Organic Solderability Preservative Evaluation

Federal Manufacturing & Technologies

G. A. Becka,
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Topical Report

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Abstract

An evaluation was conducted to determine the possible replacement of the hot air solder leveling (HASL) process used in the AlliedSignal Federal Manufacturing & Technologies (FM&T) Printed Wiring Board Facility with an organic solderability preservative (OSP). The drivers for replacing HASL include

- *Eliminating lead from PWB fabrication processes;*
- *Potential legislation restricting use of lead;*
- *Less expensive processing utilizing OSP rather than HASL processing;*
- *Avoiding solder dross disposal inherent with HASL processing;*
- *OSP provides flat, planar surface required for surface mount technology product; and*
- *Trend to thinner PWB designs.*

A reduction in the cost of nonconformance (CONC) due to HASL defects (exposed copper, solderability, dewetting and non-wetting) would be realized with the incorporation of the OSP process. Several supplier HASL replacement candidates were initially evaluated. One supplier chemistry was chosen for potential use in the FM&T PWB and assembly areas.

Summary

In an effort to reduce hazardous waste and cost of nonconformance in the Printed Circuit Boards Fabrication Department an evaluation was undertaken to replace the hot air solder leveling (HASL) process. The goals were to eliminate the use of lead in printed wiring board (PWB) fabrication and reduce and eliminate exposed copper, solderability, dewetting, and nonwetting defects. A literature search was conducted and technical conferences were attended to determine what alternative chemicals and processes exist for HASL. Nine suppliers were selected. Doublesided epoxy/glass and polyimide/glass PWB products were sent to the suppliers for processing. Test panels were returned to Allied Signal Federal Manufacturing & Technologies for evaluation. Solder rise time testing eliminated some of the suppliers that failed the solder-rise time (required < 10 seconds). Hand soldering and drag soldering of test panels were performed. Based on the test evaluations and quantity of other PWB fabricators using a specific organic solderability preservative (OSP) coating, one supplier was selected. The supplier's chemistry was procured and brought in-house. Additional test panels were fabricated. Solderability issues concerning board assembly are being investigated.

Discussion

Scope and Purpose

This project was undertaken in response to Department of Energy initiatives to reduce hazardous waste. The goal was to reduce hazardous waste and CONC (cost of nonconformance) attributed to the Printed Circuit Boards Fabrication Department associated with the tin-lead in the hot air solder leveling (HASL) process. The elimination of lead (a heavy metal) from the printed wiring board (PWB) fabrication process will benefit all programs.

Activity

Phase I: Evaluation of Supplier Chemistries

In 1993, doublesided epoxy/glass and polyimide/glass PWB products were sent to nine suppliers that offered protective coatings as HASL replacement candidates. The boards were sent back to AlliedSignal Federal Manufacturing and Technologies (FM&T) for evaluation. The nine suppliers were

1. Duratech
2. Litton Kester
3. Alpha Metals
4. Electro-Chemicals
5. Technic, Inc.
6. MacDermid
7. Enthone/OMI
8. Atotech
9. Ardrox.

In addition, bare copper panels and the standard Gyrex process were evaluated.

Solder rise time testing was performed using a Multicore Universal Solderability Tester. The Multicore solder-rise option assesses the plated-through-holes in PWBs by applying a solder globule to the underside of a PWB and measuring the time required for the solder to rise to the top of the hole. The longer the time for solder to rise to the top of the land indicates poor wetting and solderability. The Multicore will record all time up to 10 seconds, then fail all samples above the time limit. A specified flux and 75-mg (milligram) solder pellet were used on all PWBs. Six supplied chemistries failed the test (Duratech, Litton Kester, Alpha Metals, Electro-Chemicals, Bare Copper Panels cleaned using ChemCut Cleaner, and Technic, Inc.). Six supplied chemistries passed the test (MacDermid, Enthone/OMI, Atotech, Ardrox, and the standard Gyrex process).

In October-November 1993, the PWB supplied evaluation panels were hand soldered and drag soldered. In addition, the standard Gyrex HASL process and bare copper PWB panels with no solder (chemically cleaned using the Department ChemCut Cleaner) were also evaluated. Hand soldering was performed using No. 185 Rosin Flux from Litton/Kester and No. 44 Resin Core Solder with a 600-degree Metcal soldering iron with no touchup. Drag soldering was performed using the following settings. A No. 185 Rosin Flux from Litton/Kester and Kester Solder were used with no touchup allowed.

- Preheat Temperature: 425°F
- Solder Temperature: 490°F
- Flux Pressure: Operating PES specification
- Soldering Point: 1.90
- Soldering Mode: 0
- Soldering High Speed: 99
- Soldering Low Speed: 25
- Swing Speed: 05
- PWB Temperature: 275°F
- Solder Dip Time: 0
- Cycle Time: 42
- Flux Dip Time: 9.9

All PWB panels met the criteria of the specification except for the Technic, Inc. panels. Additional information can be found in Appendix A which contains a detailed summary of the evaluations and a literature search summary.

During 1993-1994, only FM&T evaluation hardware was fabricated. The evaluation hardware was

1. surface mount,
2. hand solder,
3. drag solder.

A Design of Experiment (DOE) matrix was set up (see Appendix B) to evaluate next assembly soldering methods (drag soldering, hand soldering, and surface mount) with PWB board treatment (bare copper PWBs, OSP-coated PWBs, and HASL PWBs).

One supplier (Enthone/OMI) was picked in 1995 based on initial test results at FM&T, the PWB usage of their chemistry in several PWB facilities, and because several of the initial OSP coatings evaluated were no longer being made. Enthone/OMI provided three documents for FM&T use and evaluation of its OSP coating:

1. Implementation of Organic Solderability Preservatives in PWB Manufacturing.
2. Reflow and Wave Soldering of ENTEK PLUS - Coated PWBs Answers to Key Assembly Issues.
3. ENTEK PLUS, PWB Copper Protective Coating System.

Extensive test data was provided in these documents.

Phase II: Evaluation of OSP Coating

The vendor chemistry was ordered in 1995. The OSP coating is a substituted benzamidazole. The coating deposition involves a complex reaction with copper, forms an organo-metallic bond of approximately 1500 angstroms thick, and builds up benzamidazole to final thickness. The DOE was performed in 1996 on the FM&T evaluation hardware. The processing sequence utilized with the Enthone/OMI ENTEK Plus CU-106A OSP coating was

- PC-4 Cleaner, 4 minutes, 140°F;
- RO (reverse osmosis) Water Rinse, 1 minute each station;
- Sodium Persulfate, 1 minute;
- RO Water Rinse, 1 minute each station;
- Sulfuric Acid, 2 minutes;
- RO Water Rinse, 1 minute each station;
- ENTEK Plus CU-106A, 1 minute, pH 2.55, 110°F;
- Allowed panels to air dry;
- RO Water Rinse, 1 minute;
- Bake, 165°F, 10 minutes.

Wetting balance testing of the OSP coating was performed (see Appendix C). The OSP coating was applied to copper coupons, heat treated through soldering profiles, and wetting balance tested. The OSP coating was applied to bare copper sheets (approximately 1 square foot, 0.005" thick). Two hundred coupons (0.5" by 1.0") were cut from the sheets and prepared for four thermal conditions:

- As-received;
- Two-hour bake, 85°C;
- Four-hour bake, 85°C;
- Once through reflow furnace.

The reflow was performed in a Heller 932 infrared (IR) belt furnace. A profile peak temperature of 250°C was used. After conditioning, the coupons were wetting balance tested. Three solder temperatures and two fluxes were selected for testings:

- Solder Pot Temperatures: 215°C, 235°C, and 250°C
- Low Residue (LR) Fluxes: Kester 197 RMA and Kester 922CXF

The wetting balance test provides objective data regarding part solderability. The duration of the wetting balance test is usually 5 seconds.

A transducer measures the force acting on a coupon as it is immersed in the solder pot. Initially, the coupon is buoyant. As the coupon is immersed to the full depth, the coupon is heated and wetting begins. The faster the coupon is wetted, the more solderable the coupon or coatings on the coupon. The acceptance standards in the United States require a certain degree of wetting to occur at specific times. Buoyancy is required to occur in 0.67 second, and two thirds of the maximum wetting force needs to be achieved in 1.0 second. Five coupons were tested at each data point.

All averages indicate the ENTEK Plus CU-106A performed well. The OSP met the standard in nearly all categories. Only the once-through reflow tested at 215°C was slow to reach two thirds maximum force. The wetting balance curves show good wetting occurs, but not as fast as specification requirements. The LR flux averaged 1.01 seconds while the RMA flux averaged 1.21 seconds to reach two thirds Fmax. The LR flux outperformed the RMA flux. FM&T Materials Engineering recommended continued evaluation of the OSP coating.

Phase III: Assembly Soldering

Information was obtained on the various FM&T assembly PWA processes. The three processes currently used at FM&T are A) hand soldering, B) wave soldering, and C) convection infrared (IR) soldering for surface mount.

A. Hand Soldering

- Incoming Product: Alcohol Spray
  Nitrogen Blow Dry

- Component/Wiring Installation and In-Process Cleaning:
  D-Limonene Spray
  Alcohol Spray
  Nitrogen Blow Dry
  Vacuum Bake
  Trichlorethylene Spray
  Freon Spray
  Alcohol Spray
  Nitrogen Blow Dry
  Vacuum Bake

Preheat Prior to Epoxy Cure (190°F, 1 hour)
Epoxy Cure (160°F, 15 hours)
Foam Cure (175°F, 8-24 hours)
Thermal Cycling (-40 to 160°F)

B. Wave Solder

- Prebake (165°F, average 6 hours, if necessary)

- Wave Solder: RMA Flux
  Preheat (200°F)
  Solder (490°F)

- Post Solder Cleaning: Alcohol
  D-Limonene
  Trichloroethylene

C. Surface Mount

- Preclean: Alcohol
  Nitrogen Blow Dry
  Armakleen 2001 Sapanifier
  (Aqueous Clean)

After consulting with the vendor supplier chemistry representatives, unless assembly processing changes are made, the OSP coating will not be able to be processed in the current PWA assembly fabrication areas. There are too many bakes and cleaning steps which could potentially dissolve and remove the OSP coating.

Accomplishments

Alternative replacements for hot air solder leveling (HASL) were evaluated. One HASL replacement process, an organic solderability preservative (OSP), was selected for pre-production use. The OSP chemistry was procured. Evaluation hardware was processed utilizing a Design of Experiment (DOE).

Future Work

Potentially, the evaluation hardware will be processed in PWA assembly processes and evaluated. However, FM&T PWA assembly processes will have to be modified in order to evaluate the OSP coating.

Appendix A

Alternative Chemicals/Processes for Hot Air Solder Leveling

Memorandum

Allied-Signal Aerospace Company

Kansas City Division
Kansas City, Missouri

Allied Signal

Date: December 13, 1993

To:

From:

Subject: **SUMMARY REPORT ON ALTERNATIVE CHEMICALS/PROCESSES FOR HOT AIR SOLDER LEVELING (HASL)**

This memorandum summarizes to date the activities that are ongoing and have been completed on the alternative chemicals and processes for HASL PWB product.

Doublesided epoxy/glass and polyimide/glass printed wiring product were sent to the following suppliers to apply their protective coatings as HASL replacement candidates:

1) Duratech
2) Litton Kester
3) Alpha Metals
4) Electrochemicals
5) Technic, Inc.
6) MacDermid
7) Enthone/OMI
8) Atotech
9) Ardrox

I. Materials Engineering is currently evaluating half of the panels soldered in the lab. Cross-sections of the solder joints will be performed. No estimated completion date has been given.

II. Solder Rise Time Testing was performed using a Multicore Universal Solderability Tester. The Multicore solder-rise option assesses the plated-through-holes in PWBs by applying a solder-globule to the underside of a PWB and measuring the time required for the solder to rise to the top of the hole. The longer the time for solder to rise to the top of the land indicates poor wetting and solderability. The Multicore will record all time up to 10 seconds and then fail all samples above the time limit. Kester-135 and a 75 mg solder pellet were used on all PWBs.

The following samples failed solder-rise time testing:

- Duratech
- Litton Kester
- Alpha Metals
- Electrochemicals
- Bare Copper (cleaned using ChemCut Cleaner)
- Technic, Inc.

The following samples passed and are listed in best to worst case order:

- o M-Coat (MacDermid)
- o SES-T (MacDermid)
- o Enthone-OMI
- o Schercoat Plus (Atotech)
- o Standard Gyrex Process
- o Ardrox

III. During 10-11/93, hand soldered and drag soldered protective coated PWB panels from 9 suppliers, normal Gyrex HASL PWB panels (soldered 5/11/93) and bare copper PWB panels with no solder which were chemically cleaned in the ChemCut Cleaner (Metex P-507, Sodium Persulfate/Sulfuric Acid) on 5/17/93.

All hand soldering was done using flux and solder with a 600 degree Metcal soldering iron with no touch-up.

Drag soldering was done using the following settings:

A) PREHEAT TEMPERATURE	425 degrees F
B) SOLDER TEMPERATURE	490 degrees F
C) FLUX PRESSURE	per PES
D) SOLDERING POINT	1.90
E) SOLDERING MODE	0
F) SOLDERING HIGH SPEED	99
G) SOLDERING LOW SPEED	25
H) SWING SPEED	05
I) BOARD TEMPERATURE	275 degrees F
J) SOLDER DIP TIME	0
K) CYCLE TIME	42
L) FLUX DIP TIME	9.9

The drag solder machine uses flux and solder. No touch-up was allowed.

The results are given below:

1. Technic, Inc. panels with immersion gold plating (one, polyimide/glass and three, epoxy/glass DS PWBs) were drag soldered with components. Solderability of these PWBs were failing criteria.

2. MacDermid's coatings (M-Coat and SES-T) were evaluated by hand soldering and drag soldering (one, epoxy/glass and one, polyimide/glass DS PWB for each soldering process) with components. The panels met criteria.

3. Litton Kester coating (Kester #5631-C2) was evaluated by hand soldering and drag soldering (one, epoxy/glass and one, polyimide/glass DS PWB for each soldering process) with components. The panels met criteria.

4. Duratech's coating (ANTIOX PC-X) was evaluated by hand soldering and drag soldering (one, epoxy/glass and one, polyimide/glass DS PWB for each soldering process) with components. The panels met criteria.

5. Alpha Metal's coating (Alpha 4690) was evaluated by drag soldering (one, epoxy/glass and one, polyimide/glass DS PWB) with components. The panels met criteria.

6. Ardrox's coating was evaluated by hand soldering and drag soldering (one, epoxy/glass and one, polyimide/glass DS PWB for each soldering process) with components. The panels met criteria.

7. Enthone-OMI's coating (Entek Plus Cu-106A) was evaluated by hand soldering and drag soldering (one, epoxy/glass and one, polyimide/glass DS PWB for each soldering process) with components. The panels met criteria.

8. Electrochemical's coating (Copper Inhibitor LD) was evaluated by hand soldering (one, epoxy/glass DS PWB) and drag soldering (one, epoxy/glass and one, polyimide/glass DS PWB) with components. The panels met criteria.

9. Atotech's coatings (Schercoat Plus and Schercoat) were evaluated. For the Schercoat Plus process, this coating was evaluated by hand soldering (one, epoxy/glass and one, polyimide/glass DS PWB) and drag soldering (one, epoxy/glass DS PWB) with components. The panels met criteria.

For the Schercoat process, two double-sided PWB panels (epoxy/glass and polyimide/glass) and one rigid/flex panel were processed. The two double-sided PWB panels were drag soldered . The solderability appeared to be adequate for both coverage and solder flow of the thru-holes. On the rigid/flex panel, four components were hand soldered and the joints met the criteria . The panel was then drag soldered. The joints were reflowed and the remainder of the panel was covered with solder. The holes had solder flow thru and the lands on the top side of the board were covered.

10. The normal WR Gyrex HASL panels were hand soldered (one, epoxy/glass and one, polyimide/glass DS PWB) and drag soldered (one, epoxy/glass and two, polyimide/glass DS PWBs) with components. The panels met criteria.

11. The epoxy/glass and polyimide/glass bare copper DS PWBs were drag soldered with components. The copper was cleaned using the sodium persulfate/sulfuric acid microetch in the ChemCut Cleaner prior to drag soldering. The panels met criteria.

IV. Other processes currently exist that are either being developed or used to eliminate HASL and Sn/Pb stripping. The following summarizes these current technologies:

1. Positec's Photosystems' RePro 2000 positive dryfilm photoresist system eliminates HASL, eliminates Sn/Pb strip, and allows selective plate/etch with single resist application. The process involves:

- o Laminate RePro 2000
- o Expose Pads/Holes
- o Develop Image
- o Plate Pads/Holes
- o Expose Traces
- o Develop Traces
- o Etch Traces
- o Strip RePro 2000
- o Apply Solder Mask (if needed)
- o Reflow Sn/Pb

2. The OPTIPAD process is a process of placing uniformly flat solder pads on the printed wiring board where the SMD's are to installed. The advantages of OPTIPAD are:

- o Total elimination of the use of solder paste during assembly
- o Absolute control of solder volume
- o Absolute control of solder alloy
- o Absolute assurance of the intermetallic at the interface
- o Absolute control of coplanarity throughout the board
- o Absolute assurance of no contamination of the solder joint, as a result of solder paste volatiles
- o The ability to go no clean or low clean, as a result of exact placement of flux
- o Ease of assembly of sub .5MM devices
- o Compensation for lead coplanarity

3. SIPAD technology uses solid solder which is applied during the manufacture of the printed wiring board. Some of the advantages of SIPAD technology are:

- o There is no need to apply solder paste to the board in the SMD assembly line
- o Solder is applied by the PWB manufacturer. The technology can be applied to bare copper
- o The use of photosensitive solder paste films makes processing of small batches viable
- o During wave soldering, short circuits, solder balling and wicking do not occur
- o Only one wave soldering pass is needed, regardless of whether SMDs are glued to one or both sides of the board
- o PWBs have a longer storage life due to greater thickness of the solder layer

4. At the 6th IMOG Cleaning and Contamination Control Subgroup Meeting, on 11/2/93, a paper was presented on "Solderability Retention of Copper With Organic Inhibitors." The Materials and Test Methods used were:

- o Base Substrate-OFHC Cu (degreased and acid etched)
- o Solder Alloy (wt.%):60Sn-40Pb
- o Flux Type-RMA, OA, LS, and CA
- o Organic Solderability Preservative (OSP)-benzotriazole (BTA) or commercial organometallic inhibitor (OMI-Kester 5630)
- o Accelerated Aging-flowing mixed gas (FMG) test environment
- o Solderability Test Method-wetting balance and meniscometer
- o Wetting Test Temperature-260 degrees C

The conclusions were:

- o BTA retains acceptable solder wettability on Cu after accelerated 8 month aging in a typical indoor industrial environment
- o Preliminary data suggests that BTA is more effective than OMI coating in maintaining Cu wettability
- o Wetting behavior of Cu after aging is influenced by the OSP and flux selection

5. The National Center for Manufacturing Sciences (NCMS) Surface Finishes Team is currently working on Imidazole technology and organic solderability preservatives (OSPs) over bare copper and enhanced solders to replace HASL.

Two papers (Soldering Evaluations of Organic Solderability Preservatives and Solderability and Thermal Stability of Azole Corrosion Inhibitors) were given on OSPs. The following conclusions were presented:

a) Solderability and Thermal Stability of Azole Corrosion Inhibitors:

- Organic solderability preservative (OSP) coatings are considered promising candidates for replacing Sn/Pb solder finishes on SMT assemblies
- The solderability (based on wetting balance measurements) of OSP coated copper substrates was shown to be severely degraded during multiple heating cycles for all azoles evaluated
- The thin films (less than 100 Angstroms), when subjected to temperatures greater than 100-125 degrees C, decomposed into volatile products, leaving the copper substrate susceptible to oxidation
- Films that are a factor 50-100 times thicker than monolayer azole films do not suffer a significant change in thickness during thermal treatment, but are ineffective for solderability retention. The azolate films undergo dealkylization/oxidation reactions during thermal treatment, rendering them unsolderable
- To preserve copper solderability, the soldering process should be performed under a controlled inert atmosphere, in conjunction with an aggressive soldering flux

b) Soldering Evaluations of Organic Solderability Preservatives:

- Organic solderability preservative coatings on copper are not as robust as a Sn/Pb surface finish
- None of the new OSP coatings tested were better (more solderable) than AT&T's imidazole coating used for 10 years
- Production evaluations have shown that there are Low Solids Flux materials and thermal assembly processes which will allow imidazole coated copper to perform as well as HASL Sn/Pb surfaces

6) The October Project consortium (IPC) has a Topology Project Team which is defining and optimizing the final surfaces of a PWB to facilitate the attachment of SMT devices. This group has evaluated numerous organic finishes including standard benzotriazoles, imidazoles, benzimidazoles and other proprietary materials. This Project Team has concluded that organic finishes are an extremely viable alternative to HASL. The pilot production runs performed by OEMs have provided a 10 times yield improvement in final assembly over traditional HASL processed PWBs.

7) New technology is being developed in the area of electrophoretic deposited resists developed by Shipley, Ciba-Geigy, and DuPont.

8) 3M has a Model 2101 Corrosion Control Adsorber Patch which inhibits corrosion by adsorbing scavenging corrosive agents such as hydrogen sulfide, sulfur dioxide, and organic carboxylic acid. These patches could be used with bare copper PWBs stored in vapor barrier bags.

9) Other alternatives to HASL PWBs are given in a presentation

- o Organic Coatings: "Nordsen" selective coating process which is non-atomized, width controlled using silicon/acrylic/epoxy
- o Tin Plating: Disadvantages include sliver problem; can break off causing shorts and exposed copper.
- o Electroplated nickel/gold: disadvantage of sliver problem and Au/Sn is brittle
- o Fused Solder Paste: not feasible for fine pitch less than 1 mil
- o Electroless Nickel/Gold: used in wire bonding; eliminate pth barrel cracks
- o Electroless Tin/Lead: chemical process like immersion tin; etches exposed copper and creates a porous deposit that must be reflowed
- o SM Soldering to Copper:
  - o Eliminates HASL
  - o Flat Pads
  - o Less Thermal Shock (Warp, Delamination)
  - o Reduced Manufacturing Cost
  - o Solderability (no tombstoning)

Appendix B

Design of Experiment Matrix for OSP Coating Evaluation

Evaluation Matrix

	-	o	+
X1	Drag Solder	Hand Solder	Surface Mount
X2	Bare Board	Organic Coating	HASL

Panel*	X1	X2
1	-	-
2	-	o
3	-	+
4	o	-
5	o	o
6	o	+
7	+	-
8	+	o
9	+	+

*two replications (panels 10-18)

X1 - Next Assembly Solder Method
X2 - Board Treatment
Drag Solder Parts
Hand Solder Parts
Surface Mount Parts

Appendix C

Wetting Balance Test Results for OSP Coating

AlliedSignal
AEROSPACE

Memorandum
Kansas City Division

Date: June 12, 1996

To:

From:

Subject: WETTING BALANCE TESTING OF ORGANIC SOLDER PRESERVATIVE (OSP)

SUMMARY

Organic solder preservatives (OSPs) are organic films applied to printed wiring boards to maintain copper solderability. OSPs are replacements to tin-lead HASL or reflowed solder coatings. ENTEK PLUS Cu-106A, a OSP from Enthone-OMI, was tested in the Solderability Science Lab. The OSP was applied to copper coupons, heat treated through soldering profiles and wetting balance tested. The wetting curves indicate that ENTEK Plus Cu-106A protects PWB solderability after exposure to thermal treatment such as reflow and electrical / thermal stress testing.

EVALUATION

ENTEK PLUS Cu-106A is a substituted or modified benizotriazole. The modified benizotriazole compound produces the thickest OSP coating; able to withstand additional reflows and handling. Consequently, the thicker coating requires more active flux to help solder wet the coated PWB copper.

ENTEK PLUS Cu-106A was applied to bare copper sheets. The copper was supplied in ~1sqft sheets, 0.005" thick. After the OSP was applied, the sheets were sent to the Solderability Science Lab for testing. Two hundred coupons, (0.5" by 1.0") were cut from the sheets and prepared for four thermal conditions:

1. As Received
2. Two Hour Bake @ 85 °C
3. Four Hour Bake @ 85 °C
4. Once through Reflow Furnace

The reflow was performed in a Heller 932 IR belt furnace. A profile (peak temperature 250 °C) was used.

After conditioning, the coupons were wetting balance tested. Three solder temperatures and two fluxes were selected for testing. The solder pot temperature in the tester was set at 215 °C, 235 °C, and 250 °C. Kester 197 RMA and Kester 922CXF low residue (LR) were the fluxes used for the tests.

RESULTS

A wetting balance test provides objective data regarding part solderability. The duration of the wetting balance test is usually five seconds. A transducer measures the force acting on a coupon as it is immersed in the solder pot. Initially, the coupon is buoyant. As the coupon is immersed to the full depth, the coupon is heated and wetting begins. The faster the coupon is wetted, the more solderable the coupon or coatings on the coupon. The acceptance standards in the US require certain degree of wetting to occur at specific times. Buoyancy is required to occur in 0.67 seconds and 2/3 of the maximum wetting force needs to be achieved in 1.0 second. Five coupons were tested at each data point.

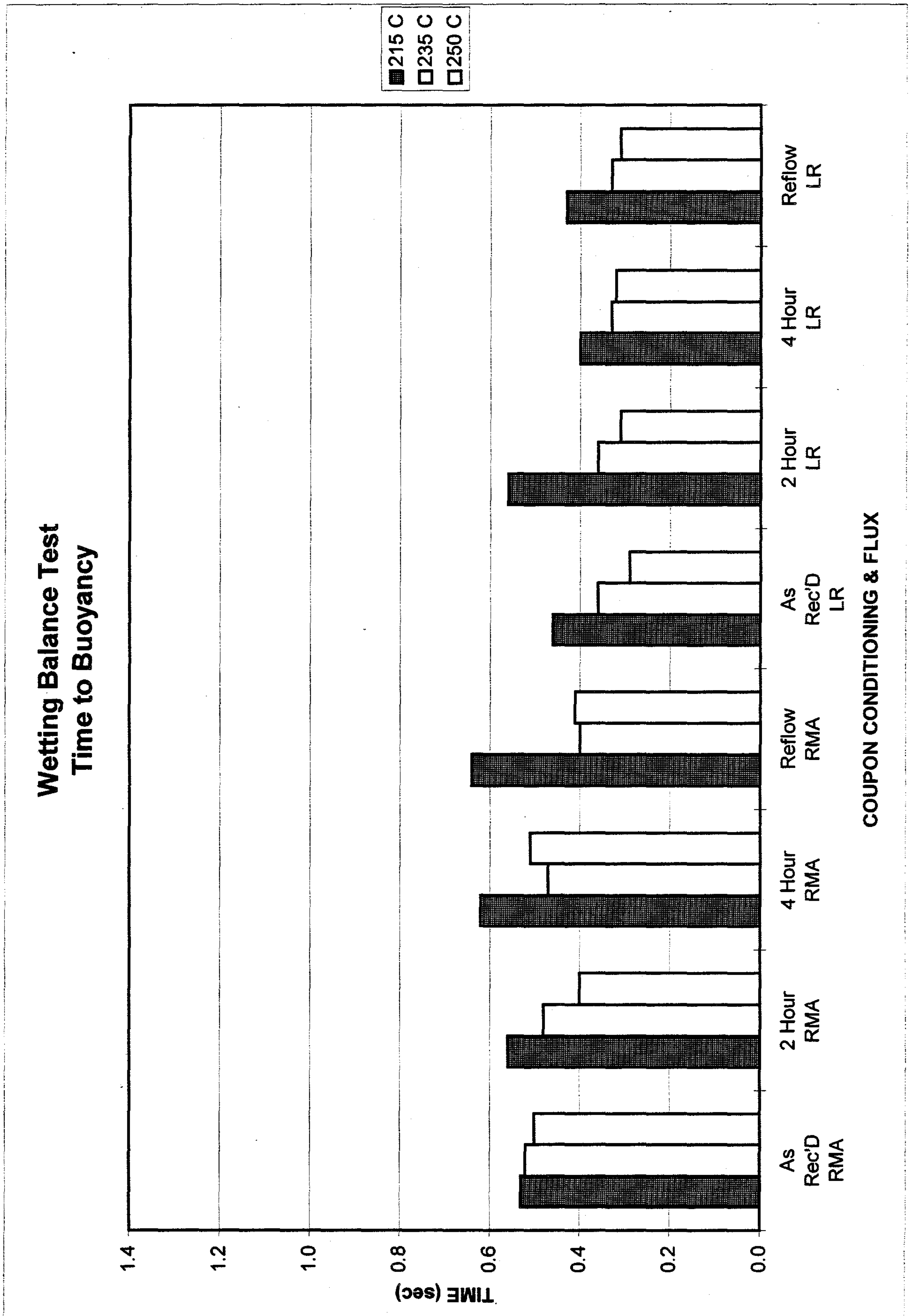
All averages indicate the ENTEK PLUS Cu-106A performs well. The OSP met the standard in nearly all categories. (See attached table.) The resultant average times to buoyancy and to 2/3 maximum force are shown on Charts 1 and 2. Only the once through reflow tested at 215°C was slow to reach 2/3 maximum force. The wetting balance curves shows good wetting occurs, but not as fast as specification requirements. The LR flux averaged 1.01 seconds while RMA averaged 1.21 seconds to reach 2/3 Fmax. Typically, the point needs to be reached in less than 1.0 second. Examining the charts, the LR flux out performed the RMA. (Note that the LR flux was applied by dipping in this test and recommended process application is through spray or ultrasonic mist. This test applied more flux than the recommended process.)

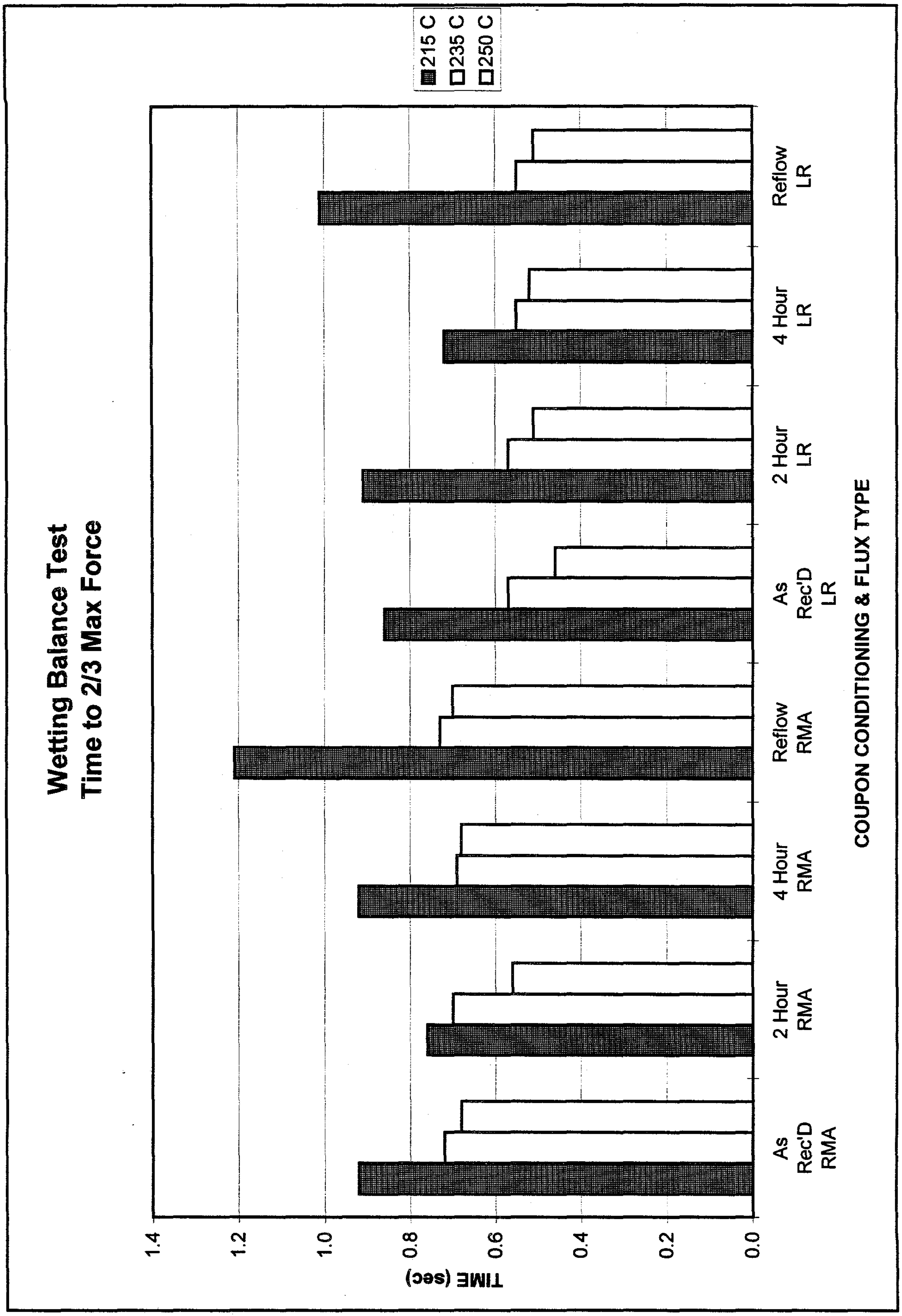
CONCLUSIONS

ENTEK PLUS Cu-106A is a good choice for continued development with intent to incorporate into production. The material did very well in these soldering tests. Contact was met with an Enthone - OMI technical representative. ENTEK PLUS Cu-106A is their standard OSP. Their representative stated one internal performance requirement is that the OSP must survive two reflows plus one additional PWA temperature excursion. Care to prevent accidental contamination with fingers or handling is important. Enthone-OMI stated the cleaning solutions that remove handling contamination will most likely remove OSPs.

WETTING BALANCE RESULTS FOR OSP
ENTEK PLUS Cu-106A

	Time to Buoyancy (seconds)			Time to 2/3 Fmax (seconds)		
Temp (C)	**215 C**	**235 C**	**250 C**	**215 C**	**235 C**	**250 C**
As Rec'D RMA	0.53	0.52	0.50	0.92	0.72	0.68
2 Hour RMA	0.56	0.48	0.40	0.76	0.70	0.56
4 Hour RMA	0.62	0.47	0.51	0.92	0.69	0.68
Reflow RMA	0.64	0.40	0.41	1.21	0.73	0.70
As Rec'D LR	0.46	0.36	0.29	0.86	0.57	0.46
2 Hour LR	0.56	0.36	0.31	0.91	0.57	0.51
4 Hour LR	0.40	0.33	0.32	0.72	0.55	0.52
Reflow LR	0.43	0.33	0.31	1.01	0.55	0.51


Wetting Balance Test
Time to Buoyancy
TIME (sec)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
215 C
235 C
250 C
As Rec'D RMA
2 Hour RMA
4 Hour RMA
Reflow RMA
As Rec'D LR
2 Hour LR
4 Hour LR
Reflow LR
COUPON CONDITIONING & FLUX


Wetting Balance Test
Time to 2/3 Max Force
215 C
235 C
250 C
TIME (sec)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
As Rec'D RMA
2 Hour RMA
4 Hour RMA
Reflow RMA
As Rec'D LR
2 Hour LR
4 Hour LR
Reflow LR
COUPON CONDITIONING & FLUX TYPE