheat, the unavailability of active materials leads to poor solder joint quality. The need to properly activate and deactivate no-clean fluxes narrows their process window when compared to water washable products. It also narrows formulation options by limiting the list of allowable ingredients when compared to water washable chemistries.

The fourth and final tier of flux categories is presence of halides. Halides are often used as activators because of their ability to rapidly reduce metal oxides. Halides can be used as high performance activators, but they can also be the root cause of post soldering corrosion, so many users try to avoid them. Halide-free fluxes are perceived as safer, but are generally less active and exhibit poorer wetting performance.

Other Considerations

Other flux formulation constituents which play an important role in performance, but are not specifically cited in the categorization process described above include surfactants. Surfactants help the flux spread across the PWB and promote capillary action up into the plated through holes by lowering the liquid's surface tension.

To simply demonstrate the effect of surface tension on the spread of liquid flux on solder mask, a drop of each deionized (DI) water and 99.9% ispoproyl alcohol (IPA) were placed on an unpopulated area of a PWB. The surface tension of DI water is 73 dynes/cm. The surface tension of is IPA 22-23 dynes/cm. While the water remained in a single bead exactly where it was dropped (figure 4), the alcohol spread out so quickly it could not be captured in a photograph. The water and IPA were then sprayed onto the same PWB substrate. Figure 5 shows the materials immediately after they were sprayed.

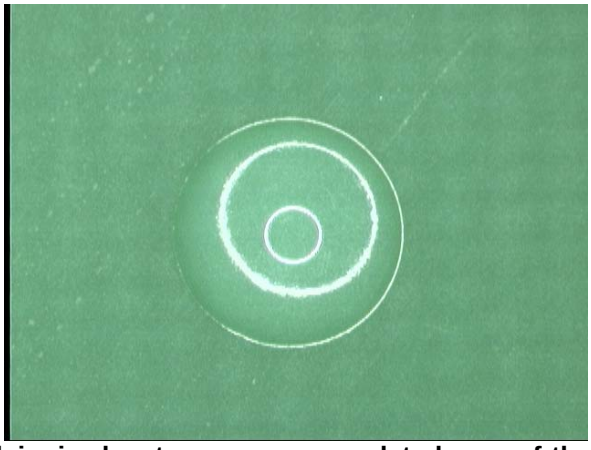

Figure 4. A drop of deionized water on an unpopulated area of the PWB. Notice how the water beads up on the solder mask.

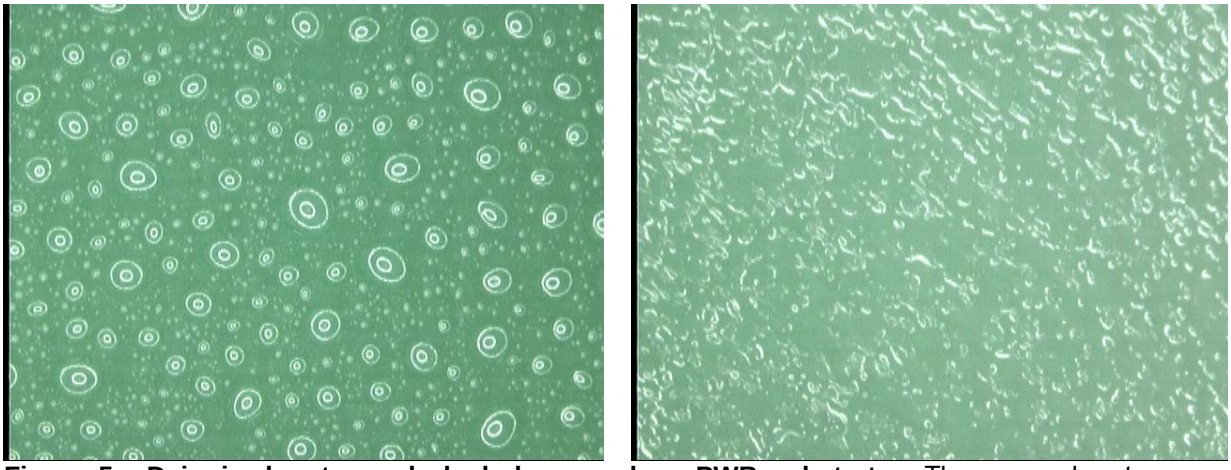

Figure 5. Deionized water and alcohol sprayed on PWB substrate. The sprayed water droplets are smaller than the one dispensed from a pipette shown in figure 4, but the alcohol's superior spread is visibly evident.

To illustrate the effect of surfactants on water, a drop of each DI water and water based no-clean flux whose surface tension was modified with surfactants (Alpha EF-2202) were placed on the PWB. The results can be seen in figure 6.

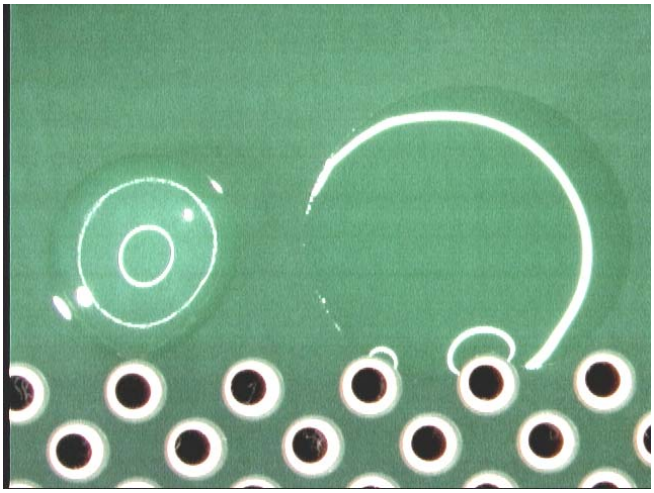

Figure 6. A drop of DI water and a drop of water-based flux on PWB solder mask. The surface tension of the water-based flux has been lowered by surfactants.

The drop of liquid on the left is DI water and the one on the right is water-based flux. The wetting (or dihedral) angle, although not accurately measurable in this simple demonstration, is visibly much higher on the DI water droplet due to its higher surface tension. Although surfactants can help decrease the surface tension of water-based flux products, they can never lower it enough to be equal to that of IPA without creating reliability hazards.

One major consideration in flux development for lead-free wave soldering is not directly related to the new alloys, but to the increases in operating temperatures and PCB contact time with the wave. It is not uncommon for contact time to be increased by more than 50%, and wave temperatures to be 25°C higher than in a SnPb process, so activators need to continue to work throughout this increased exposure. To adequately solder both tin-lead and lead-free products, no-clean fluxes must now operate in an extended temperature range, maintaining reliability in the cooler tin-lead cycles and activity in the hotter lead-free cycles.

Traditionally, acid number has been viewed as being directly related to the "available activity" in a flux. This is no longer always true, as newer formulation methods have produced some exceptions to the rule. Some fluxes with a high acid number will perform badly in a lead-free process, as they are not thermally stable and are burnt off early, allowing oxide formation and subsequent soldering defects. Some fluxes with low acid numbers have other constituents which support activity, and will perform better. When selecting a flux for lead-free soldering, the acid number of a flux should no longer be used as a primary indicator of activity.

Post soldering reliability can be assessed and graded by one of many International standards. The IPC J-STD grading system is considered the minimum requirement for many applications. Beyond this, the Telcordia test methods (previously Bellcore) are considered to be more stringent. Many fluxes pass the Telcordia electromigration test, but a considerable number fail the SIR test. Although the Telcordia SIR test is performed under different conditions than the IPC test, its minimum resistance is three orders of magnitude higher, at 1 $x10^{11}\Omega$. Reaching further is the Japanese Industrial Standard (JIS); passing this reliability test can usually only be achieved with the inclusion of rosin in the flux.

Factors in Flux Selection

Usually, the primary factors in flux selection are the performance environment of the electronic product and the assembly complexity, with residue cosmetics also weighing in. Higher performance environments typically dictate higher degrees of reliability in the flux material, while lower performance environments generally allow lower reliability. Higher complexity assemblies usually require higher activity fluxes which are more thermally stable. Residue levels and cosmetics can be a concern for operations that pin test or for products that are visible to customers or end-users.

In some cases, the location of the manufacturing site also figures into the flux selection process, as some geographic areas limit the amount of VOCs that a manufacturing facility may release to the environment. In the case of geographic environmental sensitivity, low-VOC or VOC-free fluxes are preferred. A word of caution to the reader: while all low- or no-VOC fluxes are water-based, not all water-based fluxes are low- or no-VOC. The user should not assume that a water-based flux will automatically meet their local environmental requirements; they should inquire with the supplier regarding the VOC content of their water-based flux materials. EPA method 24 provides the test protocols for determining VOC content. To be considered "VOC-free," the product must contain less than 1% volatile organic compounds by weight. Although there is no globally accepted standard definition for "low-VOC," it is usually considered to be less than 5%.

Typical Applications

At first glance, it might appear that only several combinations of formulation chemistries would be sufficient to meet all requirements and applications. Realistically, however, when all the technical and cosmetic requirements are factored together, the end result is multiple product choices even within formulation sub-categories. In other words, there is no "one size fits all" solution. This can be particularly frustrating for contract electronics manufacturers and others who build a wide variety of product types.

When selecting a wave solder flux, the three major areas of consideration are typically:

(i) end use environment/reliability
(ii) assembly complexity
(iii) residue/residue cosmetics

If these considerations are applied to different market segments of electronics assemblies, it becomes easier to understand how the end-use of the product affects both the in-process requirements and the in-service requirements, and the tradeoffs that may exist between manufacturability (solder processing and testing) and reliability.

The IPC Joint Industry Standards[9] has tried to capture all assembly types into 3 categories. These categories are defined as follows

Class 1 - General Electronic Products

Includes products suitable for applications where the major requirement is function of the completed assembly, such as home consumer electronic products.

Example of Class 1 Product: Home Consumer Electronics

The consumer electronics sector commonly uses paper-phenolic laminates. Assemblies are often glued SMT devices with radial and axial through-hole components. Assembly cost is a big consideration, but the combination of low cost laminates with some flux types poses a serious reliability hazard during the early service life of the product. In particular, rosin-free fluxes provide risk, as the porous paper laminate (such as FR-2 or CEM-1) will absorb the flux upon application. Once the carrier has dried off there is a risk that un-reacted activators remain embedded within the laminate, which when dissolved by condensation in service, could form an electrolyte and cause electromigration and eventual product malfunction. This risk is easily mitigated by the use of rosin-bearing fluxes. Any unspent activity is safely encapsulated in rosin. The use of rosin-bearing fluxes allows the use of low cost laminates, without introducing a reliability hazard.

Many products in this sector are assembled by OEM's and are never visible to customers or end-users during their service life. Therefore, residue cosmetics are not a big consideration and relatively higher levels of residue are acceptable. The preferred flux type for home and consumer electronics are rosin-bearing, alcohol-based fluxes, which allow for the high activity levels (often including halides) needed to cope with the soldering demands of low cost components and PCB's. The rosin maintains high residue dielectric strength, even in damp conditions. Recall that the inclusion of rosin in flux can lead to increased false failure rates at pin testing operations, especially if too much flux is applied during soldering. For best results, flux deposition should be monitored and test point-appropriate probe types should be used for in-circuit testing. Classification of these fluxes according to the J-STD-004A would be ROL0, ROM0, REL0, and REM0 for fluxes without halides, and ROL1, ROM1, REL1, and REM1 for fluxes with halides.

As some of the products in this class now possess more functional sophistication, the use fibreglass-based laminates like FR-4 is starting to become more popular. In the case of FR-4 substrate material, the assembler is no longer required to use rosin-bearing fluxes to insure reliability. Although the FR-4 substrate opens the choices for different flux formulations, the solderability of low cost components may still be a consideration. In this case, it is not uncommon to choose organic fluxes. These fluxes would be designated ORL0 or ORM0.

Notice that ORL1 and ORM1 are not offered as options. Halides are not combined with organic fluxes for electronics assembly, due to their corrosive nature. They can be safely used in combination with rosin-bearing fluxes, because of the encapsulation effect of the rosin. The use of halides in a formulation without rosin is what flux formulators refer to as a "recipe for disaster."

Class 2 - Dedicated Service Electronic Products

This includes products where continued performance and extended life is required, and for which uninterrupted service is desired, but not critical. Typically the end-use environment would not cause failures. Included here would typically be computers, industrial and telecommunications equipment, and automotive electronics (except for engine management, drive-train and safety-related components.)

Example of Class 2 Product : IT/Telecom Infrastructure

The most complex assemblies reside in this sector. Most of the production is double-sided SMT reflow followed by wave, or SMT reflow followed by SMT glue cure, followed by wave. In both cases the assemblies will have been subjected to two thermal

excursions prior to wave soldering. These types of circuit assemblies are typically the most heavily populated and thermally dense, having both high component and high layer counts. The oxidation on the solderable surfaces that results from the prior heat cycles combines with the high thermal density of the PWB to create a considerable soldering challenge for flux. To exacerbate the challenge, much of the production in this sector is performed by CEMs, and cosmetic acceptability of the residue becomes a consideration. Low residue levels are almost always mandatory.

The prior thermal excursions, high complexity, and need for low residues in the computer/IT infrastructure sector indicates an active, low solids material which is not overly sensitive to preheat levels. Fluxes can be water- or alcohol-based. Water-based fluxes are preferred in geographic regions that control VOC emissions, but are more sensitive to preheat in that they require more heat energy to drive off the water. Wave solder equipment should be configured with multi-zoned preheats (preferably including topside preheat) with one or more convection zones to effectively accomplish this. Alcohol fluxes are less machine dependent and do not necessarily require convection pre-heat. The low residue levels and the frequent use of pin-testing dictate rosin-free products. Common flux types used in this sector include low solids, rosin-free fluxes with high activity levels. These would be classified as ORL0 and increasingly ORM0.

Again, on an FR-4 PWB construction the OR-- category flux type is acceptable, but on paper-phenolic laminates it could present a reliability hazard. Although FR-2 is sometimes used in telecom desktop products, it is seldom used in infrastructure components. If both product families are assembled in the same facility, two different fluxes may be required.

Class 3 - High Performance Electronic Products

This encompasses products where continued high performance or performance-on-demand is critical, equipment downtime cannot be tolerated, end-use environment may be uncommonly harsh, and the equipment *must* function when required. This would typically include military weapon and defense systems, aerospace, life support systems and under-the-hood automotive electronics.

Example of Class 3 Product: Automotive Electronics

From an assembly perspective, automotive electronics are of moderate complexity. Electronics designers tend not use smaller components unless absolutely necessary. The overriding consideration in the design is for electrical and mechanical reliability. PCB area is usually small, with a low layer count (less than 8) due to lower interconnection densities when compared to many Class 2 products. PCB's are commonly an FR-4 epoxy glass construction with plated through holes. The key requirements for this sector are to achieve a high yielding and consistent soldering process while guaranteeing electrochemical reliability under relatively high voltage and harsh environmental conditions. The reliability requirements point toward a rosin-based, halide-free flux. The rosin provides consistently high-yielding soldering and long-term reliability. Typically this type of manufacturing process is well controlled, and problems associated with applying too much rosin-based flux are not often encountered. Halides are typically not required to achieve good soldering on this type of product, and the absence of halides improves the reliability of the flux's residue. Water-based fluxes may be used, but alcohol-based fluxes are generally preferred because they are more preheat-compatible and their better wetting can improve hole fill. The most logical selection for lead free automotive assemblies - alcohol-based, rosin-bearing, halide-free flux. – would be classified as ROL0, ROM0, REL0 or REM0.

Conclusion

There are many types of wave solder flux available to assemblers. To aid in differentiating and describing the flux types, J-STD-004A can be used. To determine which type of flux is best for a

given product or process, particularly when transitioning to lead-free, the user must consider the construction and end use of the product and understand the implications of activity, reliability, and residue cosmetics on the final assembly.

References

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