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Hermetic Sealing of Hybrid Microcircuits

By J. H. Williams

Published September 1980

Final Report

Prepared for the United States Department of Energy
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Bendix Kansas City Division

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SUMMARY

Hybrid microcircuits (HMCs) and large-scale integrated circuits (LSIs) used on two current projects require a hermetic seal capable of passing the leak test requirements of Mil Std 883B. A hermetic sealer was ordered from Research Instruments Corporation and set up for production sealing of HMCs and LSIs. Procedures were developed which resulted in production sealing yields of 75 percent for HMCs and 95 percent for LSIs.

An evaluation of moisture sensors to determine their suitability for use in monitoring moisture levels in sealed hybrid packages was initiated. The evaluation was not completed because the project was cancelled. The RICO sealer was characterized and schedules were developed for several LSI and HMC packages.

DISCUSSION

SCOPE AND PURPOSE

The purpose of this work was to develop the capability to hermetically seal hybrid microcircuits (HMCs) and large-scale integrated circuits (LSIs) for two projects. The requirements for the HMC packages and the LSI packages include a maximum fine leak rate of 1×10^{-7} cm^3/s for the smaller packages and 1×10^{-6} cm^3/s for the larger packages.

PRIOR WORK

Detailed descriptions of the vacuum bake, sealing processes, and cleaning processes were given in a previous report.[1] The capability was established to hermetically seal hybrid microcircuits for two other projects at Bendix Kansas City. Initial production results indicated a better than 90 percent yield for the process.

ACTIVITY

Installation and Modification of RICO Sealer

A new combination glove box; vacuum oven, and sealer (Figure 1) had been ordered from Research Instruments Company (RICO) and was installed upon receipt. The system includes an external nitrogen dryer that pulls nitrogen from the glove box through a drying column and then returns it to the glove box. The dryer lowers the moisture level capability of the system by an order of magnitude, to less than 1 ppm water, while conserving the factory's dry nitrogen supply.

Several modifications were made to the RICO sealer. The pump in the nitrogen dryer unit was a rotary lobe style pump that uses oil and grease for lubrication. Subsequently, a stainless steel bellows pump was installed and has been in operation continuously without maintenance for more than 1 year. The bellows type pump uses no oil or grease for lubrication.

A modification was made to the two vacuum pumps used on the system. One pump provides vacuum for the sealing chamber and the other pumps down the vacuum chamber used to bake out parts before sealing. To prevent the possibility that an electrical power failure might force oil from the vacuum pumps into the vacuum oven and the holding tank, solenoid valves were added to the vacuum pumps. When power to the pumps is withdrawn, the electrically-operated solenoid valves, which are closed when

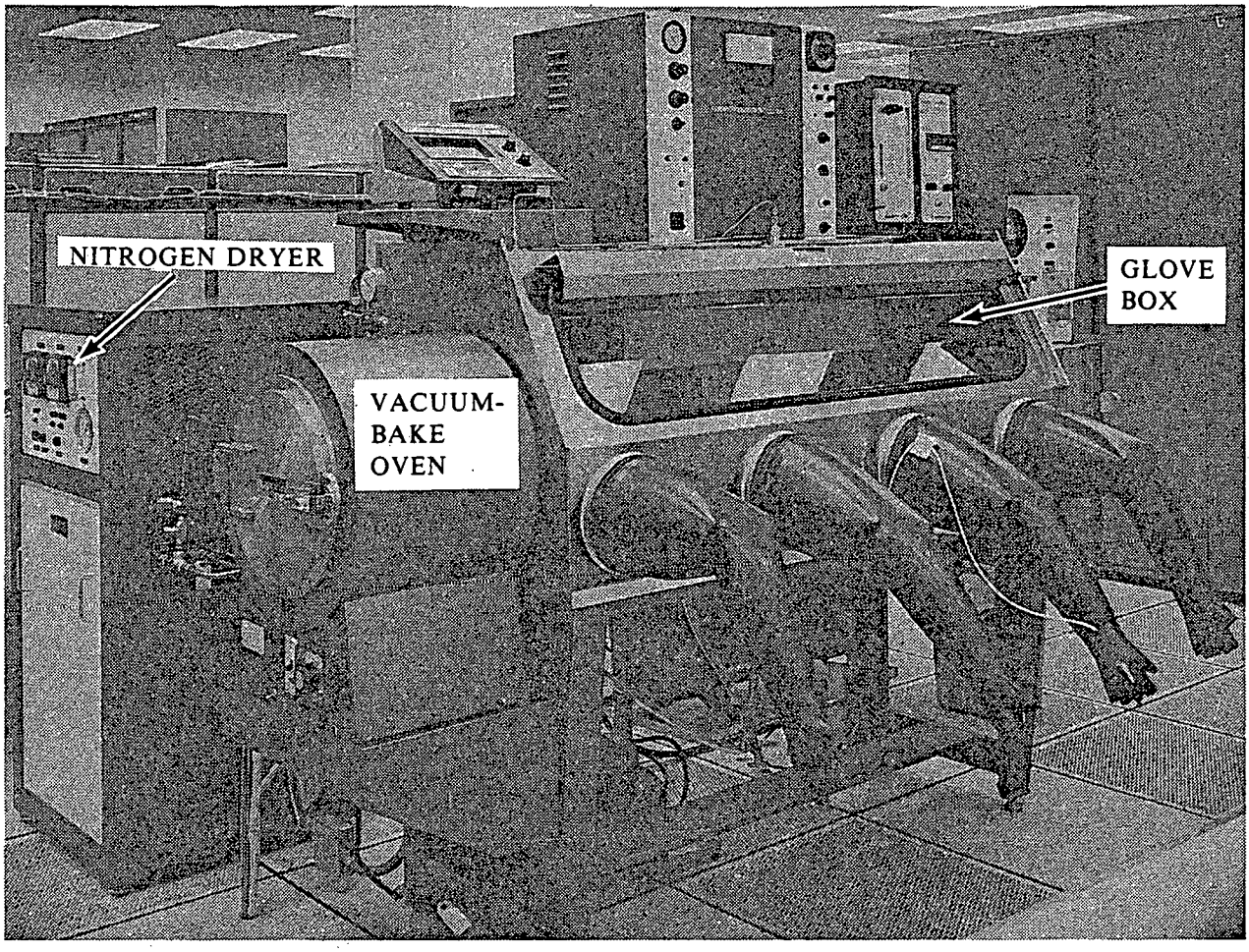

Figure 1. RICO Hermetic Sealer

energized, immediately open the foreline to the atmosphere and the vacuum oven and holding tank backfill with air instead of oil vapors.

A potassium-pentoxide electrolytic cell type of moisture monitor, which came with the sealer, was replaced after a short while with an aluminum oxide style sensor installed in the glove box, with a second sensor in the air lock. This change provides monitoring capability for the moisture levels in both the glove box and air lock. After 2 years of continuous duty, the aluminum oxide sensor has proven to be a very reliable tool for continuous humidity monitoring.

RICO Sealer Setup for LSI Package Sealing

A requirement existed to seal a quantity of development samples of 64-lead ceramic packages with LSI circuits inside. Several

hundred of the packages were available; however, their cleanliness was questionable because they had been stored for more than 4 years in plastic foam as received. Initial sealing attempts revealed a contamination problem that was causing solder dewetting. Two cleaning methods were tried in preparing the packages for sealing: a hydrogen peroxide bath and a tantalum nitride etching bath. Both packages as received and packages boiled in hydrogen peroxide for 20 minutes failed to wet. Good sealing results were obtained after the packages were placed in a tantalum nitride etchant solution for 5 minutes.

In an effort to discover the nature of the contaminants causing the dewetting, the surfaces of three packages were examined using Auger analysis. The results of the analysis indicated the presence of small amounts of silicon and copper oxide on the surfaces. The formation of the oxides may have been promoted by being subjected to 4 years of storage in the plastic foam in which they were shipped. A total of 125 LSI packages were placed in a tantalum nitride etchant solution for 15 seconds, rinsed in deionized water for 2 minutes, and dried by using a vacuum pencil to remove the water. The packages were then suspended in Freon TA vapors for a minimum of 2 minutes. Next, the die were attached to the package and wire bonded. After a 2-hour vacuum bake at 150°C, the packages were sealed. Subsequent leak testing found two packages with fine leak rates above the required 1×10^{-8} standard atmospheres cm^3/s. No packages failed the gross leak test.

The first development-order LSI parts were to be sealed in a leadless hermetic package (LHP). The LHP (Figure 2) is approximately 12.7 by 12.7 mm. Because it has no leads, three packages may be set close together and sealed simultaneously to provide the capability to seal three LHPs per cycle. Because of the LHP's unique design, it was necessary to order special tooling from RICO. A special insert was made to hold three LHPs in a triangular configuration (Figure 3). Each LHP was set on top of a heat sink assembly which had a small partial-sphere ball and socket assembly beneath it. The ball and socket allow each of the three packages to level itself against the heating element, since the three points define a plane. This ensures uniform pressure during sealing over all three packages. The heater used for the LHP sealing is 57.2 by 57.2 mm, and an operator can load three packages as easily as one.

RICO Sealer Setup for Hybrid Flatpack Sealing

Several different sizes of hybrid flatpacks are currently being used for HMCs. The sealer was initially set up to seal 12.7 by 12.7 mm and 15.9 by 15.9 mm packages. Both packages are sealed

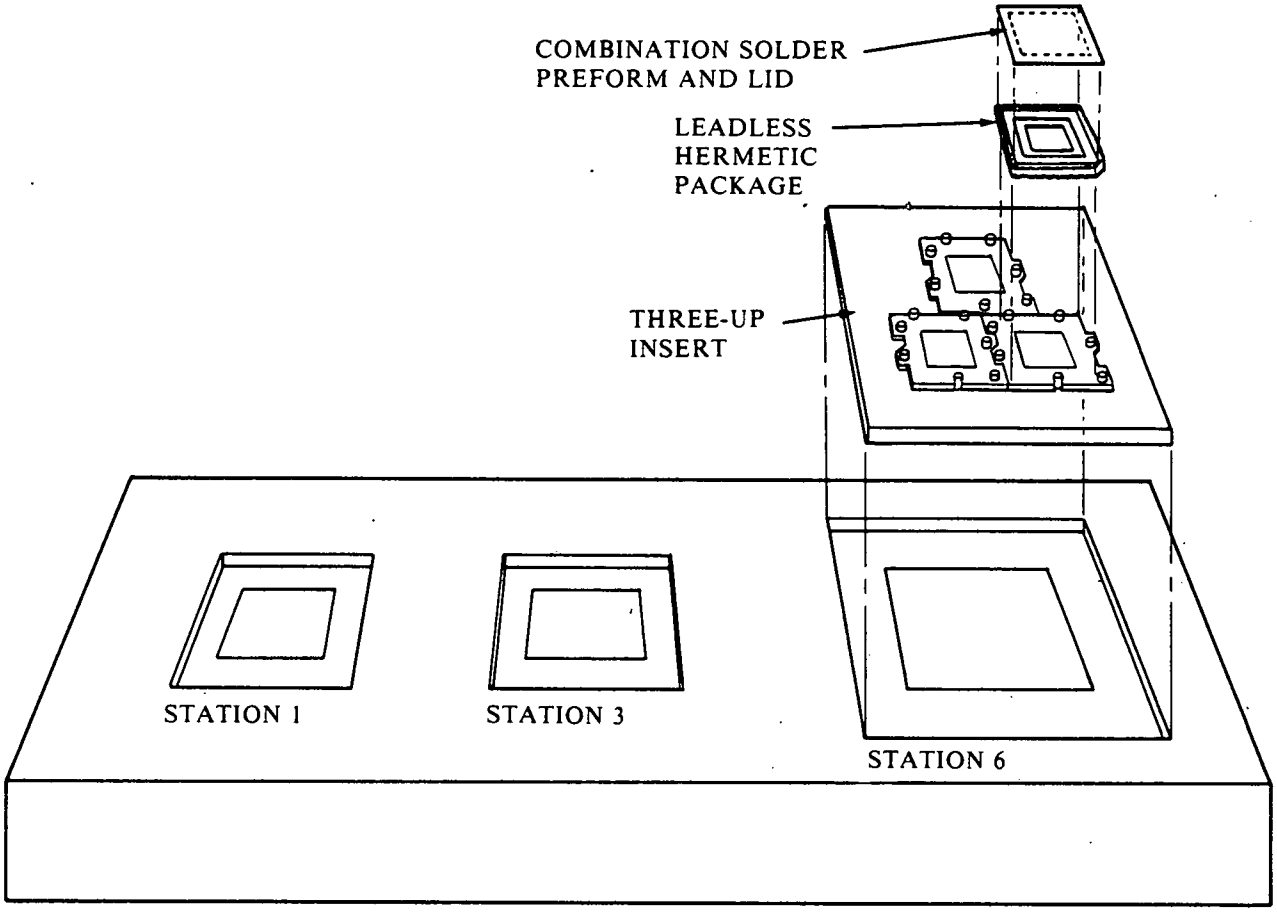

Figure 2. RICO Hermetic Sealing Stations

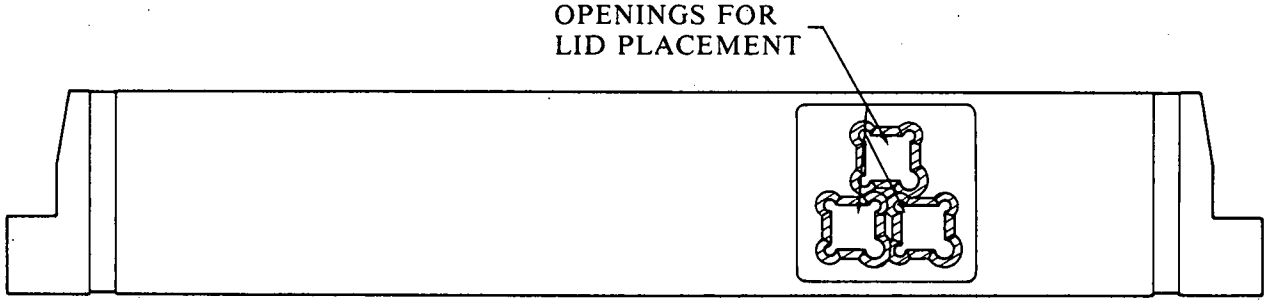

Figure 3. Alignment Tool

in the same position or station (Figure 2) by changing the insert and the mask alignment tool, as required, for the specific package. For each new package size, it is only necessary to order a new insert and a new mask alignment tool. The three-station sealing process is proving to be a simple procedure, because changing tooling requires no tools on the part of the operator (other than a pair of tweezers) and takes very little time.

ACCOMPLISHMENTS

The capability to hermetically package hybrid and large-scale integrated circuits to project requirements has been established at Bendix. The new hermetic sealer increases the capacity to hermetically seal packages by a factor of three over the sealer previously used. The nitrogen dryer on the new sealer glove box has reduced the consumption of plant dry nitrogen while reducing the internal moisture content of the glove box by 95 percent.

FUTURE WORK

A particle impact noise detection (PIND) tester is on order and will be used for testing of LSI circuits in accordance with Mil Std 883B. A delidding fixture is being built for use in rework of hermetically sealed units that must be opened for repair and then resealed.

REFERENCE

[1]J. H. Williams, Hermetic Sealing of Hybrid Microcircuits: Initial Capability Development (Topical Report). Bendix Kansas City: BDX-613-1930 (Rev.), December 1978 (Available from NTIS).

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ELECTRICAL: HMC Sealing

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