



IPC-4554

Specification for Immersion Tin Plating for Printed Circuit Boards

IPC-4554

January 2007

A standard developed by IPC

3000 Lakeside Drive, Suite 309S, Bannockburn, IL 60015-1249
Tel. 847.615.7100 Fax 847.615.7105
www.ipc.org

The Principles of Standardization

In May 1995 the IPC's Technical Activities Executive Committee (TAEC) adopted Principles of Standardization as a guiding principle of IPC's standardization efforts.

Standards Should:

- Show relationship to Design for Manufacturability (DFM) and Design for the Environment (DFE)
- Minimize time to market
- Contain simple (simplified) language
- Just include spec information
- Focus on end product performance
- Include a feedback system on use and problems for future improvement

Standards Should Not:

- Inhibit innovation
- Increase time-to-market
- Keep people out
- Increase cycle time
- Tell you how to make something
- Contain anything that cannot be defended with data

Notice

IPC Standards and Publications are designed to serve the public interest through eliminating misunderstandings between manufacturers and purchasers, facilitating interchangeability and improvement of products, and assisting the purchaser in selecting and obtaining with minimum delay the proper product for his particular need. Existence of such Standards and Publications shall not in any respect preclude any member or nonmember of IPC from manufacturing or selling products not conforming to such Standards and Publication, nor shall the existence of such Standards and Publications preclude their voluntary use by those other than IPC members, whether the standard is to be used either domestically or internationally.

Recommended Standards and Publications are adopted by IPC without regard to whether their adoption may involve patents on articles, materials, or processes. By such action, IPC does not assume any liability to any patent owner, nor do they assume any obligation whatever to parties adopting the Recommended Standard or Publication. Users are also wholly responsible for protecting themselves against all claims of liabilities for patent infringement.

IPC Position Statement on Specification Revision Change

It is the position of IPC's Technical Activities Executive Committee that the use and implementation of IPC publications is voluntary and is part of a relationship entered into by customer and supplier. When an IPC publication is updated and a new revision is published, it is the opinion of the TAEC that the use of the new revision as part of an existing relationship is not automatic unless required by the contract. The TAEC recommends the use of the latest revision. Adopted October 6, 1998

Why is there a charge for this document?

Your purchase of this document contributes to the ongoing development of new and updated industry standards and publications. Standards allow manufacturers, customers, and suppliers to understand one another better. Standards allow manufacturers greater efficiencies when they can set up their processes to meet industry standards, allowing them to offer their customers lower costs.

IPC spends hundreds of thousands of dollars annually to support IPC's volunteers in the standards and publications development process. There are many rounds of drafts sent out for review and the committees spend hundreds of hours in review and development. IPC's staff attends and participates in committee activities, typesets and circulates document drafts, and follows all necessary procedures to qualify for ANSI approval.

IPC's membership dues have been kept low to allow as many companies as possible to participate. Therefore, the standards and publications revenue is necessary to complement dues revenue. The price schedule offers a 50% discount to IPC members. If your company buys IPC standards and publications, why not take advantage of this and the many other benefits of IPC membership as well? For more information on membership in IPC, please visit www.ipc.org or call 847/597-2872.

Thank you for your continued support.



IPC-4554

Specification for Immersion Tin Plating for Printed Circuit Boards

Developed by the Plating Processes Subcommitte (4-14) of the
Fabrication Processes Committee (4-10) of IPC

IPC Standards and Artificial Intelligence (AI) Statement – 2025

IPC explicitly prohibits:

- The integration or transfer of any data whether in the form of IPC books, standards, metadata, or other formats — into AI engines or algorithms by any person or entity, including authorized distributors and their end users.
- Activities involving data harvesting, text and data mining, enrichment, or the creation of derivative works based on this data, including the use of automated data collection methods or artificial intelligence.

Any breach of these provisions is considered a copyright infringement unless expressly and formally authorized by IPC.

Users of this publication are encouraged to participate in the development of future revisions.

Contact:

IPC
3000 Lakeside Drive, Suite 309S
Bannockburn, Illinois
60015-1249
Tel 847 615.7100
Fax 847 615.7105

Acknowledgment

Any document involving a complex technology draws material from a vast number of sources. While the principal members of the Plating Processes Subcommittee (4-14) of the Fabrication Processes Committee (4-10) are shown below, it is not possible to include all of those who assisted in the evolution of this standard. To each of them, the members of the IPC extend their gratitude.

Fabrication Processes Committee	Plating Processes Subcommittee	Technical Liaisons of the IPC Board of Directors
Chair George Milad UIC/Uyemura International Corp.	Co-Chair George Milad UIC/Uyemura International Corp.	Peter Bigelow IMI Inc.
Vice Chair Gary C. Roper One Source Group, Eagle Circuits Inc.	Co-Chair Gerard A. O'Brien Photocircuits Corporation	Sammy Yi Flextronics International

Plating Processes Subcommittee

Franklin D. Asbell, Consultant	Hollese Galyon, Merix Corporation	Randy R. Reed, Merix Corporation
Gail Auyeung, Celestica International Inc.	Marion Graybeal, Consultant	Gary C. Roper, One Source Group, Eagle Circuits Inc.
Martin W. Bayes, Rohm and Haas Electronic Materials	Michael R. Green, Lockheed Martin Space Systems Company	Stan Sappington, S/G Electronics Inc.
Mumtaz Y. Bora, Kyocera Wireless Corporation	Donald Gudecauskas, UIC/Uyemura International Corp.	Daryl Sato, Intel Corporation
Trevor Bowers, Adtran Inc.	Lorianne Hamoline, Alcatel-Lucent	Michael Schneider, ECI Technology, Inc.
Peter Bratin, ECI Technology, Inc.	David D. Hillman, Rockwell Collins	Tom Selby, ThermoFinnigan LLC
Lee Burger, Electrochemicals Inc.	Kuldip Johal, Atotech USA Inc.	Atamjit Singh, Unitech Industries Inc.
Dennis J. Cantwell, Printed Circuits Inc.	Jack Y. Josefowicz, TTM Technologies	Joseph T. Slanina, Honeywell Inc.
Michael V. Carano, Electrochemicals Inc.	Thomas E. Kemp, Rockwell Collins	Joseph Smetana, Alcatel-Lucent
Peter Marc Carter, Rockwell Collins	John Konrad, Endicott Interconnect Technologies Inc	Polina Snugovsky, Celestica International Inc.
Phillip Chen, L-3 Communications Electronic Systems	Bridget Lawrence, Pentaplex Inc.	Bill Starmann, Raytheon Company
David J. Corbett, Defense Supply Center Columbus	Gary B. Long, Intel Corporation	Michael Toben, Rohm and Haas Electronic Materials
G. Sidney Cox, E. I. du Pont de Nemours and Co.	David McQuinn, Solelectron	Donald E. Walsh, UIC/Uyemura International Corp.
Donald P. Cullen, MacDermid, Inc.	John D. Meyers, Electrochemicals Inc.	Michael K. Walsh, OMG Fidelity
Gordon Davy, Northrop Grumman Corporation	Ramesh Mohabir, Celestica International Inc.	Timothy L. Wells, Endicott Interconnect Technologies Inc
Steve Dunford, Nokia Networks	Keith G. Newman, Sun Microsystems Inc.	Karl F. Wengenroth, Enthone Inc. - Cookson Electronics
C. Don Dupriest, Lockheed Martin	Mario Orduz, UIC/Uyemura International Corp.	John E. Williams, Raytheon Company
Richard M. Edgar, Tec-Line Inc.	Anders P. Pedersen, Harris Corporation, GCSD	Yung-Herng Yau, Enthone Inc. - Cookson Electronics
Theodore Edwards, Dynaco Corp.	Mike Pfeifer, Motorola Inc. ACES	
Dennis Fritz, MacDermid, Inc.	Jim R. Reed, Dell Inc.	

Table of Contents

1 Scope	1	APPENDIX 7 Solder Spread Test Protocol	20
1.1 Description	1	APPENDIX 8 Standard Development Efforts for IPC-4554, Specification for Immersion Tin Plating for Printed Circuit Boards	21
1.2 Objective	1		
1.3 Performance Functions	1		
1.3.1 Solderability	1		
1.3.2 Contact Surface	1		
1.3.3 Electromagnetic Interference (EMI) Shielding ..	1		
1.3.4 Connectors	1		
1.3.4.1 Press-Fit	1		
1.3.4.2 Edge Tab	1		
1.3.5 Wire Bonding	2		
1.4 Definition of Terms	2		
2 APPLICABLE DOCUMENTS	2	Figures	2
2.1 IPC	2		
2.2 Telcordia™	2		
3 REQUIREMENTS	2		
3.1 Visual	2		
3.2 Finish Thickness	2		
3.2.1 Immersion Tin Thickness	3		
3.3 Porosity	3		
3.4 Adhesion	4		
3.5 Solderability	4		
3.5.1 Solder Spread Test	4		
3.6 Cleanliness	4		
3.6.1 Electrolytic Corrosion	4		
3.7 Chemical Resistance	4		
3.8 High Frequency Signal Loss	5		
3.9 Whisker Issues	5		
4 QUALITY ASSURANCE PROVISIONS	7	Figure 3-1 Example of Uniform Plating	2
4.1 Qualification	7		
4.1.1 Sample Test Coupons	7		
4.2 Quality Conformance Testing	7		
APPENDIX 1 Chemical Process Definitions	8		
APPENDIX 2 Typical Process Sequence	9		
APPENDIX 3 Qualification of ISn Process by the Board Supplier	10		
APPENDIX 4 XRF Measurement Techniques	11		
APPENDIX 5 Auger/XPS and Coulometric Stripping Techniques	14		
APPENDIX 6 Tin Whiskers	19		
APPENDIX 7 Solder Spread Test Protocol	20	Figure 3-2 Example of Uniform Plating	3
APPENDIX 8 Standard Development Efforts for IPC-4554, Specification for Immersion Tin Plating for Printed Circuit Boards	21		
Figure 3-3 Example of Improper ISn Deposit Showing Inconsistent Plating	3		
Figure 3-4 Coupon for Surface Mount Solderability Testing	4		
Figure 3-5 Rating of 1 As Measured at 100 X	6		
Figure 3-6 Rating of 4 As Measured at 100X	6		
Figure 3-7 Rating of 7 As Measured at 100X	6		
Figure 3-8 Rating of 5 As Measured at 100X	6		
Figure A5-1 Auger vs. X-ray Emission Process	14		
Figure A5-2 Coulometric Stripping Analysis Using Test Coupon (A)	14		
Figure A5-3 Coulometric Stripping Analysis Using a Tube with a Gasket (B)	15		
Figure A5-4 Coulometric Stripping of Tin on Copper in Diluted Sulfuric Acid (Area = 5 cm ² ; Stripping Current = 25.30 mA; Stainless Steel Cathode)	15		
Figure A5-5 Coupons after Coulometric Stripping	16		
Figure A5-6 SNMS Measurement for an Untreated Deposit (initial thickness approximately 0.8 µm)	17		
Figure A5-7 SNMS Measurement of a Deposit; Storage of Four Hours at 155 °C and 2X Reflow Oven (initial thickness approximately 0.8 µm)	17		
Figure A5-8 Comparison of Coulometric Measurements (MacDermid p-test) with Chemical Analysis (AAS)	18		
Figure A6-4 Whisker in an Immersion Tin Plated 0.46 micron (0.018 in) Diameter Via Hole	19		
Figure A8-1 Industry Survey for ISn Deposit Recommendations	22		
Figure A8-2 Sample of XRF Measurements for the Five Suppliers to the Round Robin Testing	23		
Figure A8-3 Impact of Age on 0.6 Micron Average Thickness Deposit Through 265 Days	23		
Figure A8-4 Comparison of Impact of Aging On a 1.0 Micron Average Deposit Through 239 Days	24		
Figure A8-5 Wetting Balance Coupon	24		
Figure A8-6 Solder Spread Test Vehicle	25		

Figure A8-7	Wetting Balance Results for Vendor A Through 400 Days of Normal Storage	25
Figure A8-8	Wetting Balance Data for Vendor B Through 182 Days of Normal Storage	26
Figure A8-9	Wetting Balance Data for Vendor C Through 149 Days of Normal Storage	26
Figure A8-10	Wetting Balance Data for Vendor D Through 229 Days in Storage	27
Figure A8-11	Wetting Balance Data for Vendor E Through 239 Days of Normal Storage	27
Figure A8-12	Impact of Test Temperature on Wetting Times for Vendor A Through 229 Days of Normal Storage - Test Temperature of 215 °C	28
Figure A8-13	Impact of Test Temperature on Wetting Times for Vendor B Through 182 Days of Normal Storage - Test Temperature of 215 °C	29
Figure A8-14	Vendor B Post 1260 Days of Storage	30
Figure A8-15	Vendor E Post 1260 Days	31
Figure A8-16	Vendor C Post 1260 Days	31
Figure A8-17	Surface Morphology of Vendor B Post 1260 Days	32
Figure A8-18	Surface Morphology of Vendor C - Post 1260 Days	32
Figure A8-19	Surface Morphology of Vendor E - Post 1260 Days	32
Figure A8-20	Surface Scan Showing Cu, C, Sn and O for Vendor B	33
Figure A8-21	Chemical Map of Surface for Vendor B	34
Figure A8-22	Surface Map for Vendor C - Note a Greater Presence of Copper on the Surface	35
Figure A8-23	Vendor C at 20 Å - Note Large Carbon Rich Areas	36
Figure A8-24	Vendor E Surface Scan	37
Figure A8-25	Vendor E at 1000 Å	38
Figure A8-26	Comparison of Vendor C (top) to Vendor E (bottom) at 100 Å - Significant Difference in the Deposits	39
Figure A8-27	Contact Wetting Angles for the Four Suppliers Tested with SnPb in a Normal (Air) Atmosphere - All Four Showed Excellent Wetting	40
Figure A8-28	Contact Wetting Angles for the Four Suppliers Tested with SnPb in an Nitrogen Atmosphere - Again, All Four Showed Excellent Wetting	40
Figure A8-29	Contact Wetting Angles for the Four Suppliers Tested with SAC305 in a Normal (Air) Atmosphere - All Four Exhibit Excellent Wetting	40
Figure A8-30	Contact Wetting Angles for the Four Suppliers Tested with SAC305 in a Nitrogen Atmosphere - Again, All Four Exhibit Excellent Wetting	41
Figure A8-31	Comparison of Contact Angles for Vendor A - All Tests	41
Figure A8-32	Average SEC Values for the Five Vendors ...	41

Tables

Table 3-1	Requirements of Immersion Tin Plating	5
Table 3-2	ISn Whisker Rating Scheme Using 100 X Magnification	6
Table 4-1	Qualification Test Coupons	7