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BDX-613-1800 (Rev.)

HMC-TO-FLATPACK ATTACHMENT

Topical Report

L. R. Zawicki, Project Leader

Published April 1978

Prepared for the United States Department of Energy
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**Kansas City
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Department 842

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HMC-TO-FLATPACK ATTACHMENT

BDX-613-1800 (Rev.), UNCLASSIFIED Topical Report, Published
April 1978

Prepared by L. R. Zawicki, D/842

A method has been developed for attaching a completed hybrid microcircuit to a flatpack which can then be hermetically sealed. Ablefilm 517B and Epo-Tek H77 epoxies, in conjunction with an abraded flatpack and applied pressure during cure, were shown to provide HMC-to-flatpack bonds which meet all environmental and processing requirements of hybrid microcircuits in two recent programs.

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CONTENTS

Section	Page
SUMMARY.	4
DISCUSSION	5
SCOPE AND PURPOSE.	5
PRIOR WORK	5
ACTIVITY	5
<u>Package Preparation.</u>	5
<u>Bonding Material Environmental Tests</u>	6
<u>Outgassing Analyses.</u>	15
<u>Applied Force During Attachment.</u>	16
ACCOMPLISHMENTS.	16
FUTURE WORK.	17
REFERENCES	18
DISTRIBUTION	19

TABLE

Number	Page
1 Epoxies Evaluated During Study	7

SUMMARY

The purpose of this work was to develop a process to attach a complete hybrid microcircuit (HMC) to a flatpack which can be hermetically sealed. The HMC-to-flatpack bond must be able to withstand further processing and environmental testing including centrifuge testing (5000 g's) after exposure to various processing parameters (1 to 2 hours at 200°C) and product test requirements (48 hours at 200°C; 168 hours at 150°C; 10 temperature cycles from -40°C to +125°C).

Three items were evaluated during this work: the preparation of the flatpack, the bonding material, and the method of attachment.

Abrading the plated gold in the bottom of the flatpack using a wet blast technique was found to yield the best bonding surface. The wet blast uses 220 mesh aluminum oxide grit in a 25 to 30 percent water slurry at 241 kPa (35 psi).

Two different solders and five different epoxies were evaluated. Two epoxies, Ablefilm 517B and Epo-Tek H77,* exhibited the best bonding during the evaluations. Ablefilm 517B was chosen as the epoxy to use during production primarily because of its use in lidding HMCs.

It became evident during this work that an applied force during cure was needed to assure complete bonding of the substrate to the flatpack. Evaluations showed a minimum pressure of 10 kPa (1.5 psi) to be sufficient.

As a future development activity associated with the process, a rework procedure to remove an acceptable HMC from a flatpack would be desirable to improve overall product yield.

*Ablefilm is manufactured by Ablestik Laboratories, Gardena, California; Epo-Tek is manufactured by Epoxy Technology, Incorporated, Watertown, Massachusetts.

DISCUSSION

SCOPE AND PURPOSE

This work was conducted to develop a process of attaching HMCs to flatpacks in such a way that interconnections using gold ribbon can be made from the HMC to the flatpack leads, and the HMC package can be hermetically sealed. The HMC-to-flatpack bond must be able to withstand high temperatures (200°C) for significant periods of time, temperature cycles with short transfer times, centrifuge testing, and mechanical shock and vibration testing. The bonding material between the HMC and the flatpack must not outgas any corrosive elements which might compromise the reliability of the HMC package.

This work was conducted between January 1976 and February 1977.

PRIOR WORK

Past programs at Bendix Kansas City using HMCs did not require the HMCs to be hermetically sealed. The HMCs were "sealed" by epoxy-attaching ceramic lids to the HMCs. When hermetically sealed HMCs became a requirement, it was necessary to develop a technique for attaching a completed HMC inside a package that could be hermetically sealed. In addition to the hermetic sealing requirement, other requirements imposed on the HMC package were high temperature soaks (with and without power), temperature cycles (with short transfer times), centrifuge testing, and mechanical shock and vibration testing.

During the development of this process the program requirements on centrifuge testing were changed from 20,000 g's to 5000 g's. The bonding materials finally chosen were evaluated to satisfactorily meet the 5000 g requirement. (The g-level increment used in centrifuge testing was 2500 g's starting at 5000 g's unless otherwise stated in the particular evaluation.)

ACTIVITY

Package Preparation

Package preparation is very important: the bottom surface of the flatpack must be carefully prepared so the HMC will adhere to the flatpack. This preparation could take the form of chemical etching, degreasing, abrading, or some other process.

In addition, the method of preparation must not contaminate the inside leads or the sealing ring; if either or both of these areas are contaminated, bonding or sealing problems could result. Several methods of preparation were examined:

- TC cleaning, or cleaning for bonding, (boiling trichloroethylene, room temperature isopropyl alcohol rinse, boiling detergent wash, boiling deionized water rinse, and a five-step cascade hot deionized water rinse);
- An electrochemical cleaner;
- RF plasma cleaning with argon;
- Wetting with 75-25 lead-indium solder;
- Dry blasting;
- Wet blasting; and
- No cleaning (as received from the vendor).

The various methods of preparation were tried with various bonding materials and the results are detailed in the next section. From the results of the various experiments, the method of preparation decided upon was wet blasting.

The wet blasting is done with 220 mesh aluminum oxide grit in a 25- to 30-percent water slurry. The bottom surface of the flat-pack is abraded for approximately 30 seconds at 241 kPa (35 psi) using a 9.5 mm (0.375 in.) diameter nozzle. The surface is abraded until the bright gold finish is changed to a uniform matte gold finish with no underlying metallization exposed. An adiprene fixture is used to completely cover the flatpack (except for the area to be abraded) during the wet blast operation. This fixture protects the inside leads and sealing ring. After the wet blast operation the flatpack is thermocompression cleaned to remove loose particles and contamination.

Bonding Material Environmental Tests

During this project seven different bonding materials were evaluated: five epoxies (both pastes and preforms) and two solders. The major findings of the epoxy evaluations are summarized in Table 1. Specifics of the evaluation of these materials in conjunction with different methods of package preparation are discussed in the following paragraphs.

Table 1. Epoxies Evaluated During Study

Bonding Material	Comments
Ablefilm 517B	A frozen adhesive; limited life (approximately 8 hours) after exposure to ambient temperature; can be obtained in made-to-order preforms; no halogens found by mass spectrometric analysis; met all processing and product requirements when used in abraded flatpack with applied pressure during cure.
Epo-Tek H77	A two component paste adhesive; pot life of 24 hours once the components are mixed; epoxy dispenser required to ensure the same amount of epoxy is used each time; coverage is operator dependent; no halogens found by mass spectrometric analysis; met all processing and product requirements when used in abraded flatpack with no applied pressure during cure.
Epo-Tek H74	A two component paste adhesive; pot life of 4 hours once the components are mixed; ethyl chloride and hydrogen chloride were detected by the mass spectrometer; processing and product requirements were marginally met when used in nonabraded flatpack with no applied force during cure.
Epo-Tek H61	A single component paste adhesive; can be stored at room temperature; ethyl chloride and hydrogen chloride were detected by mass spectrometer; processing and product requirements were marginally met when used in both abraded and nonabraded flatpacks with no applied force during cure.
Epo-Tek H44	A 100 percent solids single component paste adhesive; electrically conductive; contains very fine gold particles; ethyl chloride, hydrogen chloride, and hydrogen fluoride were detected by mass spectrometer; processing and product requirements marginally met when used in nonabraded flatpack with no applied force during cure.

Ablefilm 517B

Ablefilm 517B is a glass-cloth-supported tack-free epoxy film adhesive manufactured by Ablestick Laboratories of Gardena, California. The 50.8 μm (0.002 in.) thick glass fabric is sized with epoxy resin prior to impregnation to prevent shifting of the fibers during cure. The cure schedule for this epoxy is 3 hours at 74°C, or 2 hours at 94°C, or 1 hour at 121°C, or 30 minutes at 149°C. The epoxy must be stored at -40°C and should be used within 8 hours after exposure to ambient temperature. Ablefilm 517B is currently used in production of radar HMCs to attach ceramic lids to substrates. The evaluations conducted with Ablefilm 517B are described below.

Substrates were attached to two flatpacks with Ablefilm 517B preforms and the epoxy was cured for 3 hours at 75°C with no force applied to the epoxy joints during cure. After cure the packages were centrifuge tested at 20,000 g's. In each package the substrate cracked and the epoxy delaminated from the flatpack bottom. The flatpacks showed evidence of "oil canning."

Substrates were attached to two flatpacks with Ablefilm 517B preforms and the packages were cured for 3 hours at 75°C with no force applied to the epoxy joints during cure. After cure both packages were centrifuge tested. Both packages passed 5000 g's and failed at 10,000 g's. The failure mode for both packages was substrate fracture and epoxy-to-flatpack interface failure. The flatpacks showed 101 to 127 μm (0.004 to 0.005 in.) permanent deflection of the base after centrifuge testing.

The bottom surfaces of six flatpacks were wet blasted down to the base metal (Kovar, DuPont Corporation). An additional six flatpacks had the bottom surfaces abraded to a matte gold finish with no underlying metallization exposed. These twelve flatpacks, in addition to six more flatpacks which were not wet blasted, were TC cleaned before the HMCs were attached with Ablefilm 517B preforms. The packages were cured for 3 hours and 15 minutes at 73°C with 10 kPa (1.5 psi) applied to the epoxy joints during cure. After cure the packages were centrifuge tested to 7500 g's without failure. All packages were temperature soaked for 1 hour at 200°C to simulate HMC assembly processing. Then all packages were centrifuge tested. All packages passed 3,000 g's, and two packages failed at 5000 g's. Both packages which failed were nonabraded, and the failures occurred at the epoxy to flatpack interface. The remaining 16 packages were high temperature soaked for an additional 1 hour at 200°C, centrifuge tested at 3000 g's and 5000 g's without failure, and subjected to 125°C for 168 hours. After the temperature soak the packages were centrifuge tested to 3000 g's without failure. Four of the packages failed at 5000 g's. All four packages were nonabraded, and the failures occurred at the epoxy

to flatpack interface. The remaining twelve packages (6 abraded and 6 wet blasted to the Kovar) were temperature soaked at 150°C for 144 hours. After the temperature soak all 12 packages were centrifuge tested to 5000 g's without failure and subjected to ten temperature cycles from -40°C to +125°C with short transfer times between temperatures. Four of these packages (2 abraded and 2 wet blasted to the Kovar) were subjected to a high temperature soak (1 each of the two different package preparations subjected to 200°C for 48 hours and 175°C for 48 hours). After the soak all four packages were centrifuge tested to 5000 g's without failure.

Epo-Tek H77

Epo-Tek H77 is a two component, thermally conductive but electrically insulating epoxy system manufactured by Epoxy Technology, Incorporated of Watertown, Massachusetts. The curing schedule for this epoxy is 30 minutes at 150°C or 60 minutes at 120°C. The pot life, once the two components are mixed, is 24 hours. Evaluations which were conducted with Epo-Tek H77 are discussed below.

Two flatpacks were cleaned, one in an electrochemical cleaner and one with TC cleaning. Substrates were attached to the flatpacks using Epo-Tek H77 with a cure schedule of 1 hour at 120°C. No force was applied to the epoxy joints during cure. After cure both packages were centrifuge tested to 20,000 g's without failure. After ten temperature cycles from -25°C to +125°C, both packages were centrifuge tested again to 20,000 g's without failure. Both packages were subjected to a high temperature soak for 1 hour at 200°C to simulate HMC assembly processing. After the soak both packages were centrifuge tested and both failed at 7500 g's. Both failures occurred at the epoxy-flatpack interface.

The bottom surfaces of four flatpacks were wetted with 75-25 lead-indium solder. Substrates were attached to the solder using Epo-Tek H77 with a cure schedule of 1 hour at 120°C. No force was applied to the epoxy joints during cure. After cure all packages were centrifuge tested. Two failed at 5,000 g's and two failed at 7500 g's. All failures occurred at the epoxy-to-solder interface.

The bottom surfaces of six flatpacks were dry blasted using 27 μ m (27 micron) aluminum oxide grit. The gold plating was completely removed to expose the base metal (Kovar) of the flatpacks. The flatpacks were cleaned using ethyl alcohol and blown dry with dry nitrogen prior to attachment. Substrates were attached using Epo-Tek H77 with a cure schedule of 1 hour at 120°C. No force was applied to the epoxy joints during cure. After cure four packages were centrifuge tested to 15,000 g's without failure.

After ten temperature cycles from -25°C to +125°C one of the four packages failed centrifuge testing at 17,500 g's. The remaining three packages failed centrifuge testing at 20,000 g's. The two remaining packages (of the six original) were centrifuge tested to 10,000 g's without failure. Both packages were subjected to a high temperature soak for 8 hours at 200°C and then centrifuge tested to 10,000 g's without failure.

Three flatpacks were TC cleaned and three flatpacks were not cleaned. All six flatpacks were subjected to an RF plasma cleaning with argon for three different time periods (30 minutes, 60 minutes and 90 minutes) prior to substrate attachment with Epo-Tek H77. Substrates were attached using a cure schedule of 1 hour at 120°C with no force applied to the epoxy joints during cure. After cure all six packages were centrifuge tested to 10,000 g's with the results:

Minutes in RF Plasma	At 10,000 g's	
	Cleaned	Not Cleaned
30	Passed	Failed
60	Passed	Passed
90	Passed	Passed

After ten temperature cycles from -25°C to +125°C the remaining five packages were centrifuge tested to 10,000 g's and all five passed.

The five packages were then subjected to a high temperature soak for 1 hour at 200°C to simulate HMC assembly processing. After the high temperature soak all five packages failed centrifuge testing at 5000 g's.

The bottom surfaces of two flatpacks were abraded using 27 μ m (27 micron) aluminum oxide grit. The flatpacks were dry blasted until the bright gold finish in the bottom of the flatpack changed to a uniform matte gold finish with no underlying metallization exposed. The bottom surfaces of the flatpacks were cleaned using isopropyl alcohol and scrubbed with a cotton swab. The packages were blown dry using dry nitrogen prior to substrate attachment with Epo-Tek H77. Both packages were cured for 1 hour at 120°C with no force applied to the epoxy joints. After cure both packages were centrifuge tested to 10,000 g's without failure. Next, the packages were high temperature soaked at 200°C in one-hour increments. After each hour, the packages were centrifuge

tested to 10,000 g's. Both packages were subjected to a total of 10 hours at 200°C, and both packages passed centrifuge testing to 10,000 g's after each hour increment at 200°C. After the temperature soak the packages were temperature cycled ten times from -55°C to +100°C; both packages were centrifuge tested to 10,000 g's without failure.

The bottom surfaces of six flatpacks were wet blast abraded using 220 mesh aluminum oxide grit in a 25 to 30 percent water slurry. The bottom surfaces were abraded for 30 seconds each at 241 kPa (35 psi) using a 9.5 mm (0.375 in.) diameter nozzle. No underlying metallization was exposed. The flatpacks were TC cleaned before the substrates were attached with Epo-Tek H77. The packages were cured for 1 hour at 120°C with no force applied to the epoxy joints during cure. All packages were centrifuge tested to 10,000 g's after curing. Two of the six packages failed at 10,000 g's. The remaining four packages were high temperature soaked at 200°C in approximately 1-hour increments. After each hour the packages were centrifuge tested to 10,000 g's. These four packages were subjected to a total of 3.3 hours at 200°C, and all four packages passed centrifuge testing to 10,000 g's after each hour. After the high temperature soak, the four packages were temperature cycled ten times from -55°C to +100°C and then centrifuge tested to 10,000 g's without failure.

Four flatpacks were cleaned with isopropyl alcohol and blown dry with dry nitrogen before the substrates were attached with Epo-Tek H77. The bottom surfaces of two of the flatpacks were abraded by dry blasting with 27 μ m (27 micron) aluminum oxide grit. The other two flatpacks had no other processing. The packages were cured for 1 hour at 120°C with no force applied to the epoxy joints during cure. After cure the four packages were centrifuge tested. One abraded package failed at 10,000 g's, the remaining abraded package failed at 12,500 g's; one package failed at 20,000 g's and one package passed 20,000 g's.

Substrates were attached to four flatpacks with Epo-Tek H77 with no package preparation. The packages were cured for 1 hour at 120°C with no force applied to the epoxy joints during cure. After cure the four packages were centrifuge tested to 12,500 g's without failure. The four packages were temperature soaked at 150°C for 168 hours and then centrifuge tested. Three packages passed 12,500 g's. One package failed at 10,000 g's. The three remaining packages were temperature soaked at 150°C for an additional 192 hours, and then centrifuge tested. After a total of 360 hours at 150°C, the three remaining packages passed 12,500 g's. Two of the packages were further soaked at 150°C for an additional 336 hours. These two packages were temperature soaked a total of 696 hours at 150°C; both failed at 10,000 g's when centrifuge tested.

Substrates were attached to two flatpacks with Epo-Tek H77 with no package preparation. The packages were cured for 1 hour at 120°C with no force applied to the epoxy joints during cure. After cure both packages were centrifuge tested to 7500 g's without failure. The packages were high temperature soaked at 200°C for various time periods (1 hour, 3 hours, 7.5 hours, 29.5 hours, 102 hours). After each of the time periods the packages were centrifuge tested with the following results: after 1 hour both packages passed 7500 g's; after 3 hours one package passed 7500 g's and one package failed at 7500 g's; after 7.5 hours the remaining package passed 7500 g's; after 29.5 hours the remaining package passed 7500 g's; and after 102 hours at 200°C the last package failed at 5000 g's.

The bottom surfaces of three flatpacks were wet blasted. The gold plating was completely removed and the base metal (Kovar) was exposed. The flatpacks were TC cleaned before the substrates were attached with Epo-Tek H77. The packages were cured for 1 hour at 120°C with no force applied to the epoxy joints during cure. After cure the packages were centrifuge tested to 10,000 g's. One of the packages failed; the other two passed. The remaining two packages were high temperature soaked for 1 hour at 200°C and then centrifuge tested. One package failed; the other passed 10,000 g's.

After four flatpacks were TC cleaned, substrates plated with tantalum nitride, chromium, and gold were soldered face down into the bottom of the flatpacks with 75-25 lead-indium solder. Substrates were attached to the backside of the soldered gold mirror with Epo-Tek H77. The packages were cured for 1 hour at 120°C with no force applied to the epoxy joints during cure. After cure the packages were centrifuge tested at 5000 g's without failure. The four packages were high temperature soaked for 1 hour at 200°C to simulate HMC assembly processing and then centrifuge tested to 7500 g's. Three of the four packages failed at 7500 g's. The fourth package passed.

Epo-Tek H74

Epo-Tek H74 is a two component thermally conductive epoxy manufactured by Epoxy Technology, Incorporated. It has a curing schedule of 20 minutes at 100°C. The pot life, once the two components are mixed, is 4 hours. The evaluations conducted with Epo-Tek H74 are described below.

Substrates were attached to two flatpacks with Epo-Tek H74 with no package preparation. The packages were cured for 20 minutes at 100°C with no force applied to the epoxy joints during cure. After cure the packages were centrifuge tested to 17,500 g's and both packages failed.

Substrates were attached to four flatpacks with Epo-Tek H74 with no package preparation. The packages were cured for 20 minutes at 100°C with no force applied to the epoxy joints during cure. After cure the packages were centrifuge tested with the following results: one package failed at 10,000 g's, two packages failed at 12,500 g's and one package passed 12,500 g's. The remaining package was temperature soaked for 336 hours at 150°C and centrifuge tested. It failed at 7500 g's.

Substrates were attached to two flatpacks with Epo-Tek H74 with no package preparation. The packages were cured for 20 minutes at 100°C with no force applied to the epoxy joints during cure. After cure the packages were centrifuge tested to 7500 g's without failure. The packages were high temperature soaked for 1 hour at 200°C and then centrifuge tested. One failed at 5000 g's; the other passed 7500 g's.

Epo-Tek H61

Epo-Tek H61 is a single component, thermally conductive and electrically insulating epoxy with a curing schedule of 30 minutes at 150°C or 60 minutes at 120°C. The evaluations conducted with Epo-Tek H61 are described below.

Substrates were attached to two flatpacks using Epo-Tek H61 with no package preparation. The packages were cured for 1 hour at 120°C with no force applied to the epoxy joints during cure and then centrifuge tested. One package failed at 12,500 g's, and the other failed at 15,000 g's.

Substrates were attached to four flatpacks with Epo-Tek H61 with no package preparation. The packages were cured for 1 hour at 120°C with no force applied to the epoxy joints during cure. After cure the packages were centrifuge tested with the following results: one package failed at 7500 g's, two packages failed at 10,000 g's, and one package passed 7500 g's. The remaining package was temperature soaked for 336 hours at 150°C and then centrifuge tested. It failed at 5000 g's.

The bottom surfaces of two flatpacks were wet blasted down to the base metal (Kovar). The flatpacks were TC cleaned before the substrates were attached with Epo-Tek H61. The packages were cured 1 hour at 120°C with no force applied to the epoxy joints during cure. After cure both packages were centrifuge tested to 10,000 g's without failure. The packages were then high temperature soaked for 1 hour at 200°C to simulate HMC assembly processing and centrifuge tested with the following results: one package failed at 5000 g's and one failed at 7500 g's.

The bottom surfaces of two flatpacks were abraded until the bright gold finish changed to a uniform matte gold finish. No underlying metallization was exposed. The flatpacks were TC cleaned before the substrates were attached with Epo-Tek H61. The packages were cured for 1 hour at 120°C with no force applied to the epoxy joints during cure. After cure the packages were centrifuge tested to 10,000 g's without failure. The packages were high temperature soaked for 1 hour at 200°C to simulate HMC assembly processing and centrifuge tested. One failed at 5000 g's and one failed at 7500 g's.

Epo-Tek H44

Epo-Tek H44 is a 100 percent solid single component electrically conductive gold epoxy. It contains very fine gold particles and has a curing schedule of 30 minutes at 150°C or 60 minutes at 120°C.

Substrates were attached to two flatpacks with Epo-Tek H44 with no package preparation. The packages were cured for 1 hour at 120°C with no force applied to the epoxy joints during cure. After cure both packages were centrifuge tested and both failed at 7500 g's.

Lids were soldered to the backs of two flatpacks to increase the thickness of the flatpack base to 0.76 mm (30 mils). Substrates were attached to the two flatpacks with Epo-Tek H44 with no package preparation. The packages were cured for 1 hour at 120°C with no force applied to the epoxy joints during cure and then centrifuge tested. Both failed at 15,000 g's.

75-25 Lead-Indium Solder

Substrates were soldered into two flatpacks with 75-25 lead-indium solder. The substrates were metallized with chromium and gold to facilitate soldering. The packages were then centrifuge tested and both failed at 20,000 g's. One had a fractured substrate and solder-to-flatpack delamination. The other showed severe fracturing but no delamination. Both exhibited severe "oil canning."

80-20 Gold-Tin Solder

Gold metallized substrates were soldered to the bottom surfaces of two flatpacks with 80-20 gold-tin solder. The packages were centrifuge tested: one failed at 12,500 g's and the other failed at 15,000 g's.

Outgassing Analyses

In addition to testing the strength of the different bonding materials through various times and temperatures, outgassing analyses were performed on the epoxy bonding materials. Halides, in particular chlorides, can adversely affect silicon and can help promote stress corrosion cracking in Kovar.¹ Therefore, any halogenated material outgassed from any of the epoxy bonding materials was documented.

Epo-Tek H44

This gold-filled epoxy appears to outgas a great variety of low molecular weight materials such as hydrogen chloride, hydrogen fluoride, and ethyl chloride. There are no low molecular weight residual solvents. Outgassing initiates around 80°C. Some weight loss is shown as low as 225°C. This mass spectrometric analysis was performed on cured material.

Epo-Tek H61

This epoxy is a diglycidyl ether of resorcinol and shows an amine cure agent and a possible novalac component. Outgassing initiates around 75°C. Materials such as ethyl chloride and hydrogen chloride initially outgas at 150°C with a trace of hydrogen chloride outgassed at 215°C. This mass spectrometric analysis was performed on cured material.

Epo-Tek H74

This epoxy is a diglycidyl ether of bisphenol-A that is cured with an acid anhydride. There is no detectable outgassing until the epoxy had been heated to 230°C. There is a trace of hydrogen chloride at 270°C. The analysis was performed on cured material.

Epo-Tek H77

Uncured Material. Outgassing of this paste epoxy was heavy from ambient through 75°C. The major component appears to be an unsaturated solvent (possible methyl cyclohexadiene). Also present are a phthalic acid and phthalic anhydride. The other component outgassed is the diglycidyl ether of bisphenol-A. From approximately 80°C through 325°C, the outgassing is composed of epoxy fragments, primarily the diglycidyl ether of bisphenol-A.

Cured Material. This is a bisphenol-A epoxy that uses an anhydride cure agent. The cure agent is probably nadic methyl anhydride. Outgassing initiates at approximately 85°C.

Neither the uncured nor the cured sample showed any sign of a halogenated material.

Ablefilm 517B

Uncured Material. Outgassing of this epoxy preform begins at ambient temperature and continues through approximately 66°C. Over this temperature range tetrahydrofuran and 4-phenylimidazole are quite intense. The outgassing subsides until approximately 125°C. From 125°C to 325°C traces of tetrahydrofuran and diacyl ether of bisphenol-A were outgassed.

Cured Material. The outgassing from this material was from 250°C through 300°C and consisted of bisphenol ether epoxy fragments.

Neither of the samples showed any sign of a halogen material.

Applied Force During Attachment

It became evident during this project that an applied force during cure was necessary to ensure complete coverage of the bottom surface of the flatpack and the backside of the substrate. Previous work showed that 41 kPa (6 psi) assembly pressure yielded higher tensile strengths than 552 Pa (0.08 psi) assembly pressure. (This work was done using Ablefilm 517 and Ablefilm 532.) Using this work as a reference, a pressure of 10 kPa (1.5 psi) was applied during cure to packages using Ablefilm 517B adhesive preforms. Subsequent centrifuge results showed that 10 kPa was sufficient to keep the substrate attached to the flatpack.

Some cure schedules are better than others. Ten substrates were attached to abraded flatpacks using Ablefilm 517B preforms. A cure schedule of 1.5 hours at 120°C with 31 kPa (4.6 psi), applied during cure, was used. Using this schedule and pressure, there was considerable bubbling of the epoxy and the epoxy crept up onto the substrate and pins. An additional ten substrates were attached to abraded flatpacks using Ablefilm 517B preforms with a cure schedule of 3.5 hours at 75°C with 31 kPa (4.6 psi) applied during cure. The epoxy showed no evidence of bubbling or creep.

ACCOMPLISHMENTS

A process to attach a complete HMC to a flatpack was developed to support the new program requirements. The attachment process does not introduce any new parameters that affect further processing (bonding of gold ribbon interconnections and hermetic sealing).

The results of the evaluations show that, for the materials tested, Ablefilm 517B and Epo-Tek H77 are the best for HMC to

flatpack attachment. Both have their own advantages and disadvantages. Ablefilm 517B is obtained in preforms made to order (length, width, and thickness). This ensures that the same amount of epoxy is used each time in the same configuration. An epoxy dispenser would be required to apply the same amount of H77 each time. In addition, operator training would be required to ensure that the same configuration is obtained each time. Ablefilm 517B is a frozen adhesive which has limited life (approximately 8 hours) after exposure to ambient temperature. H77 is a two component epoxy that has a pot life of 24 hours once the components are mixed. The curing schedule that must be used with Ablefilm 517B is 3.5 hours at 75°C. The H77 curing schedule is 1 hour at 120°C. Both epoxies appear to withstand high temperatures (200°C) very well.

The results also indicate that some form of abrading needs to be done on the flatpacks, and that pressure needs to be applied during cure to ensure reliable attachment after periods of time at high temperature.

FUTURE WORK

For every production process a rework procedure is needed or some parts built to that process must be scrapped. This process is no exception. A rework procedure for this process needs to be developed so an acceptable HMC can be removed from a bad flatpack without damage to the HMC and so the bottom surface of a used acceptable flatpack may be reworked to provide an acceptable bonding surface.

REFERENCES

¹Joe A. Silva, *Adhesives for Hybrid Microcircuits*. Sandia Corporation, Albuquerque, Report SAND 76-0179, August 1976.

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UNCLAS Topical, April 1978.

A method has been developed for attaching a completed hybrid microcircuit to a flatpack which can then be hermetically sealed. Ablefilm 517B and Epo-Tek H77 epoxies, in conjunction with an abraded flatpack and applied pressure during cure, were shown to provide HMC-to-flatpack bonds which meet all environmental and processing requirements of hybrid microcircuits in two recent programs.

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