

# **An Overview of IPC Plating Specification Completions, Revisions and Future Plans**

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**Uyemura International Corporation**

**IMAPS**

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# **IPC Specifications**

## **Plating Subcommittee 4-14**

**Specifications are reference documents to be called out by designers and original equipment manufacturers (OEMs).**

**Designers may take exception with one or more items in the specification to ensure that the product meets the requirements of its intended use.**

**The term “AAUBUS”, (As Agreed Upon Between User and Supplier); is part of any specification.**

# **IPC Specifications**

## **Plating Subcommittee 4-14**

**Specifications are consensus documents**

**They are agreed upon by a panel of interested industry participants composed of**

- 1. Suppliers,**
- 2. Manufacturers,**
- 3. Assembly houses**
- 4. End users (OEM).**

**The IPC Plating Sub-committee 4-14, is no exception.**

# **IPC Specifications**

## **Plating Subcommittee 4-14**

**If there is consensus then the committee documents it in a specification.**

**In cases where no consensus is readily arrived at, the committee undergoes its own testing in what is commonly referred to as a “Round Robin” (RR) study.**

# **Plating Subcommittee 4-14 Round Robin Investigation**

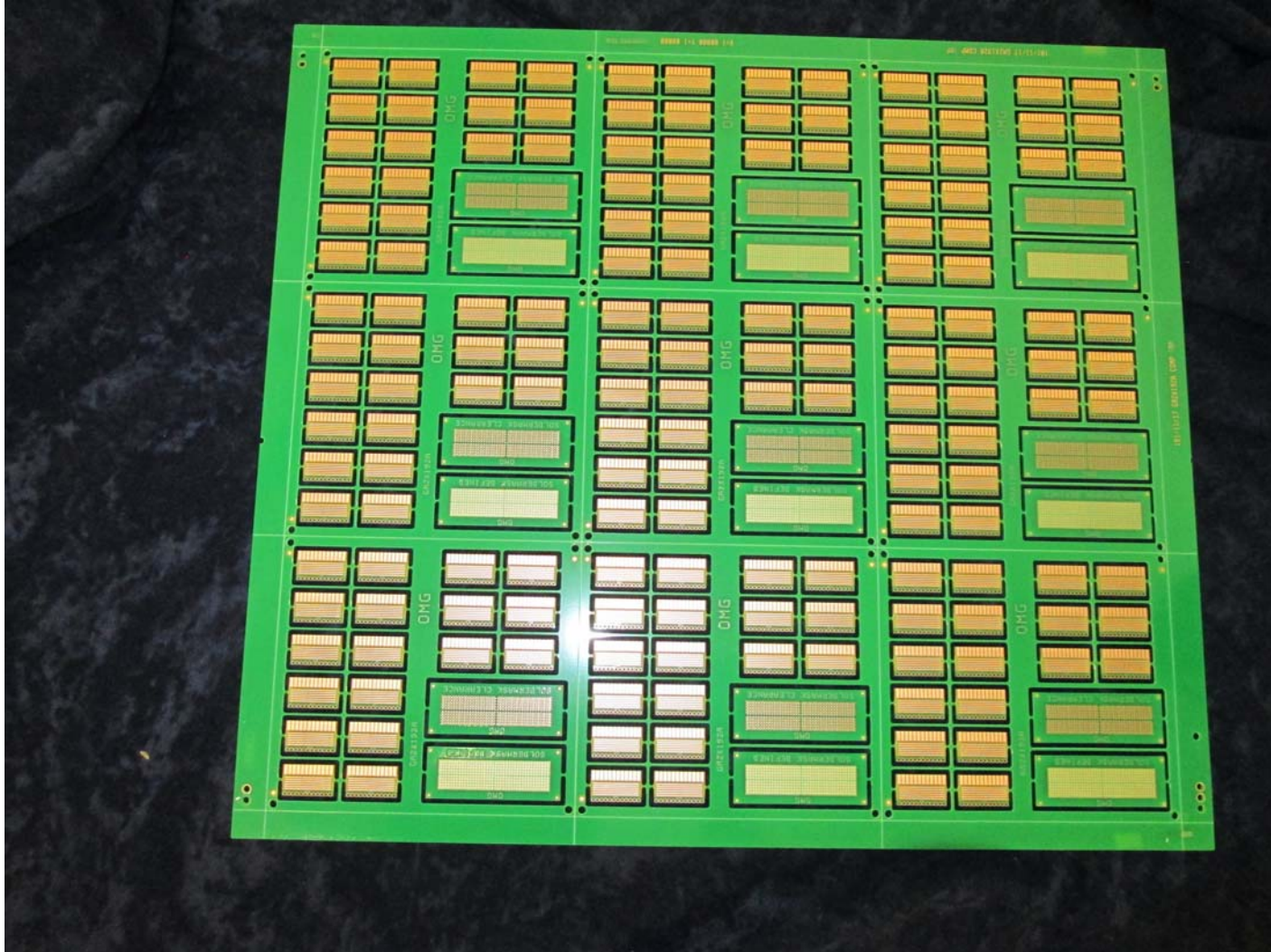
**In a RR investigation, an agreed upon test vehicle (TV) is designed and manufactured.**

**TVs are then sent around to the different suppliers who deposit the agreed upon thicknesses to be investigated.**

**The TVs are collected and the deposit thicknesses are verified and documented.**

**The TVs are then coded.**

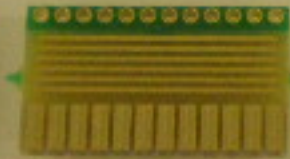
# The Test Vehicle



VI



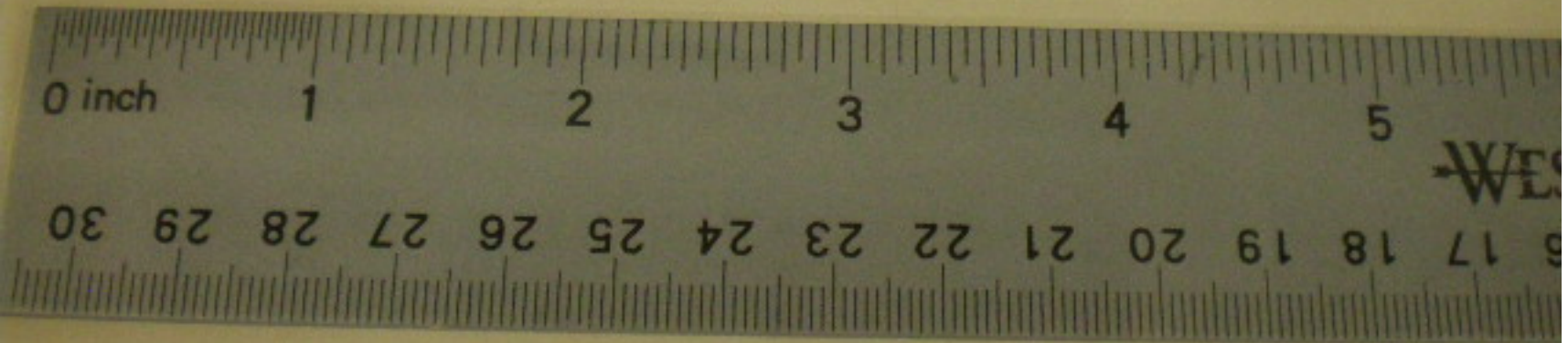
VII



VIII



Ps/N:



## **Plating Subcommittee 4-14 Round Robin Investigation**

**The TVs are sent around again to the different testing sites that test for the desired attribute like soldering, contacting and wire bonding capabilities of the different finish thicknesses.**

**The data is then collected sorted out and documented.**

**At this point a new attempt at consensus is made and upon arrival the thickness specification is set.**



# Plating Subcommittee 4-14

## The Document

### Draft

After consensus is complete a draft is prepared.

### Peer Review

1. The draft is then posted for peer review.
2. Any IPC member can review the document and suggest technical or editorial changes
3. All comments are then reviewed and all issues are resolved before the final draft is issued.

### Publication

At this time the IPC takes on the task of publishing the document in its final format.

# **Plating Subcommittee 4-14**

## **The Committee**

**Active since 2001**

**Co-chaired by George Milad and Gerard O'Brien**

**IPC liaison is Tom Newton**

**An Extensive Member List.**

**OEMs**

**Assembly Manufacturers**

**Board manufacturers**

**Suppliers**

**Labs and Consultants**

# **Plating Subcommittee 4-14**

## **Member Companies 1 of 2**

### **OEM and CM**

**Lockheed Martin, Raytheon, Oracle, Adtran, Rockwell Collins, Hewlett Packard, Alcatel-Lucent, Dell, St Jude Medical, Delphi, Schneider Electric, Continental Corporation, Panasonic, IBM, Northrop Grumman, BAE Systems, Honeywell, Boeing, Tyco Electronics, Peregrine Semiconductor, Space Systems /Loral, Amonix, Celestica, Winstrom**

# **Plating Subcommittee 4-14**

## **Member Companies 2 of 2**

### **Board Manufacturing**

**Viasystems, TTM, I3, Molex, Superior Processing,  
Alternate Final Finishing,**

### **Suppliers**

**Macdermid, OMG, Uyemura, Atotech, Cookson  
Electronics, MEC, ECI Technology, Kulick & Sofa,  
Metalor, Fischer Technology, Hesse-Mechatronics, H<sub>2</sub>O**

### **Labs and Consultants**

**ST and S Group, Sandia laboratories, DFR Solutions, TAS  
Consulting**

# Plating Subcommittee 4-14

## Member Companies

### Operation

- The committee operates thru one hour bi-weekly conference calls.
- All decisions are made in the concalls by those in attendance.
- The call minutes are documented and circulated.

### Acknowledgement

To date all committee activities have been voluntary and acknowledgement is in order for the members and equally important to their management that allow for the voluntary time invested by their employees.

# **IPC Specifications**

## **Plating Subcommittee 4-14**

**Since its inception the IPC Plating Sub-committee 4-14 has issued the following:**

**IPC-4552 ENIG Specification 2002**

**IPC-4552 ENIG Specification Amended 2012**

**IPC-4553 Immersion Silver specification 2005**

**IPC-4554 Immersion Tin Specification 2007**

**IPC-4553A Revised Immersion Silver 2009**

**IPC-4554 Amended Tin Specification 2011**

**IPC-4552 Amended ENIG Specification 2012**

**IPC-4556 ENEPIG Specification 2013**

# Plating Subcommittee 4-14

## IPC-4552 ENIG Specification (2002)

The ENIG IPC-4552 Specification was issued in 2002,  
No lead free (LF) solder in use.

For thickness IPC-4552 stated :

- *The EN thickness shall be 3 to 6  $\mu\text{m}$  [118.1 to 236.2  $\mu\text{in}$ ]*
- *The minimum IG thickness shall be 0.05 [1.97  $\mu\text{in}$ ] at four sigma (standard deviation) below the mean. The typical range is 0.075 to 0.125  $\mu\text{m}$  [2.955 to 4.925  $\mu\text{in}$ ].*

# **Plating Subcommittee 4-14**

## **IPC-4552 ENIG Specification (2002)**

**To arrive at these numbers**

- **The committee had conducted a series of test in a round robin (RR) study**
- **The study included suppliers, PCB manufacturers, EMS providers and OEMs.**
- **The data collected is summarized in the Appendix of the specification.**



# **Plating Subcommittee 4-14**

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# Plating Subcommittee 4-14

## IPC-4552 ENIG Amended Spec (2012)

*The lower limit for Gold thickness was reduced from 0.05  $\mu\text{m}$  to 0.04  $\mu\text{m}$  (1.6  $\mu\text{in}$ )*

### With Restrictions:

- Limited time from manufacturing to assembly
- Demonstrate the consistency of the plating process.
- Ability to measure low Gold thickness

# Plating Subcommittee 4-14

## IPC-4552 Rev-A ENIG Specification

The IPC-4552 A, ENIG Specification Revision is in progress.  
Expected completion **2015**

### The Purpose

- To reduce the lower limit of Gold thickness and to set an upper limit. **Under consideration 1.6 to 4.0 uins**
- Determine if the restrictions could be lifted.
- This entails an extensive RR study
- Testing to include LF solder and LF stressing conditions

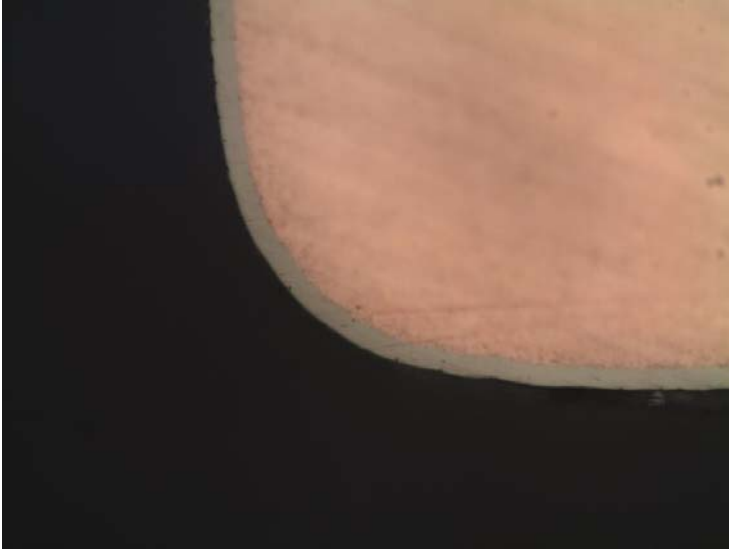
# **Plating Subcommittee 4-14**

## **IPC-4552 Rev-A ENIG Specification**

**The revision of IPC-4552 A would include the following  
Additional Documents:**

- **Test Method (TM) for stripping Immersion gold during failure analysis**
- **Test Method (TM) for determining the phos content of electroless nickel**
- **Acceptability criteria for nickel corrosion (Black Pad). Include a CORROSION CHART**

## EXAMPLES OF CORROSION CHART

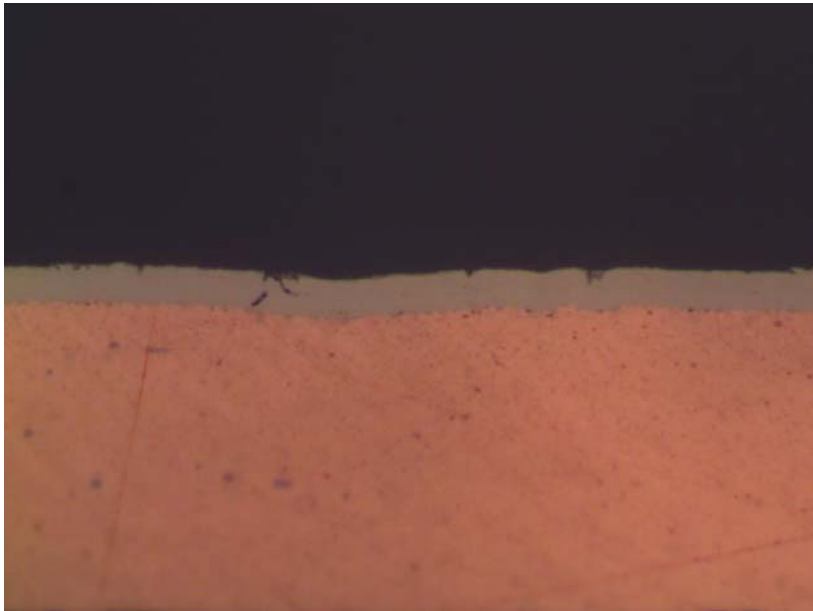


**Target condition – no hyper corrosion defects or enhanced grain boundary definition**

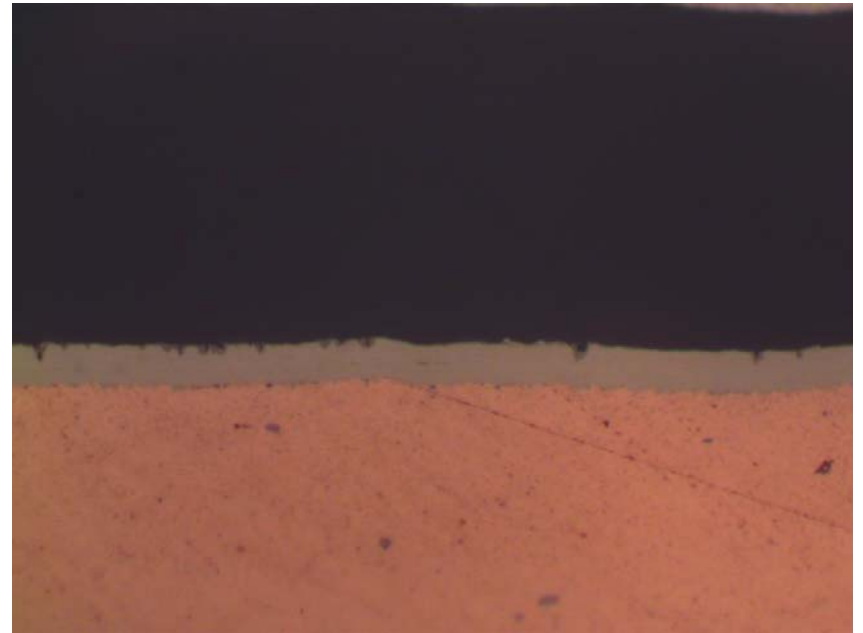


**Acceptable condition < 10 observations in the field of view**

## EXAMPLES OF CORROSION CHART

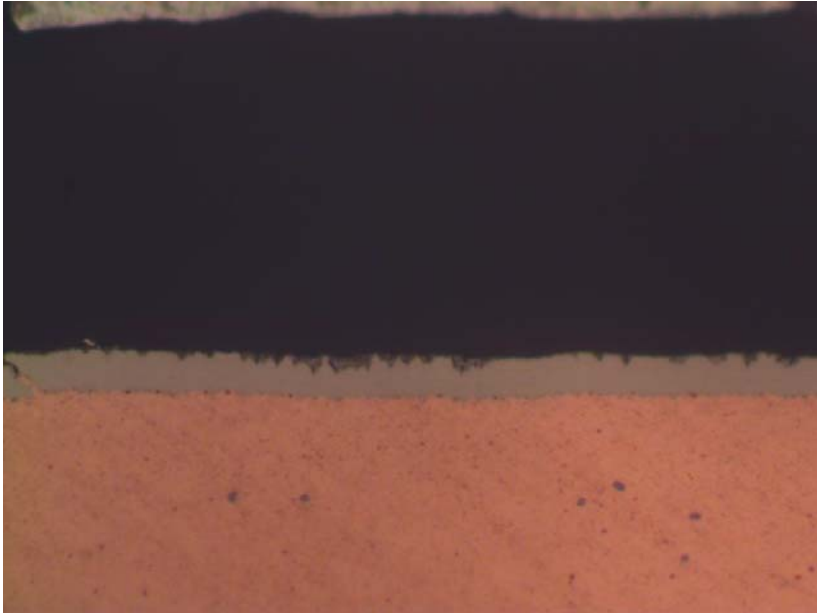


**Acceptable condition < 10  
observations in the field of view**

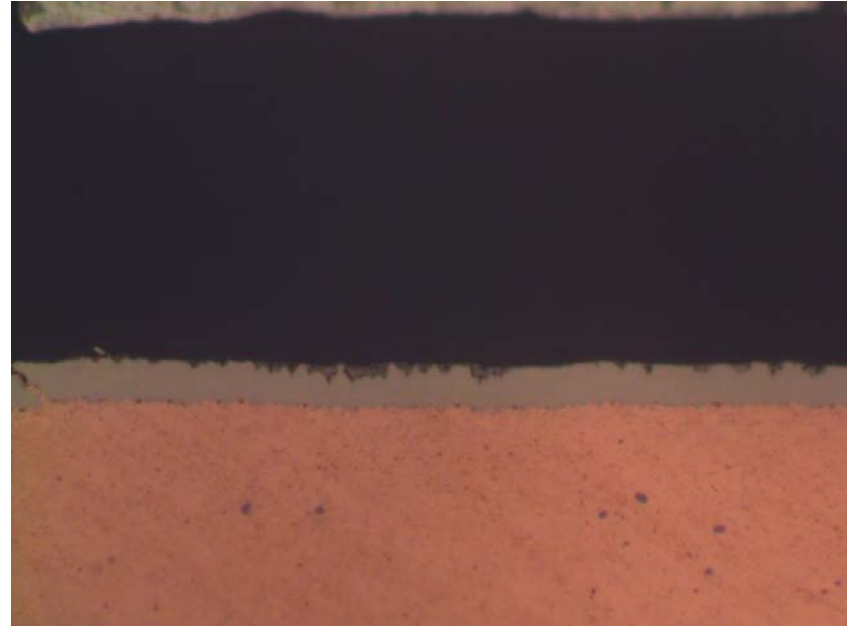


**Rejectable – more than ten  
observations in the field of view**

## EXAMPLES OF CORROSION CHART



**Rejectable – penetration to the copper surface**



**Rejectable - Evidence of contiguous corrosion with depth penetration > 10%**



# **Plating Subcommittee 4-14**

## **IPC-4553 Immersion Silver (2005)**

- **In 2005 there were 2 distinct types of commercialized immersion silver with different thickness recommendations, referred to as “Thin” and “Thick”.**
- **Each required its own thickness specification.**
- **The initial 4553 specification stated the following for thickness of deposit**

# Plating Subcommittee 4-14

## IPC-4553 Immersion Silver (2005)

### Two Thickness Specification:

**Thin Silver** :  $0.05\mu\text{m}$  ( $2\mu''$ ) minimum at  $-2\sigma$  from process mean as measured on a pad of area  $2.25^2\mu\text{m}$  ( $3600^2$  mils). Typical value  $0.07\mu\text{m}$  ( $3\mu''$ ) to  $0.12\mu\text{m}$  ( $5\mu''$ )

**Thick Silver**:  $0.12\mu\text{m}$  ( $5\mu''$ ) minimum at  $-4\sigma$  from process mean as measured on a pad of area  $2.25^2\mu\text{m}$  ( $3600^2$  mils). Typical value of  $0.2\mu\text{m}$  ( $8\mu''$ ) to  $0.3\mu\text{m}$  ( $12\mu''$ ).

# Plating Subcommittee 4-14

## IPC-4553 A Immersion Silver (2009)

### A single Thickness Specified

- *0.12  $\mu\text{m}$  [5  $\mu\text{in}$ ] minimum to 0.4  $\mu\text{m}$  [16  $\mu\text{in}$ ] maximum at  $\pm 4\sigma$  from process mean*
- *As measured on a pad of area 2.25 mm<sup>2</sup> or 1.5 mm X 1.5 mm [approximately 0.0036 in<sup>2</sup> or 0.060 in X 0.060 in.*
- *Typical value between 0.2  $\mu\text{m}$  [8  $\mu\text{in}$ ] to 0.3  $\mu\text{m}$  [12  $\mu\text{in}$ ].*
- *An Upper Limit was set.*

# **Plating Subcommittee 4-14**

## **IPC-4554 Immersion Tin (2007)**

**For immersion tin the committee specified a lower limit for thickness. The relatively thick value of 1 micron was chosen to ensure that enough virgin tin would be available at the surface for soldering after storage.**

**It is well understood that tin forms an intermetallic (IMC) layer with the underlying copper, and that this layer continues to grow in thickness over time.**

# Plating Subcommittee 4-14

## IPC-4554 Immersion Tin (2007)

The immersion tin thickness will be:

*1.0  $\mu\text{m}$  (40 $\mu$ " ) minimum at  $-4\sigma$  from process mean as measured on a pad of area 2.25 $\mu\text{m}$  (3600 $^2$  mils). Typical value of 1.15 $\mu\text{m}$  ( 46 $\mu$ " ) to 1.3 $\mu\text{m}$  (52 $\mu$ " ).*

The immersion tin Specification IPC-4554 was **amended in 2011**. The amendment addressed solderability testing and specified the allowed stress testing conditions for the deposit and the type of fluxes to be used for both tin/lead and LF testing.

# **Plating Subcommittee 4-14**

## **IPC-4555 OSP Specification (No Date)**

**After more than one year of struggling with specification IPC-4555; organic solderability preservative (OSP). Nothing was specified.**

**There was no consensus arrived at.**

**Mostly this was due to the wide assortment of organic products that were used for solderability preservation for the various application; each with its own thickness recommended values.**

# **Plating Subcommittee 4-14**

## **IPC-4556 ENEPIG Specification (2013)**

**This is the last specification issued by the committee. The document produced is very comprehensive and includes a wealth of information from the RR studies that were conducted.**

**The Appendix contains a documentation of these studies; each authored by the principle who conducted the testing.**

**It also includes a section on the proper methods of equipment setup for a reliable measurement of very thin layers of metal deposits.**

# **Plating Subcommittee 4-14**

## **IPC-4556 ENEPIG Specification (2013)**

### **Appendices 1 thru9**

- 1. Chemical Definitions and Process Sequence; Martin Bayes  
Dow Chemical Company**
- 2. Round Robin Test Summary; George Milad Uyemura  
International Corporation**
- 3. ENEPIG PWB Surface Finish XRF Round Robin Testing;  
Gerard O'Brien S T and S Group.**
- 4. Factors Affecting Measurement Accuracy of ENEPIG  
Coatings by XRF; Frank Ferrandino, Calmetrics Inc.**
- 5. ENEPIG PWB Surface Finish Wetting Balance Testing;  
Gerard O'Brien – President S T and S Group.**
- 6. Solder Spread Testing; Brian Madsen, Continental**
- 7. ENEPIG PWB Surface Finish Shear Test Project; Dave  
Hillman,et al.Rockwell Collins Inc.**
- 8. Gold Wire Bonding; Stephen Meeks St Jude Medical**
- 9. XRF Thickness Measurements of thin Au and Pd (ENEPIG):  
Recommendations for Instrumentation (Detectors) and  
their Limitations; Michael Haller Fischer Technology**



# **Plating Subcommittee 4-14**

## **IPC-4556 ENEPIG Specification (2013)**

The thickness specification for ENEPIG states

*Nickel: 3 to 6  $\mu\text{m}$  [118.1 to 236.2  $\mu\text{in}$ ] at  $\pm 4$  sigma (standard deviations) from the mean.*

*Palladium: 0.05 to 0.30  $\mu\text{m}$  [2 to 12  $\mu\text{in}$ ] at  $\pm 4$  sigma (standard deviations) from the mean. No upper limit.*

*Gold: minimum 0.030  $\mu\text{m}$  [1.2  $\mu\text{in}$ ] at - 4 sigma (standard deviations) below the mean.*

*All measurements to be taken on a nominal pad size of 1.5 mm x 1.5 mm [0.060 in x 0.060 in] or equivalent area.*

# Plating Subcommittee 4-14

## IPC-4556 ENEPIG Specification

### Amended 2015

The thickness specification for ENEPIG states  
*Nickel: 3 to 6  $\mu\text{m}$  [118.1 to 236.2  $\mu\text{in}$ ] at  $\pm 4$  sigma (standard deviations) from the mean.*

*Palladium: 0.05 to 0.30  $\mu\text{m}$  [2 to 12  $\mu\text{in}$ ] at  $\pm 4$  sigma (standard deviations) from the mean. No upper limit.*

*Gold: minimum 0.030  $\mu\text{m}$  [1.2  $\mu\text{in}$ ] at - 4 sigma (standard deviations) below the mean, **maximum 0.07  $\mu\text{m}$  [2.8  $\mu\text{in}$ ]** .*

*All measurements to be taken on a nominal pad size of 1.5 mm x 1.5 mm [0.060 in x 0.060 in] or equivalent area.*

# **IPC Specifications Plating Subcommittee 4-14**

**Committee conference calls are held every other  
Wednesday at 11:00 am EST.**

**Call in Number is 847 597 2999**

**Pass Code is 013 98 92 #**

**Everyone is welcome to participate.**

**A notification e-mail is sent out before each  
conference call**

# IPC Plating Committee 4-14

*Thank You*

*George Milad*

[gmilad@uyemura.com](mailto:gmilad@uyemura.com)

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