IPC-HDBK-4691

2015 - November

Handbook on Adhesive Bonding in Electronic Assembly Operations

A standard developed by IPC

Association Connecting Electronics Industries

IPC®

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-HDBK-4691

Handbook on Adhesive Bonding in Electronic Assembly Operations

Developed by the Electronic Assembly Adhesives Task Group (5-11c) of the Assembly & Joining Committee (5-20) of IPC

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

Contact:

IPC
3000 Lakeside Drive, Suite 105N
Bannockburn, Illinois
60015-1249
Tel 847 615.7100
Fax 847 615.7105

Introduction

As available materials have improved and as manufacturing efficiency drives consideration of alternatives to traditional processes, adhesive bonding has become increasingly more important industry wide. The major function of adhesives is to fasten two or more ''adherents'' (i.e., materials and/or parts which are to be bonded) together. This document covers known terminology associated with these materials and processes as related only to electronic assembly.

Adhesives are increasingly being used in applications, replacing the more traditional methods of fastening. In spot welding and mechanical fastening, the strength of the structure is limited to the areas where the members of the structure are in contact with the weld or fasteners. But when parts are bonded together with adhesives, the stress is transmitted from one member to another in such a way that stresses are uniformly distributed over the entire surface area of the bond. Adhesives can be used to bond together dissimilar materials, whereas welding and soldering are limited to a few materials that can be bonded together by these methods. In addition, adhesives are being specified in applications which require reduced weight and space that preclude the use of hardware fasteners. Adhesive bonding is used in conjunction with various types of assemblies and components (e.g., printed circuit assemblies (PCA), connectors, transformers, enclosures, etc.). The designer and the users of adhesive bonding for electronic applications must be aware of the properties of various types of adhesive bonding and their interactions with assemblies and components to protect them in the end-use environment for the design life of the end item. This document was written to assist designers and users of adhesive bonding in understanding the characteristics of various adhesive bonding types, as well as the factors that can modify those characteristics when the adhesive bonding is applied. Understanding and accounting for these materials can ensure the reliability and function of electronics.

Acknowledgment

Any document involving a complex technology draws material from a vast number of sources across many continents. While the principal members of the Electronic Assembly Adhesives Task Group (5-11c) of the Electronics & Joining Committee (5-20) are shown below, it is not possible to include all of those who assisted in the evolution of this handbook. To each of them, the members of the IPC extend their gratitude.

Electronics & Joining Committee

Chair
Leo P. Lambert
EPTAC Corporation

Vice Chair
Renee J. Michalkiewicz
NTS - Baltimore

Electronic Assembly Adhesives Task Group

Chair
Nate Grinvalds
Rockwell Collins

Technical Liaison of the IPC Board of Directors

Bob Neves
Microtek (Changzhou) Laboratories

Electronic Assembly Adhesives Task Group

Frederick P. Beltran, L-3 Communications
Neil Bolding, MacDermid Autotype Inc
Lance Brack, Raytheon Missile Systems
Beverley Christian, BlackBerry
Laura Cohen, Continental Automotive Systems
Robert W. Cooke, NASA Johnson Space Center
Caroline Ehlinger, Rockwell Collins
Nate Grinvalds, Rockwell Collins
Ife Hsu, Intel Corporation
Richard Iodice, Raytheon Company
Maurice LeBlon, AI Technologies, Inc.
Jane Li, LENOVO (Beijing) Limited
Zhe (Jacky) Liu, ZTE Corporation
Michael J. McCourt, Elantas Adhesive Systems
Garry McGuire, NASA Marshall Space Flight Center
Agnieszka Czarowski, BAE Systems
Douglas O. Pauls, Rockwell Collins
Dan Strawn, Ellsworth Adhesives
Brian J. Toleno, Henkel Corporation
Debie M. Vorwald, Rockwell Collins
Bill R.Vuono, TriQuint Semiconductor
Fonda B. Wu, Raytheon Company
Leo Zhao, LENOVO (Beijing) Limited

This Page Intentionally Left Blank

Table of Contents

Figures

Tables

Handbook on Adhesive Bonding in Electronic Assembly Operations

1 SCOPE

For the purpose of the initial version of this document, the discussion of adhesives will be limited to liquid, paste and gel materials and closely related film adhesives, which require some form of ''cure'' mechanism to achieve their full performance. Materials that rely primarily on pressure-sensitive bonds, whether coated on an inert film or not (generically ''tapes'') will not be addressed at this time. Similarly, though there is much overlap in material chemistry and application, the subcommittee has chosen to defer the discussion of underfill materials at present. Underfill materials are discussed in J-STD-030. Surface mount adhesives are also not addressed in this document. Surface mount adhesives are discussed in IPC-SM-817.

Adhesives, for the purpose of this document, are defined as a material (e.g., epoxy, silicone, urethane, cyanoacrylate, polyimide, etc.) that is applied in an uncured state and subsequently processed (i.e., cured) to form a rigid or rubber-like state.

Processing characteristics and curing mechanisms are dependent on the adhesive chemistries used. The desired performance characteristics of an adhesive are dependent on the application and must be considered when selecting adhesive bonding materials and adhesive bonding processes. Users are urged to consult their suppliers for detailed technical data.

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

Adhesive bonds may have several functions depending on the type of application. The most common are to:

- Attach one or more electronic functional devices to a substrate.
- Absorb mechanical stresses that would otherwise compromise electrical (e.g., solder) joints.
- Inhibit corrosion.
- Improve fatigue life of solder joints to leadless packages.
- Inhibit arcing and corona, in particular for high-voltage applications.
- Provide mechanical support and prevent damages due to mechanical shock and vibration.
- Provide a mitigation method for the growth of tin whiskers.

1.1 Purpose The term ''adhesive bonding'' can be ambiguous and be interpreted to mean many things in various industry assembly processes.

The purpose of this handbook is to assist individuals who must either make choices regarding adhesive bonding or who must work in adhesive bonding operations and also to provide guidelines for the design, selection and application of adhesive bonding as it pertains to electronic assembly only.

2 APPLICABLE DOCUMENTS

2.1 IPC[1]

IPC-T-50 Terms and Definitions for Interconnecting and Packaging Electronic Circuits[2]

IPC-CH-65 Guidelines for Cleaning of Printed Boards and Assemblies

IPC-TM-650 Test Method Manual

2.6.1.1 Fungus Resistance - Conformal Coating

2.6.3.1 Solder Mask - Moisture and Insulation Resistance

1. www.ipc.org
2. Current and revised IPC Test Methods are available on the IPC Web site (www.ipc.org/html/testmethods.htm)