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Standards for Compatibility of Printed Circuit and Component Lead Materials

Microminiature electronic component technology has been faced with many packaging problems. Essentially, the problems relate to the compatibility of lead materials, joining techniques, transfer molding concepts, printed circuit board materials, and process and material specifications. In an effort to resolve these problems, an investigation was conducted to extend the usefulness of existing process data and fabrication technology and to develop other refinements. The investigation was divided into four task categories: (1) analysis of welding parameters; (2) evaluation of printed circuit board materials; (3) development of microsoldering techniques; and (4) study of transfer molding. The primary objectives of these tasks were to: (1) determine correlation between microweld pulse parameters, infrared emission, and weld strength; (2) evaluate printed circuit board materials to determine requirements and availability of materials to be used in space environment; (3) develop criteria and techniques applicable to microsoldering as applied to thin films, thick films, and flat packs; and (4) develop quality criteria and process limits for transfer molding. The results of the investigation are summarized below:

1. Welding Parameters—To study the effects of varying welding parameters, statistical experiments were designed using four wire materials. These welding parameters included Watt-second energy, weld pulse risetime, and electrode pressure for each wire combination. During each weld, simultaneous recordings were made of voltage, current, and infrared radiation. Set-down and weld strength were also recorded. Analysis of the information derived from the statistical experiments revealed new insights into critical weld pulse parameters, with particular emphasis on pulse slope and energy and their effects on the physical weld characteristics, such as metallic structure and strength.

Correlation between infrared heat radiation and the quality of the weld joint has been verified. This correlation is important because it is the basis for a reliable in-process nondestructive inspection technique that is instantaneous and automatic. That this infrared radiation technique is one possible solution to the problem of obtaining consistent high-quality welds under volume production conditions is amply documented from the thousands of welds performed.

2. Printed Circuit Board Materials—The influence of space environment on the electrical and mechanical properties of circuit board material was evaluated to determine the material type most satisfactory for use in space applications. The investigation included an analysis of the techniques of etching, soldering, and welding to determine their effect on the outgassing rate of boards subjected to a high-vacuum environment.

The laboratory testing condition established as satisfactory for material exposure is a vacuum of 1.0×10^{-5} mm of Hg. This test environment permitted executing the program in five phases. Phase 1 was a mass material screening exposure to the simulated environment. Phase 2 was a selective, more detailed material exposure analysis utilizing a microbalance for more precise weight loss determinations. Phase 3 was an analysis of the test results of Phase 2. Phase 4 summarized the conclusions based on the results. Phase 5 dealt with material types best suited for space applications.

(continued overleaf)

3. Microsoldering—The various factors involved in microsoldering were studied, and extensive tests were conducted to determine the most compatible combination of soldering methods, solder alloy, flux type, deposited surfaces, and pad size that would produce acceptable solder joints on thin and thick film circuits.

Acceptable solder joints were determined through the pull, fatigue, creep, and environmental tests. The primary results of the study are as follows:

(a) The most constant and acceptable joints were obtained by using a modified parallel gap resistance weld-soldering machine. Hand soldering with extensive skill could meet minimum requirements. Optical soldering was not suited to applications study in this program.

(b) A commercial low-temperature melting alloy proved to be satisfactory for soldering solid gold wire. Where gold-plated (less than 0.000070-inch) copper and Kovar leads were used, 60Sn/40Pb provided the highest strengths.

(c) Mild fluxes are recommended for microsoldering operations.

(d) The most satisfactory thin film surfaces for the solder joint area were chrome/gold/chrome (0.000015-inch)/gold (0.000020- to 0.000070-inch).

(e) Platinum gold ink, oven cured, provided the most satisfactory surface for thick films; palladium gold was almost as good.

4. Transfer Molding—Transfer molding of epoxy compounds was found to be an effective, reliable, and low cost method of encapsulating cordwood electronic modules. To apply this technique, it was necessary to establish quality assurance requirements. A preliminary procurement specification was prepared for soft flow epoxy compounds capable of polymerization at 250°F or below at 480 psi maximum pressure. Six compounds (from three suppliers) met the initial screening tests and were subsequently run through extensive electrical, physical, mechanical, and thermal tests. Data from these tests were then used to establish a proposed Material Specification and Design Guideline for transfer molding of electronic circuits. A developmental mold was designed and fabricated. This mold, by change of an insert, can accommodate modules from 1×1×1 to 1×1×3.50 inches. The mold was checked for proper filling and venting and then was used for molding test modules.

Note:

Complete details may be obtained from:

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