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IPC White Paper and Technical Report on Halogen-Free Materials Used for Printed Circuit Boards and Assemblies

Developed by the Halogen-Free Materials Task Group (4-33a) of the Environment Health and Safety Committee (4-30) of IPC

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

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Approval

Because this publication is a White Paper as well as a Technical Report, it expresses the official position of the IPC organization. Accordingly, the April 2001 IPC Policy on Position Statements has been followed to approve the release of this White Paper as a General Position Statement. To this end, this document was balloted and approved by the IPC 8-10 Technical Activities Executive Committee (TAEC) and bears the signatures of both the Chair of the TAEC and the President of the IPC.

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EXECUTIVE SUMMARY

SCOPE

This document summarizes the IPC position on the subject of ''halogen free'' materials for the electronics industry. It was developed over a period of three years by a team representing every level of the electronics supply chain and has been reviewed and accepted by the IPC's Technical Activities Executive Committee (TAEC). This document is applicable to materials for interconnecting electronics including but not limited to copper-clad laminates and prepregs, resin coated copper foils, flexible materials and soldermasks. This document reflects the state of the information and technology as of 1 December, 2002.

INTRODUCTION

Across a variety of industries, consideration is being given to the use of alternatives to halogenated flame retardants. Thus, the use of non-halogenated flame retardants in polymer applications is currently an area of much research and discussion. Halogens are the Group 7 elements in the periodic table and include fluorine, chlorine, bromine and iodine. Electrical and electronic products may be considered ''halogen-free'' if they are assembled without the intentional use of these elements in the raw materials and these elements are not intentionally present in the end product. Even when halogenated flame retardants are not added to the polymer formulations, the finite levels of these elements may be present as impurities in the raw materials and as a by-product of the polymerization process employed. The proposed industry standard for incidental occurrence of chlorine and bromine in electronic base materials is 0.15% maximum total chlorine plus bromine as defined by the international industry standard IEC 61249. Due to the nature of their (flammable components) composition and function (transmission of electrical charges), printed circuit boards (PCBs) require ignition protection. Flame retardant materials, which prevent ignition and spread of flames should ignition occur, present a number of manufacturing challenges in terms of cost, performance, fire safety, and health, environmental, and regulatory issues.

Tetrabromobisphenol A (TBBPA) is the primary flame retardant used in PCBs. TBBPA is an organic molecule whose composition includes approximately 59% bromine and thus falls under the broad classification of halogenated flame retardants. It is cost effective, compatible with PCB components, qualified in use on a worldwide basis, and has no health, environmental, or regulatory issues that exclude its use. Still there exist a number of activities that are being driven by marketing strategies and not scientific data which call for its reduction or elimination from PCBs. Clearly there is no legislation or regulations, pending or otherwise, calling for the removal of TBBPA currently.

This document serves as a historical perspective and status of industrial, environmental, and legislative programs. It also provides information on cost, performance, product reliability, consumer safety, and end-of-life issues of common and alternative flame retardants used in PWBs.

RESEARCH

A shift from TBBPA to non-halogenated flame retardants in printed circuit boards would have a profound impact upon the PWB industry, thus this position paper was commissioned by IPC to examine the need for such a shift. The exhaustive review is summarized in the appendices as shown below:

APPENDIX 1: Fire Safety and Electronics
APPENDIX 2: Flame Retardants used in the PWB Industry
APPENDIX 3: Halogens in Non-Brominated Epoxy Resins and Their Electrical Laminates
APPENDIX 4: Toxicological, End-of-Life, and Recycling Issues
APPENDIX 5: Political and Marketing Driver and Organizational Efforts
APPENDIX 6: IEC 61249-2-21, Specification for Non-Halogenated Epoxide/Woven E-glass Laminates of Defined Flammability
APPENDIX 7: Test Method for the Determination of Halogens in Base Materials

From the vast amount of information reviewed, a confident conclusion may be reached as to the use of TBBPA as a flame retardant in printed circuit boards. The resulting position of IPC is as stated below.

CONCLUSION

There is no data indicating that the halogen flame retardants presently used in printed circuit boards present any significant environmental or health hazard. Although halogenated flame retardants have been in use in electronic products for many decades, there have been no reports of illness or death attributable to their use and in fact injuries and/or death are known hazards of the fires associated with non-flame retarded electronic equipment. There is also no data indicating that any of the materials currently being

considered as replacements for these halogenated flame retardants are any better or worse for the environment.

Until relevant data are presented proving the current flame retardants incorporated into the polymeric structure have an adverse environmental impact and the alternatives are better, IPC will not support any reduced ppm level or recommend specific alternative chemistries. It is IPC's position that these reduced levels do not ensure product reliability and may exclude certain laminate and prepreg base materials from the market.

IPC, IEC and Underwriters Laboratories have chosen to segregate halogen free materials from their halogen containing counterparts. The basis for these decisions was in part due to the differences in thermal stability, physical performance such as moisture absorption and the PWB processing. The ''halogen-free'' materials are not direct replacements for halogen containing grades with similar target performance. For Underwriters Laboratories, ''halogen-free'' materials must undergo Long Term Thermal Aging (LTTA), full index testing and Metal Clad Industrial Laminate (MCIL) testing in order to fully characterize these products before listing.

IPC documents will provide the electronics community with a test method for standardizing the analysis for halogens in base materials as well as defining maximum levels of chlorine and bromine for these newly developed grades of base materials. The purpose of this activity is standardization and consistency within the supply chain and is not considered an endorsement by IPC of these materials. IPC does encourage continued research in both base materials development and the study of the impact of these materials on health, safety and environmental concerns.

In light of this data, IPC recognizes the term ''halogen-free'' as a marketing term only and will not advocate a conversion from a known safe method of generating flame resistance for base materials.