X-623-67-79

NASA TM X-55710

INVESTIGATION OF STERILIZABLE COMPOUNDS FOR EMBEDMENT OR CONFORMAL COATING

BY

M.W. HANCHETTE

FACILITY FORM 602

N67-33969	
(ACCESSION NUMBER)	(THRU)
12	1
(PAGES)	(CODE)
TMX-55710	18
(NASA CR OR TMX OR AD NUMBER)	(CATEGORY)

FEBRUARY 1967

GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

NASA and NASA Contractors ...

INVESTIGATION OF STERILIZABLE COMPOUNDS

FOR EMBEDMENT OR CONFORMAL COATING

M. W. Hanchette

NASA and NASA Contractors Only

INVESTIGATION OF STERILIZABLE COMPOUNDS FOR EMBEDMENT OR CONFORMAL COATING

INTRODUCTION

A thorough literary search was made on the subject of heat resistant potting compounds, and the best source of information was a preliminary report from Jet Propulsion Laboratory, titled "Effects of the Thermal Sterilization Procedure on Polymeric Products." (This report is now final as Technical Report No. 32-973.) This report lists several compounds as being compatible with 145°C bake cycles and gives a considerable amount of physical test data. However, since their tests were on samples of the materials themselves, the need was felt for further testing, involving actual and representative applications. Accordingly, a number of compatible compounds which appeared to have possible use for encapsulating or conformal coating were chosen and sample quantities obtained. These compounds were as follows:

1.	Epocast 212/951	(epoxy)	Furane Plastics
2.	Hysol 4248	(epoxy)	Hysol of California
3.	Scotchcast 260	(epoxy)	3 M Company
4.	Scotchcast 241 A/B	(epoxy)	3 M Company
5.	Stycast 1090/9	(epoxy amine syntactic foam)	Emerson & Cuming
6.	Sylgard 182	(silicone)	Dow Corning
7.	Sylgard 184	(silicone)	Dow Corning
8.	RTV 615 A/B	(silicone)	General Electric
9.	Eccobond 55/9	(epoxy amine)	Emerson & Cuming
10.	Eccocoat VE A/B	(epoxy)	Emerson & Cuming

PRELIMINARY TESTS

Preliminary tests were made by forming simple molds from aluminum foil, mixing the compounds according to directions, and pouring the compounds upon narrow strips of printed circuit boards placed in the molds. After curing, the samples were baked at 145°C for 24 hours or more. The silicones survived without noticeable change, but require the use of a primer coat for adhesion, and are too flexible to add any structural strength to a printed circuit board. However, as seen later, they make good molds for other compounds, and present the possible use as a damping material in cases where structural rigidity is not necessary or desired.

Epocast 212/951 turned from water clear to dark amber and warped the board during the bake.

Hysol 4248 is a one part, amber colored, high temperature curing compound. It cured with an uneven wrinkled surface and warped the board badly.

Scotchcast 260 is a dry powder which forms a thin green glaze coating when subjected to 150°C or more. The thin coating makes this quite impractical for even a conformal coating of any strength.

Scotchcast 241 A/B is a two part, elevated temperature curing compound. It cured to a chocolate colored, hard but very slightly flexible state, and although it seemed to warp the board slightly, it appeared to have possibility.

Eccobond 55/9 is also a two part, elevated temperature curing compound. It cured to a hard milky white which changed to a caramel color during baking. Some warpage also occurred.

Eccocoat VE A/B, another two part, elevated temperature curing compound, is meant for very thin coatings. It produced a soft spongy material in attempting to obtain a conformal coating thickness.

Stycast 1090 used with hardener no. 9 is a room temperature curing compound. It produces a jet black hard material. The Stycast didn't show any perceptible change, nor cause any warpage of the board.

FINAL TESTS

At this point, a small circuit board measuring 1 1/2 inches by 2 5/8 inches, was potted with the Stycast 1090/9, since that appeared to be the best choice. The board contained a relay drive circuit which included a glass enclosed relay. After baking at 145°C for 72 hours, there was no visible change and the circuit still operated. However, in order to double check results and attempt to determine if the borderline compounds could be used or be made useable, four identical circuit boards were potted as described below. These boards measured 2 1/8 inches by 4 inches and contained a precision amplifier circuit which included a glass diode, precision resistors, and various transistors and capacitors. An aluminum mold, as shown in Figure 1A, was fabricated and used to form silicone rubber molds as shown in Figure 1B. Figure 1C shows the silicone rubber mold and printed circuit board restrained by the metal mold, and ready for potting. The four boards were potted as follows:

1. Stycast 1090/9
2. Scotchcast 241 A/B
3. Scotchcast 241 A/B with microspheres added
4. Eccobond 55/9 with microspheres added

After curing, the boards were baked at 145°C for one 64 hour cycle, one 3 1/2 hour cycle and one 3 hour cycle. The Stycast 1090/9 remained unchanged. The others all warped somewhat during cure and more during the bake. The Eccobond 55/9 also changed color from milky white to orange. Figures 2 and 3 show the potted boards after baking. The lengthwise warping that occurred can be seen in Figure 3. Weight losses were negligible on all boards, and all circuits still operated without significant change.

CONCLUSIONS

On the basis of warpage alone, which could cause breakage of delicate components and connections, Stycast 1090/9 must be selected as the most suitable compound for conformal coating or encapsulating. It is also the lightest with a specific gravity of .84, and has very good mechanical and electrical properties. There are undoubtedly many more compounds that could be tested, and possibly some that would be more desirable. However, without going into an expensive and time consuming program, it is felt that Stycast 1090/9 is the best choice for immediate or near future application where strength and heat resistance are requisite.

RECOMMENDATIONS

In view of the fact that the Stycast is heavier than desirable, and also that boards potted with it will be unrepairable, the following recommendations are made for consideration in designing printed circuit packages:

1. If possible, avoid the use of potting by using thicker boards and numerous mounting points, avoiding long unsupported spans.

Also, if possible provide separate mountings for heavy components such as large toroids.

2. If more strength is needed, use a conformal coating and build up around the bulkier components.
3. For still more strength use a conformal coating and add stiffening webs of the same material in a grid pattern.
4. For ultimate strength, completely encapsulate the entire board.

The recommended potting procedure is as follows:

1. Clean the board to be potted and prepare a mold if necessary.
2. Mix the Stycast 1090 thoroughly in the can in which it is received.
3. Weigh out the quantity required. Add 9% of Catalyst No. 9 by weight and mix thoroughly. Pot life of the catalyzed mixture is about 30 minutes at room temperature.
4. Pour onto board or into mold and place in vacuum chamber a few minutes to evacuate trapped air and eliminate possibility of large voids.
5. Allow to stand at room temperature. After about four hours the mold may be removed, and the cure is complete after about 24 hours.

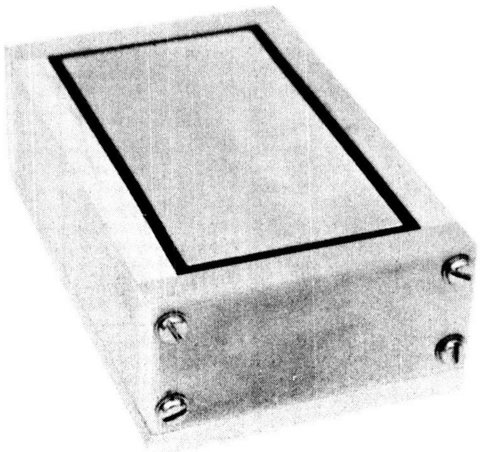
INVESTIGATION OF STERILIZABLE COMPOUNDS FOR EMBEDMENT OR CONFORMAL COATING

M. W. Hanchette

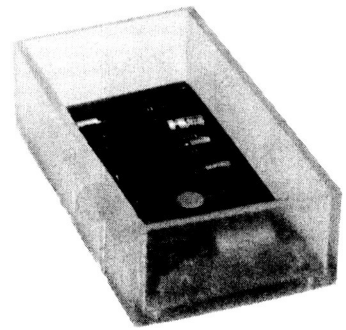
ABSTRACT

Heretofore, potting has been heavily relied upon to help electronic packages survive vibration environments. Probably the most widely used are the "foam in place" plastic compounds, because of their low specific gravity. Planetary missions now introduce the requirement of ability to withstand several long sterilization bake cycles at 135°C to 145°C. Since the light weight foams will not withstand the high temperatures without excessive shrinking or deterioration, it was important to determine which compounds, if any, would be suitable for use on the Quadrupole Mass Spectrometer.

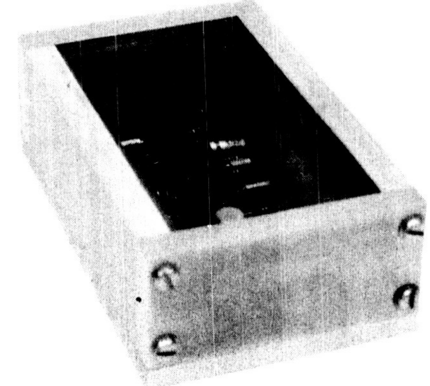
This paper describes the search, testing, etc. which led to the eventual selection of Stycast 1090/9 as the most suitable for filling the immediate need, although it is somewhat heavier than desired and makes a potted item unrepairable. Also included are recommendations for designing printed circuit boards and usage of the compound.



A



B



C

FIGURE I

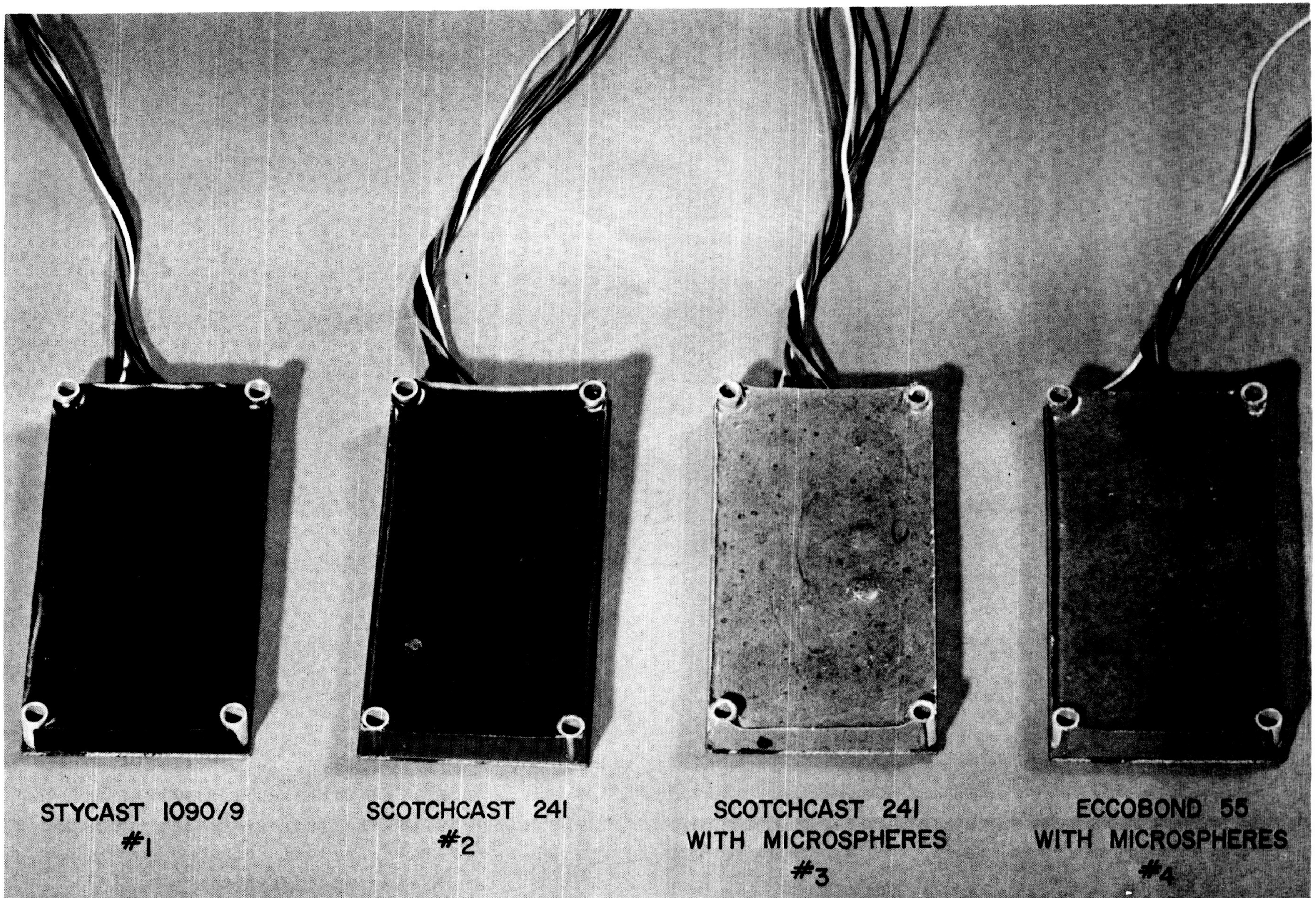

STYCAST 1090/9
#1
SCOTCHCAST 241
#2
SCOTCHCAST 241
WITH MICROSPHERES
#3
ECCOBOND 55
WITH MICROSPHERES
#4

FIGURE-2

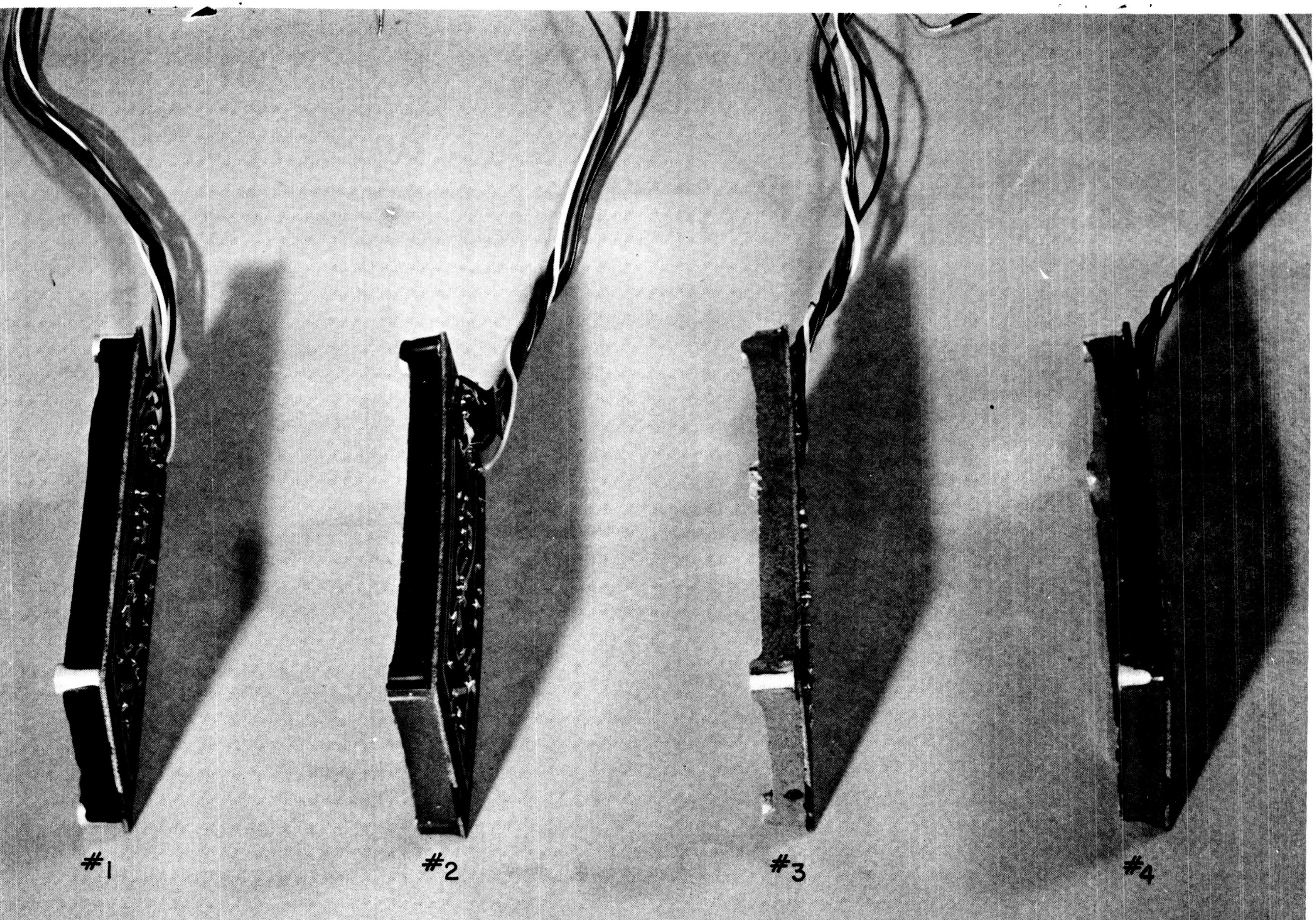


FIGURE-3