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American Competitiveness Institute

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The EMPF is a U. S. Navy-sponsored National Electronics Manufacturing Center of Excellence focused on the development, application, and transfer of new electronics manufacturing technology by partnering with industry, academia and government centers and laboratories in the U.S.

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Designing for Environmental Compliance

Product engineers have been designing for conformity to environmental standards for several years. Since 2003, several pieces of legislation have been enacted, including the Directive 2002/95/EC on the Restriction of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS, European Union), The Administrative Measure on the Control of Pollution Caused by Electronic Information Products (China), The Act for Resource Recycling of Electrical and Electronic Equipment and Vehicles (Korea), and The Electronic Waste Recycling Act of 2003 (State of California, USA). Each directive sets limits for the maximum concentration by weight of certain substances that can be present in a product. The product categories that are affected by the legislation are:

- Household Appliances
- IT Equipment
- Telecommunications Equipment
- Consumer Equipment
- Lighting Equipment
- Toys, Leisure, and Sports Equipment
- Automatic Dispensers

Medical devices and monitoring / control instruments are exempt from the current requirements as are certain infrastructure equipment in the telecommunications category.

In spirit, the legislation is addressing the environmental impact of electronics products at the end of their service life, when the product is discarded. Lowering or eliminating the presence of banned materials in products produces lower concentrations of these substances in waste streams. These requirements, which had been considered for many years, are now enforced by law. The risks to a manufacturer that attempts to ship a product that is not in compliance include an import ban as well as other monetary penalties.

Fortunately for product designers, adherence to the new environmental requirements is much easier to achieve as component manufacturers now support a green supply chain. In addition, manufacturing technology advancements have made it possible to produce reliable assemblies with green components and materials. Still, it is critical for product engineers to understand the fundamentals of green design, and more critically, how to authenticate the green compliance of the parts and processes used to produce a product.

The substances which are addressed by the environmental legislation are lead, cadmium, mercury, hexavalent chromium, poly-brominated biphenyls, and poly-brominated diphenyl ethers. These six materials have seen widespread use in a broad range of electronic components. The ban on lead required changing the materials and processes used for soldering. Cadmium was commonly used for connector contacts and in switches. Mercury could be found in relays, switches and flat screen backlighting systems. Hexavalent chromium was used as a corrosion inhibitor for metal housings. Poly-brominated biphenyl and poly-brominated diphenyl ether were added to plastics to reduce the flammability of those materials.

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Ask the EMPF Helpline!

Recently, a customer called the EMPF Helpline after observing intermittent opens on their Thin and Fine Pitch Ball Grid Arrays (TFBGA)...

Recently, a customer called the EMPF Helpline after observing intermittent opens on their Thin and Fine Pitch Ball Grid Arrays (TFBGA). Their Printed Wire Assembly (PWA) is a lead free design and the TFBGAs were soldered with SAC305 (Sn 96.5%, Ag 3.0%, Cu 0.5%) solder paste.

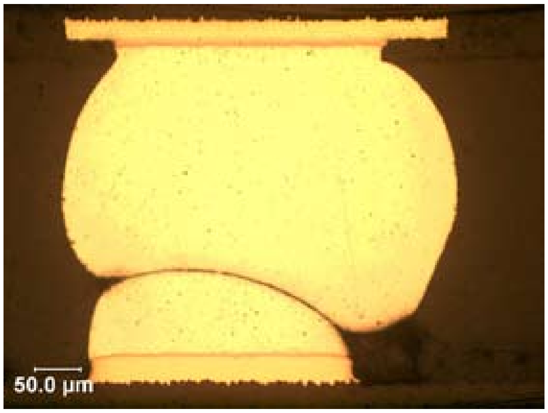

Figure 2-1: “Head and Pillow” non-wetting between solder paste and solder ball.

X-ray inspection of the identified failure locations on the TFBGA indicated that there may have been non-wetting between the paste and the solder balls. This type of non-wetting is seen in Figure 2-1 and is referred to as “head and pillow”. Confirmation of “head and pillow” failures requires destructive analysis. The EMPF micro-sectioned the failed TFBGAs to examine the possible failure location (Figure 2-2).

Optical microscopy indicated that the solder paste never wetted the solder balls. Further analysis using high magnification Scanning Electron Microscopy (SEM) imaging (Figure 2-3), clearly shows a gap between the solder ball and solder paste. The pads were observed to be well adhered to the substrate with minimal voiding in the solder balls. The failed ball joints did not show cracks or separations at the solder to pad interface or at the component to solder interfaces. Energy Dispersive Spectroscopy (EDS) analysis of the bulk solder confirmed that lead free, Sn based solder was present in both the ball and paste regions.

SEM/EDS analysis at the component to solder interface (Figure 2-4) detected the presence of Sn and Ni intermetallic compounds (IMC). These compounds indicate that sufficient heat was applied to obtain the necessary melting and dissolution required for good solder joint formation. In addition, SEM/EDS analysis at the solder to pad interface detected the presence of Sn and Cu, another indication of an IMC formation which confirms good wetting of solder to the pads and components. Due to the lack of phosphorous and cracks in the intermetallics, the EMPF concluded the failure mechanism was not related to “black pad”. The destructive failure analysis confirms that the intermittent open failures are the classic “head and pillow” case of non-wetting between solder balls and solder paste. This is usually the result of a non-optimized reflow profile allowing the solder paste to finish reflowing and the flux to completely volatize before reflow occurs at the solder ball. The observation that only certain solder joints displayed the “head and pillow” appearance may be due to these solder joints being located near more thermally conductive traces.

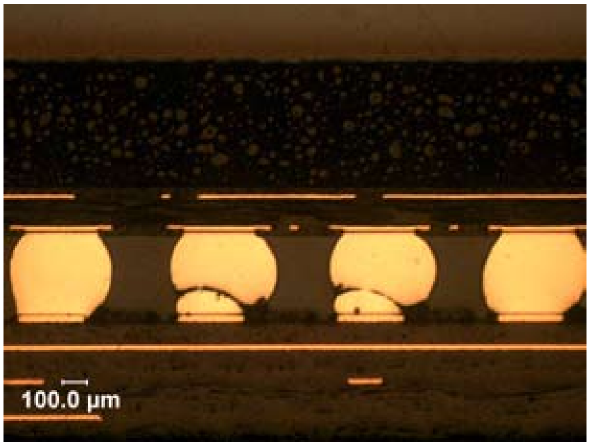

Figure 2-2:TFBGA micro-section of intermittent open locations.

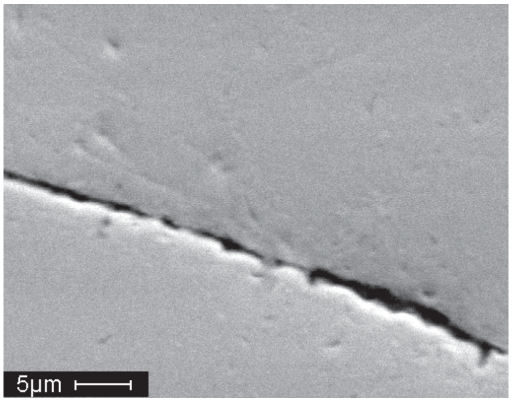

Figure 2-3: Highly magnified SEM view of the gap between solder ball and paste.

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Designing for Environmental Compliance (continued from page 1)

While the source of these banned substances is mostly found in the components, it is the product producer that is responsible for compliance to the environmental standard. The product producer introduces the raw material into the marketplace where the consumer, in time, transfers the electronics product into the waste stream. Fortunately for the products producer, the component and material suppliers ultimately provide the supporting documentation for to prove the environmental compliance of an electronics assembly. The elimination of the banned substances from a product can be largely achieved by simply partnering with electronics suppliers who can readily authenticate the materials composition of the components that are used in the final product.

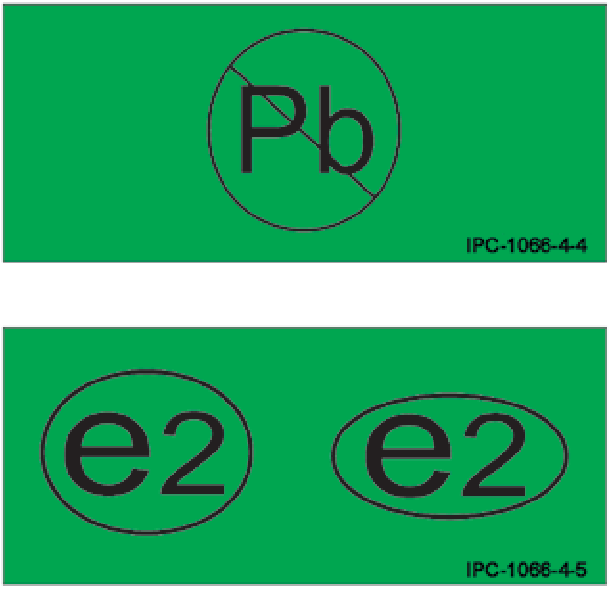

Figure 1-1: IPC marking for environmental compliance standards

When selecting a component for a design, it is important to check the RoHS status of a device in addition to verifying the electrical characteristics of the device. Component manufacturers and component distributors are increasingly providing this information on web sites and on datasheets. The available information varies from a simple declaration that a device is RoHS compliant to more detailed reporting where the actual concentrations of the banned materials are indicated. Note: A lead free declaration only indicates partial RoHS compliance.

An effort has been made to standardize the exchange of RoHS compliance information between component suppliers and users. A volunteer committee consisting of members of the IPC with representatives from component manufacturers, products companies, electronic assembly manufacturers developed the IPC-1750 standard set. The documents provide specific guidelines to develop consistent data exchange formats to improve environmental data transfer throughout the global supply chain. The standards are available for free from the IPC. Printed circuit boards are also affected by the environmental compliance standards (Figure 1-1). The processing notes found on PCB fabrication drawings traditionally specified PB HASL or lead hot air solder level finishes. Pb HASL cannot be used in RoHS applications. A number of RoHS compliant and Pb free finish options are supported by PCB fabricators. Immersion White Tin, Immersion Silver, Immersion Gold and Pb free HASL are all RoHS compliant finishes.

Finally, the designer must consider the impact of the Pb free soldering process on the selection of components for an electronic assembly. Pb free solder processes require higher temperature reflow profiles. The higher temperature profile may damage or degrade plastic components that were previously compatible with the lead soldering profile.

Keith Sullivan - Senior Design Engineer

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VOC-Free Wave Soldering Fluxes

Environmental concerns are becoming increasingly more important in the development of manufacturing processes. Long gone are the days of using carcinogenic ozone depleting, yet extremely effective, chemicals to clean flux residues from the surfaces of boards. The strict controls on trichloroethylene implemented as part of the Montreal Protocol have spurred the popularity of no-clean and water soluble soldering fluxes as well as more environmentally friendly cleaning solvents. The RoHS (Restriction of Hazardous Substances) legislation by the European Union as well as other regulations with similar scope, have banned the use of lead in solders for many products. This has increased the popularity of lead-free solders, especially among manufacturers of commercial electronics. The ISO 14000 series of environmental control systems standards requires manufacturers to continually improve their environmental performance. These standards and regulations have acted to increase the sensitivity of manufacturers to the environmental impact of their manufacturing processes.

Figure 3-1 Typical wave solder process

One of the ways in which a manufacturer's environmental performance can be improved is by the reduction of VOC (Volatile Organic Compound) emissions during the manufacture of electronics assembly. The Environmental Protection Agency defines a VOC as "any compound of carbon, … which participates in atmospheric photochemical reactions." The EU defines a VOC as "any organic compound having an initial boiling point less than or equal to 250°C when measured at a standard atmospheric pressure of 101.3 kPa." The environmental impact of VOCs are manifested by the fact that many VOCs are greenhouse gases and many others react with nitrogen oxides and deplete ozone in the atmosphere.

For most manufacturers, the largest area of high VOC usage with known tested alternatives is currently the wave solder process. Wave soldering fluxes have historically been comprised of a fluxing agent in a solution of IPA (isopropyl alcohol). The solvent content in these fluxes can be in excess of 95%. A properly developed wave solder process will evaporate the IPA carrier after the flux solution is applied to the assembly. In addition, the use of IPA based thinners is required to control the viscosity of the flux materials during wave or foam flux application methods, increasing the amount of IPA used during the wave solder process (Figure 3-1). As IPA is considered a VOC by both the EPA and EU definitions, this is an area where significant reduction can be made by developing a process that uses fluxes that do not contain VOCs.

VOC-free soldering fluxes replace the IPA solvent with water. This is not a simple drop-in replacement for existing VOC-bearing flux materials, as some of the pertinent properties of water differ from those of IPA. The most significant property that differs is the boiling point, but consideration for the differences in the freezing point and surface tension need to be accounted for as well. When properly implemented, the use of VOC-free fluxes can result in a process with equivalent quality as one that uses VOC-bearing fluxes but with a much lower impact on the environment.

The first change in strategy when implementing a VOC-free wave soldering flux, is the change in storage and handling considerations. The freezing point of water (0°C) is much higher than that of IPA (-89°C). Because of this, more care needs to be applied to exposure to low temperatures, especially during transit between a supplier and a user. If a water-based flux is allowed to freeze, the fluxing agent may precipitate out of solution, resulting in a material that is not homogeneous when introduced to the process. This can result in an increase in soldering defects as a result of inconsistent flux material deposition on the assembly.

One benefit of switching to a water-based flux is the reduced flammability hazard when compared to its alcohol based counterpart. As water is non-flammable, water-based fluxes no longer have to be stored in special cabinets on the production floor. Fire suppression systems no longer need to be considered as a necessary part of a wave solder installation. Shipping methods for raw flux materials are not restricted due to flammability concerns.

Additional storage and handling related benefits to water-based fluxes is the reduced evaporation of the solvent when compared to IPA. This requires less monitoring and control of the flux's acid number and viscosity and reduces the need for thinner addition. One drawback to the reduced tendency for evaporation, when using a water-based flux, is the increased likelihood that condensed water may build up in the wave solder equipment.

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Lead Free Assemblies

Due to legislation put forth by European Union (EU) and Asian governments, electronics manufacturers are now contending with a conversion to lead-free solder electronics manufacturing. The EU legislation went into effect in July 2006. Lead-free manufacturing has become the newest technology driver in electronics manufacturing.

While the binding EU and Asian legislation are directed toward the commercial electronics industry, it is inevitable that military and aerospace hardware will be manufactured with lead-free solders in the future due to the small percentage of the electronics industry (1 to 2 per cent) that is represented by military equipment. The EMPF is continuing to work with military hardware manufacturers and government agencies to identify and mitigate risks associated with the mandated lead-free manufacturing.

The EMPF has been involved in Lead-free electronics for many years. Since the late-1990s the Department of Defense (DoD) has been concerned with the long term reliability of new lead-free electronic hardware. Thermo-mechanical modeling of the visco-elastic properties of lead-free solders including creep fatigue, elastic and plastic strain, thermal expansion, elastic modulus, and stress relaxation, are critical details in the extrapolation of performance for a given set of environmental conditions. Presently, the ability to predict reliability solely on lead-free material attributes and behavior is not sufficient to warrant confidence in a result without verification of the mode of failure and the trigger mechanism responsible for the effect. Engineers must understand the differences between the common lead-free solder alloy systems and the tin-lead system. Production of high reliability electronics relies on the combination of an understanding of lead-free materials systems, implementation of standardized production processes, and establishment of a quality control system based lead-free materials.

In 1998-2000 the EMPF developed and began to teach a 2-day Lead-Free Electronics Training course in anticipation of the need for both government and industry to understand and deal with the critical ramifications of using lead-free electronic hardware in AHR (Avionics and High Reliability) systems. The need for this training became critical in July 2006, when the premiere piece of legislation, the European Union RoHS (Restriction on Hazardous Substances) went into effect, banning any electronics hardware from European markets. The EMPF course (and its custom analogs), upgraded continuously over the years, has graduated nearly 500 students from both the private and public electronics manufacturing sectors. Continuous upgrades of this course were facilitated by the high importance attached to this subject in concert with the center's Navy ManTech mission.

The EMPF course, titled "Lead-Free Manufacturing" consists of two half-days of lectures on the subjects associated with lead-free electronics and two half-days of hands-on exercises in surface mount component reflow soldering, wave soldering, rework, and repair of actual lead-free electronic assemblies. Participants in this course will gain an understanding on the technical and legislative issues surrounding the implementation of lead-free solders in an electronics manufacturing environment. The student will acquire the technical insight necessary to ascertain the reasons behind the selection of components, alloys, substrates, finishes, design, and environmental tests to achieve reliability in lead-free assemblies. The engineer will gain an understanding of facilitating the preventative measures necessary to retain DoD critical mission compliancy for electronic assemblies. All of the standard courses listed in the EMPF course schedule are administered in Philadelphia, but can be taught at any suitable location for in-house training if desired.

This central position of the EMPF in the RoHS lead-free electronics government/industry implementation ensures that updates to the EMPF lead-free training course are timely and authoritative. The EMPF has also been instrumental to the offering of a lead-free electronics workshop in concert with the Defense Microelectronic Activity (DMEA) and several other ELF IPT (Executive Lead Free Integrated Process Team) members for DoD Program Managers. This workshop clearly outlines the role of the GEIA (Government Electronics and Information Technology Association) Lead-Free Standards documents in the implementation of the proposed DoD policy and acquisition strategy. The workshop is slated by the DMEA to become a Continuous Learning Module within the Defense Acquisition University.

Fred Verdi- Engineer

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Manufacturer's Corner: Conformal Coating Systems

Circuitry does not last forever, but coating electrical components will significantly increase functionality over time. The process of conformal coating can be completed through a variety of methods, from spraying and dipping to flow and selective or automated machines. Conformal coating is used in many different industries, from consumer and industrial electronics to the military. This type of coating must be able to hold up under a variety of adverse environments, including humid and hot conditions.

There are a variety of external agents which can decrease the life of electrical circuitry. Moisture, dust, and even salt air can corrode the internal conduction of any circuitry. Conformal coating resists these agents and extends product life.

The EMPF has two conformal coating application machines from GEN3 Systems, the DC2001 dip coater and the SB2900 sprayer.

Figure 5-1 Gen3 2001 dip coater

The model DC2001 dip coating machine is a small, safe, and easy to use batch system for the application of conformal coating materials and photo resists by accurate and precise dipping. It features a regulated speed control that can be adjusted to apply a wide range of different viscosity materials in order to obtain an extremely smooth, even coating thickness to a tolerance of ±5%. In addition, a pneumatically driven air-over-oil system enables the substrate carrier to operate in a smooth motion during immersion and withdrawal strokes. The speed of the strokes is variable and can be independently programmed and controlled. Viscosity monitoring is also provided featuring a flow cup stopwatch and conversion table. Since the model DC2001 is totally air operated, it is safe to use with all flammable liquids and can process over 100 assemblies an hour.

The model SB2900 coater has been specially designed for the application of conformal coatings to PCBs by batch spraying. It features an ergonomic design to minimize operator fatigue and provides greater control of the spray gun position and direction. This limits overspray and unnecessary material wastage.

The SB2900 can be equipped with an explosion-proof UV or white light and employs a hands-free, rotating table for visual inspection. The spray chamber has a restricted opening and downward extraction plenum chamber to limit operator exposure to solvent vapor. To ensure optimum filtration efficiency, the primary, secondary, and tertiary filters are all easily replaceable.

A standard 10 liter pressure pot feed system can be supplied with pre-blended material to minimize filling downtime as well as solvent pressure pots for semi-automatic purging and cleaning of the spray head. These can be stored in the integrated storage space beneath the booth.

Figure 5-2 Gen3 SB2900 sprayer

The SB2900 spray booth is specifically designed for optimum operator health and safety as well as minimum material waste during the spraying of boards or assemblies.

Gen3 Systems works closely with industry standards development bodies such as IEC (International Electro-Technical Commission) and IPC. Graham Naisbitt, Gen3's President, will be giving a workshop discussing the theory and practice of conformal coating on May 19th and 20th at the EMPF. For more information related to this equipment, please contact Ken Friedman, 610-362-1200 x279 or via email at kfriedman@aciusa.org.

Ken Friedman - EAB Coordinator

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Graham Naisbitt, Gen 3

May 19-20, 2008

For more info, contact
Ken Friedman, EAB Coordinator
610-362-1200 ext 279
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Tech Tips...
Lead-Free Reworking

Hand soldering, paste reflow, and wave soldering are the dominant forms of technology used to apply solder in the manufacturing of electronic assemblies. They pre-date the shift toward the greener, lead free processes now making their way into the mainstream of electronic manufacturing.

The transition process (Figure 6-1) presents a daunting number of possible permutations of board finishes, component finishes, and solder alloys that may manifest themselves in an assembly operation, most often at an inconvenient time. Engineers, operators, and technicians must be cognizant that there are different manufacturing parameters for producing lead free assemblies and the subsequent rework that follows.

	SnPb Processes	Lead Free Processes
Production	SnPb Solder SnPb Finished Boards SnPb Finished Components	Lead Free Solder Lead Free Finished Boards Lead Free Finished Components
Transition & Sustainment	SnPb Solder SnPb Finished Boards Lead Free Finished Components	Lead Free Solder SnPb Finished Boards Lead Free Finished Components
	SnPb Solder Lead Free Finished Boards SnPb Finished Components	Lead Free Solder Lead Free Finished Boards SnPb Finished Components
	SnPb Solder Lead Free Finished Boards Lead Free Finished Components	Lead Free Solder SnPb Finished Boards SnPb Finished Components

Figure 6-1: Transition process to Lead Free Manufacturing

cut here and save!

Hand Soldering

One of the more common problems often overlooked with reworking a lead free solder joint, is the importance of pre-heating substrates prior to the application of the soldering iron to the joint area. The pre-heating will reduce the contact time of the soldering tip to the joint, which will mitigate the localized overheating of the underlying pad. A controlled temperature hot plate is a recommend tool for preparing the substrate for lead free soldering. The following conditions can be used for soldering SAC 305 (Sn 96.5%, Ag 3.0%, Cu 0.5%):

- preheat temperatures – 100 to 125° C
- soldering tip temperatures – 345° C
- tip dwell times less than 2 seconds

Another important aspect of securing a successfully re-worked solder joint, is to ensure total cleanliness of the area to be reworked. This includes using clean soldering tips, and removing old solder from both the component and pad area. Contamination of the newly applied solder will result in the formation of oxides that will prevent proper wetting and bonding. Often, to compensate for difficulty in applying a proper fillet, an operator may affix the soldering iron in the pad area for an excessive amount of time, causing delamination of the substrate. It is important to remember that the tip temperatures are considerably higher for lead-free soldering. Compensating with additional flux is not a panacea to correct improper technique and incorrect soldering parameters. Excessive flux can lead to cleaning difficulties and disproportionate formation of solder voids from volatile flux residuals.

Ball Grid Array (BGA) Rework

Among the commonplace areas where the transitional phase from Sn/Pb to lead free will impact production and quality, is in the placement of mixed solder BGAs. The EMPF has encountered numerous applications where a mismatch in the paste and BGA solder alloy, has caused the formation of cold solder joints. For example, the operator presets their profile to accommodate a eutectic paste alloy, while applying a SACB (SnAgCuBi) solder ball, resulting in a non collapsed BGA (Figure 6-2).

Figure 6-2 non collapsed BGA

In situations such as this, it is recommended that the profile from the higher melt alloy be used to induce homogeneity in the formation of the solder. Temperatures are typically 30-40° C higher at the liquidus peak, than the eutectic Sn/Pb counterpart. Keep in mind, the desired peak temperature of the alloy can be

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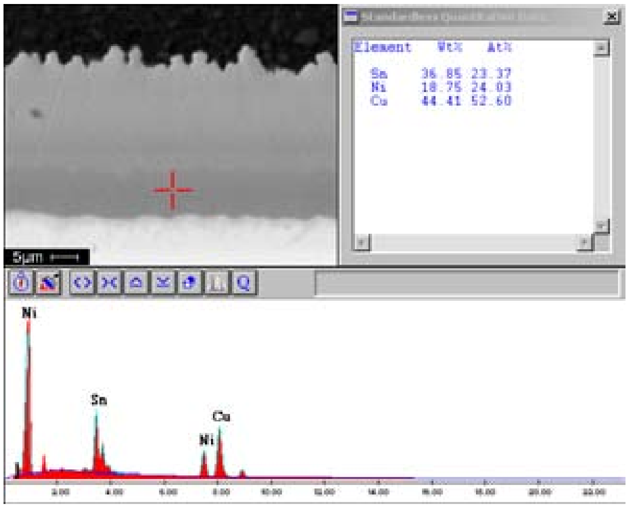
Ask the EMPF Helpline (continued from page 2)



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Element    Wt%    At%

  Sn      36.85  23.37
  Ni      18.75  24.03
  Cu      44.41  52.60
```

Figure 2-4: IMC composition of component to solder ball interface. (Cross hairs show location of the IMC)

The EMPF recommends reviewing the reflow profile in order to solve "head and pillow" failure modes. In addition, the EMPF recommends checking the paste printing variables (printing speed and pressure) to assure that the proper amount of paste is deposited on the PCB. This can be affected by the contact between the stencil and the PCB, the stencil thickness, and the aperture design.

Finally, the EMPF recommends reviewing the board designs for excessive heat transfer that may prevent the proper reflow of the solder balls. A large ground plane located near the TFBGA may conduct enough heat away to interfere with proper reflow of the solder balls. Preheating the board and modifying the reflow profile may be necessary for the solder balls to reflow properly. A board designed for extreme conductive cooling may become a soldering challenge for the manufacturing engineer.

The EMPF offers a full range of lab services that support BGA and TFBGA failure investigations. These services include X-ray examinations, elemental analysis using X-ray fluorescence (XRF), solderability tests, micro-sectioning, and SEM/EDS. The EMPF also offers manufacturing process development support such as board design reviews for excessive cooling. More information about these services can be found on the EMPF web site, http://www.empf.org or by calling the EMPF technical staff at (610) 362-1320.

Rebecca Morris - Materials Engineer

Tech Tips...

Lead-Free Reworking (cont. from page 7)

substantially higher than its melting point, and will depend upon the efficiency of the reflow system to handle the gradient heat effect.

Some applications where a stenciled paste deposit is not warranted or prohibitive, the use of a tacky flux (which incorporates mixtures of flux and residual amounts of alloy), can be substituted. The profile, as exemplified in a typical BGA rework station, should have the appropriate zone parameters at the preheating, soak, and liquidus stages. As in any reflow process, it is imperative that a test board be sacrificed so that a proper profile can be developed. This is done by creating a "temperature envelope" around and directly under the BGA, by the strategic placement of thermocouples. This will ensure that temperature uniformity is being achieved across the zone of interest, and that no adjacent components are being adversely affected due to excessive heat.

The use of lead free solder and finishes has become essential in both new designs and field applications where reworked substrates and replacement components are required to keep pace with a changing COTS (commercial off-the-shelf) supply chain. The EMPF has been at the forefront of these changes, and is committed to helping our valued customers through the technical roadblocks.

Carmine Meola- Manager, Factory Services & Training

VOC-Free Wave Soldering Fluxes (continued from page 4)

This could potentially result in corrosion of metal surfaces, which is not a concern with IPA. Increased diligence towards cleaning and maintenance is required to ensure this does not damage the equipment over time.

The surface tension of a water-based flux is different than that of an alcohol-based flux. This property affects the ability of the flux to spread and cover an assembly when it is applied. Water has a significantly higher surface tension and thus a greatly reduced ability to spread to an assembly after application. This can result in areas of an assembly devoid of flux during soldering and the typical defects that can occur when flux is not present during soldering. Water-based fluxes require the addition of a wetting agent or an organic co-solvent during formulation to reduce the surface tension of the material. A user that requires true “VOC-free” material should inquire as to the additive used on a candidate water-based flux, as organic co-solvents may themselves be VOCs.

The most significant difference in material properties between water-based and alcohol-based fluxes is the change in the boiling point of the solvent in the flux system. The boiling point of water is 100°C; the boiling point of IPA is 82°C. In addition, water has a higher volatilization energy (the energy required to change a material from a liquid to a gas once the boiling point has been reached) than IPA. Without appropriate development and control of the preheating profile, there is a potential for a residual solvent to remain on the assembly during exposure to the solder wave. When solvent contacts the solder wave, it explosively boils off and results in spattering of solder. This spattering can result in the presence of random solder balls located on the assembly.

There are two concerns that need to be addressed in order to alleviate the potential issues in evaporating the water off an assembly utilizing VOC-free fluxes. The first is the increased temperature requirement for the preheat profile. A comparison of products from a North American flux manufacturer shows that the topside preheat temperature requirements increase from 3° - 10°C when switching to a VOC-free flux, from a VOC-bearing flux. Careful profile development must be performed in order to ensure that excess solvent is not present during contact with the solder wave. Care must also be exercised to ensure that the preheat profile is not too high. This can deplete the activity of the flux too early in the process, which can result in typical solder defects due to premature flux evaporation.

The second consideration is the type of preheat technology used to impart heat to an assembly. A convection-based preheater, e.g. forced air, is recommended as it is a more effective method of preheating than purely radiation-based preheaters. This is due to the increased amount of energy required to evaporate water. In addition, the act of blowing air across the bottom of a fluxed assembly, expedites the removal of excess water that may be present.

VOC-free soldering fluxes are a viable alternative to existing wave solder fluxes for the manufacturer that is sensitive to the environmental impact of their manufacturing processes. VOC-free fluxes offer some additional benefits, most notably due to the fact that they are non-flammable. Conversion of a process to use VOC-free fluxes requires careful profile development as the process window is narrower than that of alcohol-based fluxes. Once a good process is developed, VOC-free flux materials can produce a process quality equivalent to alcohol-based fluxes, but with a significantly reduced impact on the environment.

Jason Fullerton - Senior Product & Applications Engineer

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1 *“Title 40: Protection of Environment, Part 51-Requirements for Preparation, Adoption, and Submittal of Implementation Plans, Subpart F—Procedural Requirements, 51.100: Definitions.”* (Website). GPO Access: Electronic Code of Federal Regulations (e-CFR), United States Government Printing Office.

2 *“Directive 2004/42/CE of the European Parliament and of the Council”* (Website.) EUR-Lex, European Union Publications Office.

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April 24-25
June 5-6
August 21-22
October 30-31

IPC-A-610
January 21-25
February 25-29
April 14-18
May 12-16
June 9-13
July 21-25
August 11-15
September 15-19
October 13-17
November 3-7
December 1-5

IPC-A-610 Recertification
January 15-16
March 18-19
May 13-14
July 15-16
September 9-10
December 9-10

IPC-A-600 PWB Acceptability
January 8-10
February 26-28
April 8-10
May 27-29
July 29-31
August 26-28
October 7-9
November 18-20

Rework, Repair, & Modification of Electronic Assemblies IPC-7711/7721 CIT Certification
January 28-February 1
March 3-7
June 9-13
July 7-11
September 22-26

IPC-7711/7721 CIT Recertification
February 18-19
April 1-2
June 23-24
September 2-3
November 17-18
December 2-3

CIS/Operator

IPC J-STD-001
Call for Availability

IPC/WHMA-A-620 Wire Harness Manufacturing
March 11-13
June 24-26
September 30 -October 2
December 16-18

SMT Rework & Circuit Repair IPC-7711/7721 (Modules 1 & 4-7)
February 11-14
May 5-8
August 11-14
October 27-30

SMT Rework/ IPC-7711 (Modules 1, 4-6)
February 12-14
May 6-8
August 12-14
October 28-30

Surface Mount & Thru-Hole Rework of Electronic Assemblies IPC-7711 (Modules 1 & 3-6)
March 17-20
July 28-31
October 6-9

Repair & Modifications of PCB's IPC-7721 (Modules 1 & 7-9)
February 4-7
April 28 - May 1
August 4-7
November 10-13

Circuit Repair IPC-7721 (Modules 1 & 7)
February 4-5
April 28-29
August 4-5
November 10-11

IPC Challenge
January 18
February 22
March 21
April 25
May 16
June 6
July 18
August 22
September 12
October 31
December 5

Skills

Chip Scale Manufacturing
March 25-27
June 17-19
October 21-23

BGA Manufacturing Inspection & Rework
January 17-18
April 3-4
June 19-20
July 23-24
August 27-28
October 15-16

Continuing Professional Advancement in Electronics Manufacturing

High Reliability Certification
Call for Availability

Lead Free Manufacturing
February 27-28
May28-29
October 16-17
December 10-11

Design for Manufacturability
February 20-21
April 9-10
May 21-22
August 6-7
October 8-9

Failure Analysis and Reliability Testing
January 9-11
March 4-6
May 20-22
July 8-10
September 9-11

Wave Soldering
January 22-23
April 1-2
September 2-3
December 16-17