ASSOCIATION CONNECTING
ELECTRONICS INDUSTRIES®

IPC-HDBK-830

Guidelines for Design, Selection and Application of Conformal Coatings

IPC-HDBK-830

October 2002 A standard developed by IPC

2215 Sanders Road, Northbrook, IL 60062-6135
Tel. 847.509.9700 Fax 847.509.9798
www.ipc.org

The Principles of Standardization

In May 1995 the IPC's Technical Activities Executive Committee 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 (TAEC) 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 standard/guideline 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 standard?

Your purchase of this document contributes to the ongoing development of new and updated industry standards. 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 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 revenue is necessary to complement dues revenue. The price schedule offers a 50% discount to IPC members. If your company buys IPC standards, 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 847/790-5372.

Thank you for your continued support.

IPC

ASSOCIATION CONNECTING
ELECTRONICS INDUSTRIES®

IPC-HDBK-830

Guidelines for Design, Selection and Application of Conformal Coatings

Developed by the Conformal Coating Handbook Task Group (5-33c) of the Cleaning and Coating Committee (5-30) of IPC

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

Contact:

IPC
2215 Sanders Road
Northbrook, Illinois
60062-6135
Tel 847 509.9700
Fax 847 509.9798

This Page Intentionally Left Blank

Acknowledgment

Any Standard involving a complex technology draws material from a vast number of sources. While the principal members of the Conformal Coating Handbook Task Group (5-33c) of the Cleaning and Coating Committee (5-30) 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.

Cleaning and Coating Committee

Chair
Frank Cala, Ph.D.
Church and Dwight Co., Inc.

Conformal Coating Handbook Task Group

Co-Chairs
Fonda Wu
Raytheon Systems Co.

and

Sharon Goudie
Dow Corning Corporation

Technical Liaison of the IPC Board of Directors

Nilesh S. Naik
Eagle Circuits Inc.

Conformal Coating Handbook Task Group

David C. Adams, Rockwell Collins
Paul Alexander, Shin-Etsu Silicone
Norazmi Alias, UCB Asia Pacific Sdn Bhd
Lloyd Armogan, Rockwell Collins
Kim M. Atkins, Specialized Coating Services
Simin Bagheri, Celestica International Inc.
James P. Bartlett, Ph.D., P.E., North Dakota State University
Heather Benedict, Plexus Corp.
Paul A. Berry, P.E., Dow Corning Corporation
Gerald Leslie Bogert, Bechtel Plant Machinery, Inc.
Alan M. H. Brewin, National Physical Laboratory
Ronald J. Brock, NSWC - Crane
Frank Cala, Ph.D., Church & Dwight Co. Inc.
M. Lee Collier, Electra Polymers & Chemicals America
Graham Collins, Litton Systems Canada Ltd.
David J. Corbett, Defense Supply Center Columbus
Amelia A. DeBaggis, Honeywell Inc.
William E. Donges, Nordson Corporation
David A. Douthit, LoCan, LLC
Jari Drlik, Lockheed Martin Space Systems
Thomas G. Farrell, Underwriters Labs Inc.
Hugh Fay, Loctite Corporation
Larry Fisher, Dexter Electronic Materials
Jess V. Ford, Ph.D., InSurf
Mahendra S. Gandhi,
Scott D. Glasspoole, Honeywell Inc.
Sharon K. Goudie, Dow Corning Corporation
Michael R. Green, Lockheed Martin Space Systems
Eric T. Green, Lockheed Martin Space Systems
David Greenman, Concoat Limited
James A. Gryga, Jr., Rockwell Automation/Allen-Bradley
Dennis Hardy, Benchmark Electronics Inc.
Frank R. Hart, Precision Valve & Automation, Inc.
David Hill, 3M Company
Bernard Icore, Northrop Grumman Corporation
David H. Johnson, U.S. Air Force
Buck Johnson, 3M Company
Ted Jones, InSurf
Joseph E. Kane, BAE Systems Controls
Dave Kelly, Schenectady Europe
Dr. William G. Kenyon, Global Centre for Process Change, Inc.
Phil Kinner, Concoat Limited
Gregg Klawson, General Dynamics - C4 Systems
Michael J. Knoellinger, LGA
Michael J. Kroeger, Honeywell Inc.
Vijay Kumar, Lockheed Martin Missile & Fire Control
Xavier Lambert, Schneider Electric SA
Roger H. Landolt, Cookson Electronics
James Lawrence, Humiseal Division/ Chase Corporation
James Licari, Avanteco
Curtis A. Lustig, Shipley Company, L.L.C.
James F. Maguire, Intel Corporation
Michael Mallory, L-3 Communications
Rene R. Martinez, TRW Electronics & Technology Division
William Dean May, NSWC - Crane
Thomas McConihay, General Electric Co.
Randy McNutt, Northrop Grumman
Renee J. Michalkiewicz, Trace Laboratories - East

James H. Moffitt, Moffitt Consulting Services

Terry L. Munson, CSL Inc.

Graham Naisbitt, Concoat Limited

Robert Netzel, Northrop Grumman Corporation

Debora L. Obitz, Trace Laboratories - East

Gary Okafuji, Toro Co.

Deepak K. Pai, C.I.D.+, General Dynamics-Advanced Information

Douglas O. Pauls, Rockwell Collins

Marcio A. Ponce, Dow Corning Corporation-South America

Jeffrey Quarberg, Sauer Danfoss

Rick B. Ramirez, Specialized Coating Services

William A. Rasmus, Jr., Northrop Grumman Space Systems

Mia S. Riley, Trace Laboratories - East

Barry Ritchie, Dow Corning Corporation

John H. Rohlfing, Delphi Delco Electronics Systems

Joseph C. Salvini, Underwriters Laboratories Inc.

Darrell C. Schneider, Viasystems Inc.

Mark Schumacher, Crown Equipment Corporation

Stanley S. Seelig, Dynaloy, Inc.

Christina Semkow, Rockwell Automation/Allen-Bradley

Paul Shafer, Sealant Equipment & Engineering

Joseph L. Sherfick, NSWC - Crane

Lowell Sherman, Defense Supply Center Columbus

Ray Simon, L-3 Communications

John C. Sines, BAE Systems Controls

Garth Sperry, L-3 Communications

Erik Tegehall, IVF

Ronald E. Thompson, NSWC - Crane

James R Thompson, DaimlerChrysler Huntsville Electronics

Dung Q. Tiet, Lockheed Martin Space Systems

Brian J. Toleno, Ph.D., Henkel Loctite Corp.

James D. Tower, Precision Valve & Automation, Inc.

Laura J. Turbini, Ph.D., University of Toronto

Paula VanDenberg, Plasma Systems

Crystal E. Vanderpan, Underwriters Laboratories Inc.

David A. Vaughan,

Donald Waddell, Rockwell Automation

Larry Waksman, Shin-Etsu Silicone

John Waryold, Humiseal Division/ Chase Corporation

Philip W. Wittmer, Delphi Delco Electronics Systems

Henry Wong, TRW Electronics & Technology Division

Greg Wood, EMPF/ACI

Fonda B. Wu, Raytheon Electronic Systems

Lamar Young, Specialty Coating Systems Inc.

Don Youngblood, Honeywell Inc.

Table of Contents

Figures

Tables

Guidelines for Design, Selection and Application of Conformal Coatings

1 SCOPE

1.1 Introduction Conformal coatings are used in conjunction with printed circuit assemblies (PCAs). The designer and the users of conformal coatings for electronics applications should be aware of the properties of various types of conformal coatings and their interactions with PCAs to protect the PCAs in the end-use environment for the design-life of the PCA (or beyond). This document has been written to assist the designers and users of conformal coatings in understanding the characteristics of various coating types, as well as the factors that can modify those properties when the coatings are applied. Understanding and accounting for these materials can ensure the reliability and function of electronics.

1.2 Purpose The purpose of this handbook is to assist the individuals who either make choices regarding conformal coating or who work in coating operations. This handbook represents the compiled knowledge and experience of the IPC Conformal Coating Handbook Task Group. It is not enough to understand the properties of the various conformal coatings, the user needs to understand what is to be achieved by applying the conformal coating and how to verify that the desired results have been realized.

1.3 Scope Conformal coating, for the purpose of this document, is defined as a thin, transparent, polymeric coating that is applied to the surfaces of PCAs to provide protection from the end-use environment. Typical coating thickness ranges from 12.5 µm [0.49 mil] to 200 µm [7.9 mil].

Processing characteristics and curing mechanisms are dependent on the coating chemistries used. The desired performance characteristics of a conformal coating depend on the application and should be considered when selecting coating materials and coating processes. Users are urged to consult the suppliers for detailed technical data.

This guide enables a user to select a conformal coating based on industry experience and pertinent considerations. It is the responsibility of the user to determine the suitability, via appropriate testing, of the selected coating and application method for a particular end use application.

A conformal coating may have several functions depending on the type of application. The most common are:

- To inhibit current leakage and short circuit due to humidity and contamination from service environment.
- To inhibit corrosion.
- To improve fatigue life of solder joints to leadless packages.
- To inhibit arcing, corona and St. Elmo's Fire.
- To provide mechanical support for small parts that cannot be secured by mechanical means, to prevent damages due to mechanical shock and vibration.

1.4 Terms and Definitions

Acetone – A volatile fragrant flammable liquid ketone C_3H_6O used chiefly as a solvent and in organic synthesis.

Adhesion promotion – The chemical process of preparing a surface to enhance its ability to be bonded to another surface, i.e., a layer of conformal coating.

Adhesion failure – The rupture of an adhesive bond such that the separation appears to be at the adhesive-adherent interface.

Anisotropic – Having properties that vary depending on the direction of measurement.

Anthropogenic – Relating to or resulting from the influence of human beings on nature.

ARUR – Abbreviation standing for acrylic resin and urethane resin combination chemistries.

Bridging – Fillet or meniscus formation of coating around the leads of a component caused by capillary action.

Creep – Strain, deformation, or movement of coatings caused by time and/or temperature.

Cross-linking – The formation of chemical bonds between molecules in a thermosetting resin during a polymerization reaction.

CTE – (Coefficient of Thermal Expansion) Linear dimensional change with respect to an original dimension due to a change in temperature.

Cure – A change in the physical properties of a polymer by a chemical reaction.

Degradation – Decrease in quality or integrity. Loss of desired physical, chemical or electrical properties.

Delamination – A separation between a conformal coating layer and the surface it is adhering to.

De-masking – The process of removing or disengaging a maskant film, tape, boot or plug.

De-wetting – The propensity of the coating material to refuse to wet the surface evenly.

Dielectric constant – The ratio of the capacitance of a configuration of electrodes with a specific material as the dielectric between them to the capacitance of the same