MAD-1021 SLAPPER FABRICATION

LASL P.O. CM8-2909G-1

by

G. V. Nessler

R. A. VanKlombenberg

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MOUND FACILITY

Miamisburg, Ohio 45342

operated by

MONSANTO RESEARCH CORPORATION

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for the

U. S. DEPARTMENT OF ENERGY

Contract No. EY-76-C-04-0053

 

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Introduction

One hundred MAD-1021 slapper test devices were built to fill the reimbursable order CM8-2909G-1 (E-14066) for W. F. Hemming of Los Alamos Scientific Laboratory (LASL).

Abstract

Physical Vapor Deposition (PVD) techniques were successfully used to prepare the MAD-1021 slapper foil assemblies. The 0.381 mm square bridge foils were of aluminum 3 micrometers thick. Copper solder pads of 1.0 to 1.5 micrometer thickness were also applied using PVD techniques. A total of 120 were fabricated and submitted to the fabrication group for assembly. The 100 completed slapper units were fabricated with 0.025 mm thick Kapton flyers. Barrels for these slapper units were 0.38 mm long with a 0.42 mm diameter.

Process Discussion

Bridge foils and solder pads were successfully deposited onto fused silica substrates using PVD process techniques developed for the MAD-1021.

The fused silica substrates were of the MAD-1021 configuration having a nominal thickness of 1 mm. These substrates had been obtained from Dynasil Corporation, Berlin, N.J.

The configuration of the aluminum bridge foils and solder pads were defined by using mechanical masking techniques. Both foil and solder pad masks were of bimetal type available from Towne Laboratories, Somerville, N. J. Solder pad masks were of the type normally used in the preparation of 1.5 mm square overplates on the MAD-1021 leads (apron). This size proved to be an effective solder pad mask. This allowed a nominal 0.560 mm solder pad set back from the bridge foil portion of the aluminum deposit.

Cleaning of substrates for aluminum PVD were by chemical means. A technique using acetone, water and alcohol was used. Ultrasonic baths and vapor degreasing techniques were employed in the various steps. The process was such that each solvent effectively dissolved the preceeding for effective removal and less residual contamination. This cleaning has been successfully used on similar products on a routine basis.

Thirty-substrates per run were processed on the rotating dome substrate support system. This assured minimum sloping of the foil edge. Average

in run spread for the foil thickness maximum to minimum was 0.000132 mm. A total of six runs were completed to provide necessary foil assemblies. An electron beam gun source was used for the metalization. A nominal deposition rate of 0.27 micrometers per minute was maintained by an Inficon XMS-3 monitor controller.

Solder pads were prepared on a coater equipped with a canted dome planetary substrate support which permitted 80 to 90 parts per cycle to be processed. Filament evaporation techniques were used for the necessary metalization. The foil PVD cycle included a 250°C (at a 10°C/min rise) substrate bake prior to the aluminum deposition cycle. The parts were allowed to cool to approximately 100°C and then reheated to 250°C. The actual aluminum deposition was completed at this point with a normal chamber pressure of 1.0×10^{-3} Pa (8×10^{-6} torr). The completed parts were cooled to at least 50°C before removal from the vacuum.

Copper solder pads were applied as soon as possible after the aluminum deposit was exposed to air.

The aluminum surface was ion cleaned in a hi-voltage A.C. plasma generated in a 99.99% pure argon atmosphere. This argon was fed into the chamber through a titanium hot-filament scrubber. The chamber pressure was maintained between 3.3 and 6.6 Pa (2.5×10^{-2} to 5.0×10^{-2} torr).

A bonding layer of 50 Å to 100 Å chrome was ion plated prior to copper deposition. Copper deposition was begun before termination of the chrome deposition to provide a codeposited bonding layer. No film pull off was observed when copper leads were soldered in place. Butt tensile tests of aluminum and copper aluminum interfaces yielded bond values between 41 to 56 mega pascal (approx. 6000 to 8000 psi). Occasional failure occurred in the pull stud bonding agent or the substrate material.

All depositions were made with small optical flats located and deposited concurrently with each run to provide representative thickness of the deposition cycle. Process control of the electron beam evaporated aluminum was with an Inficon thickness monitor controller. Copper deposition was by time and quantity of evaporant from resistance heated filament sources. Repeatability of $\pm 3\%$ is routinely experienced. All thickness determination were made using Gould-Tallysurf thickness/profile instruments. Pull tests were conducted using a Quad Group, Sabastian I adherence tester with Scotchweld 2214 as the bonding agent between the pull studs and the deposits tested.

Immediately following the PVD process the bridge circuit to the bridge length and width dimensions are verified using a Nikon comparator. The acceptance was based on a square bridge dimension of 0.381 mm with a tolerance of ± 0.025 mm. At this time the bridge circuit is also visually inspected for imperfections.

Copper connectors are soldered to the copper solder pads. The soldered units were then cleaned with distilled water to remove solder flux residuals.

The 0.025 mm Kapton flyer was punched, cleaned with alcohol, and air dried. The flyer was bonded to the bridge/substrate assembly with epon-versamid by using a pressing fixture. A silicon rubber pad with a teflon release sheet was pressed against the Kapton flyer by the fixture to spread out the adhesive so that a thin (0.005 mm) adhesive layer with no voids is obtained.

A housing (molded of polyaryl ether thermoplastic) is bonded to the flyer/bridge/substrate assembly and potted with epon-versamid. With the housing potted in place the bridge circuit and connectors are protected from damage resulting in a mechanically rugged unit.

As requested, the housing barrel-well diameter was increased to allow some radial movement of the barrel. The barrels used in these slapper units were machined from MACOR (a machinable glass ceramic). The length of the barrels was 0.38 mm long and the diameter was 0.42.

Summary

All fabrication was on a best effort basis. Normal PVD control and evaluation procedures were utilized. All bridges and solder pad films

were judged satisfactory for the intended usage with no evidence of peeling by scotch tape pull tests and butt tensile tests. Visual inspection of the bridges screened out any units with an irregular bridge. A resistance measurement of the final unit further verifies the uniformity of the bridges.

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