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Precision Gold Conductors for HMCs

Kansas City Division

M. R. Widmer

KCP-613-5376

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Final Report

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PRECISION GOLD CONDUCTORS FOR HMCs

M. R. Widmer

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Final Report
M. R. Widmer, Project Leader

Technical Communications
Kansas City Division

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Abstract

Ti/Pd/Au multiple code coded switch (MCCS) networks were built and compared to Cr/Au MCCS networks. The data showed no measurable difference between the two systems. Interface resistance of both types of networks was measured as a diagnostic aid to determine if hydrogen was affecting the Ti/Pd/Au MCCS networks. The data showed that although hydrogen does affect Ti/Pd/Au, the changes are not significant with respect to MCCS environments. An evaluation of several proprietary gold electroplating solutions for use in the production of Ti/Pd/Au conductors was performed. All the testing results were comparable to the current product requirements.

Summary

The Ti/Pd/Au metallization system was evaluated for MCCS thin film network (TFN) fabrication. The Cr/Au metallization system was used for MCCS TFNs, and the Ti/Pd/Au metallization system was used for Mark 4 and Mark 5 TFNs. The advantages of converting the MCCS to Ti/Pd/Au networks are the following:

1. Potential cross contamination between the Cr/Au and Ti/Pd/Au product lines is eliminated;
2. Engineering and manufacturing support are dedicated to maintaining one major process and, therefore, to minimizing processing errors inherent with multiple processes; and
3. Equipment and facility requirements needed to support TFN manufacturing processes are minimized.

Twenty Ti/Pd/Au substrates of each of five MCCS patterns were processed through Manufacturing for this evaluation. The Ti/Pd/Au MCCS networks were compared to Cr/Au MCCS networks in terms of epoxy bond test, standard inspection, and edge

monitor bond testing. The data showed no measurable difference between the two systems.

Because exposure of the two metallization systems to hydrogen has shown that a hydrogen environment affects Ti/Pd/Au and not Cr/Au, interface resistance of both types of networks was measured as a diagnostic aid to determine if hydrogen was affecting the Ti/Pd/Au MCCS networks. The data showed that although hydrogen does affect Ti/Pd/Au, the changes are not significant with respect to MCCS environments. For the worst case, there was an increase of 0.2% on a $\pm 1\%$ resistor.

However, it was decided not to convert the MCCS TFN fabrication to Ti/Pd/Au metallization, mainly because the MCCS schedules were small enough not to recommend a major change in the network fabrication.

Several proprietary gold electroplating solutions were investigated for use in the manufacture of Ti/Pd/Au TFN conductor fabrication. The preliminary investigations

showed that one of them produced the most consistent gold plating deposit. That solution was then evaluated for use in the production of Ti/Pd/Au conductors to ensure against any detrimental effect on product.

The evaluation consisted of processing 30 networks from 17 electroplating runs and then testing them for edge monitor bonding,

temperature change in resistance (TCR)/life stability, via resistance, beam lead bonding, ribbon bonding, and capacitor soldering. The testing data were compared to the product specifications and the data obtained from production gold deposit bond and pull tests.

No future work is planned for this project.

Discussion

Scope and Purpose

This report includes two separate evaluations that deal with the titanium/palladium/gold thin film network (TFN) metallization system:

1. Evaluation of the titanium/palladium/gold (trimetal) system for MCCS TFN fabrication to improve yields, and
2. Evaluation of a proprietary gold plating solution for the gold conductor pattern plating on titanium/palladium metallized substrates to enhance the quality of the gold conductors.

Prior Work

The Mark IV TFNs built with the chromium/gold system had seasonal low yields. The problem was high metallization failures caused by high corrosion susceptibility of the chromium/gold system. A few years of testing and development activity at AlliedSignal Inc., Kansas City Division (KCD), resulted in a titanium/palladium/electroplated gold (or trimetal) system for manufacturing TFNs.¹

The study showed that the trimetal is superior to chromium/gold in terms of corrosion susceptibility, metallization adhesion, and production costs. The relative corrosion susceptibility was determined by measuring changes and interface resistance after exposure to the vapors of the various processing solutions used in the thin film fabrication process. The chromium/gold changes were typically 100 to more than 1000 times the changes measured for trimetal networks. The corrosion resistance of the trimetal system also contributed to the consistent metallization adhesion as measured by the lead frame bond pull test. Pattern

electroplating greatly reduces gold handling costs. At the time of the study, the Mark IV was the main program suffering from the low yields and, therefore, only Mark IV units were converted from the chromium/gold to the trimetal system.

With the introduction of the trimetal process to the Mark IV program, there was a gradual increase in network yield. For example, in 1982 the chromium/gold Mark IV network yield was 79%. In 1985, the titanium/palladium/electroplated gold Mark IV network yield was 97%. MCCS TFNs inherently did not have low yield problems; however, converting the MCCS program from chromium/gold to titanium/palladium/gold was considered beneficial for the following reasons:

1. There is minimum potential for cross contamination between the chromium/gold and titanium/palladium/gold product lines;
2. Costs associated with processing and reclaiming precious materials are reduced (for a typical MCCS pattern, the chromium/gold process required evaporating 100 times more gold than was required by the pattern electroplating process);
3. The engineering and manufacturing support are dedicated to maintaining one major process (therefore, there is a potential for more process improvement and for minimization of processing errors inherent with multiple processes);
4. Equipment and facility requirements for support of manufacturing processes are minimized; and

5. Yields are increased for all the thin film programs.

Production experience with the gold electroplating and the trimetal Mark IV TFNs has shown that the titanium/palladium/gold networks are indeed better in quality compared to the chromium/gold networks. However, the higher rate of electrolytic aging of the plating solution because of the processing production quantities also showed rapid changes in the solution chemistry and, as a backup approach, qualification of a proprietary type III (99.9% minimum gold) plating solution was needed.

Activity

Evaluation of Titanium/Palladium/Gold System for MCCA Thin Film Networks

The titanium/palladium/gold evaluation plan was developed by representatives from both Sandia National Laboratories, New Mexico (SNL/NM), and KCD. The basic plan contained the following steps:

1. Process 10 substrates of each of the five patterns through the Micro Miniature Electronic Assembly Department and collect all standard processing inspection and yield data.
2. Build five trimetal hybrids for each of the five patterns. Process the parts through all standard inspection and test operations.
3. Ship completed hybrids to SNL/NM for additional testing.
4. Process and evaluate a second set of 50 substrates.

One of the differences between MCCA and Mark IV applications is that MCCA used epoxy-attached capacitors but Mark IV did not. Therefore, the evaluation included the use of an epoxy to attach capacitors to the trimetal.

In some instances, MCCA units may see a gradual increase in hydrogen concentration in the service container environment. Hydrogen is known to interact with both titanium and palladium, so tests were conducted to evaluate the effect of hydrogen on trimetal networks.

Epoxy Bond Test

Four types of WR and MCCA capacitors were bonded to chromium/gold and trimetal monitors using the standard MCCA process. The resulting data are shown in Table 1. The data show no measurable difference between the two systems.

Hydrogen Exposure

Exposure of the two metallization systems to hydrogen has shown that hydrogen affects trimetal and not Cr/Au. Hydrogen affects trimetal by lowering back-side (no tantalum nitride) lead frame peel strength and changing the interface resistance. Unlike Mark IV, because MCCA did not have back-side metallization, back-side adhesion is not an MCCA problem. Interface resistance was measured as a diagnostic aid to determine if hydrogen was affecting the metallization. Resistance measurements have shown the bulk resistance of tantalum nitride to be unaffected. The interface resistance changes would, in the worst case, change the MCCA resistors less than 1%. Although hydrogen does affect trimetal, the changes are not significant with respect to MCCA environments. The interface resistance data are shown in Figure 1.

Hydrogen-Induced Interface Resistance Changes

Interface resistance data were collected as an indicator of changes caused by hydrogen and not as a result of direct concern about interface resistance. The series short resistor pattern on the Mark IV edge monitor² was used to measure interface (tantalum

Table 1. Epoxy-Attached Capacitors Push-Off Strengths (lb)

Capacitor	Chromium/Gold					Trimetal				
	No. of Samples	Avg.	Std. Dev.	Max.	Min.	No. of Samples	Avg.	Std. Dev.	Max.	Min.
314535 (100 x 45)	17	18.45	4.19	24.97	13.43	13	18.45	3.67	24.69	14.66
314509 (120 x 100)	12	23.93	2.25	24.98	17.87	8	24.18	1.31	24.95	21.44
314507 (120 x 100)	10	24.8	0.02	24.84	24.77	10	24.73	0.34	24.87	23.77
314533 (80 x 50)	15	9.63	2.82	12.76	0.34	14	10.85	4.88	17.32	2.88

nitride/titanium/palladium/gold) resistance changes. The series short resistor consists of 98 square (0.005 inch x 0.005 inch) resistors in series. Major changes in the series short resistor relative to a control resistor with the same design value permits calculation of small changes in the interface resistance. The percent change in the resistance of the series short resistor is plotted in Figure 1.

The change in the series short resistor can be multiplied by 8 to obtain an approximation of the percent change in interface resistance for comparison to earlier data shown in Table 2. The maximum change of 2.5% in the series short resistor is in response to a 20% change in the interface resistance. This change should be considered relative to the changes shown for the two metallization systems in Figure 1. Figure 1 also shows that interface resistance on chromium/gold monitors changes over 1000% after exposure to gold etch vapors and up to 17% after immersion in DI water for 3.5 hours.

A 20% change in the interface resistance will change the nominal 30 ohm/mil interface to 36 ohm/mil. The worst case change to MCCS resistors would be a 0.2% change on the

$\pm 1\%$ resistor on the memory hybrid. Hydrogen-induced changes in any of the materials of the interface between the tantalum nitride resistor and the gold conductors can be detected.

The prime conclusions from the data are as follows.

1. Hydrogen-induced interface resistance changes do not produce a significant change in MCCS resistors. The maximum change on the series short resistors indicates a maximum interface resistance change of 6 ohm/mil. This is a worst case increase of 0.2% on a $\pm 1\%$ resistor.
2. The absence of measurable change in the resistance of the control resistor on the monitor indicated no change in the bulk resistance of the tantalum nitride.
3. Ten percent hydrogen decreases the rate but not the amount of change. In most cases, nearly stable values are reached within 15 days in 100% hydrogen and within 124 days in 10% hydrogen.

Figure 1. Hydrogen Exposure (0, 10, and 100% Hydrogen)

Table 2. Interface Resistance Change (percent)

Conditions	Type of Etch	Cr/Au (Stabilized)	Ti/Pd/Au (Stabilized)
Accelerated Aging 225°C for 208 Days ³		1200 to 6000	60 to 250
Two-Hour Vapor Exp. ¹	Au Etch	294 to 1155	-0.4 to 0.1
	Cr Etch	8.9	0.2
	Ta Etch	5.8 to 29	-3.1 to 0.06
	Ti & Pd Etch	163	0.09
Water Immersion ¹ 3.5 hours		3 to 17	0
Hydrogen Exposure		0	20

4. One of the two MCCS containers in 100% hydrogen leaked (see data on Samples 17 through 20 in Figure 1).
5. The amount and direction (positive or negative) of the interface resistance change is related to an undetermined process variable. Monitors from a single substrate and monitors fabricated in the same general time period showed similar responses.

palladium monitors increased between 43 and 60% after hydrogen exposure. Therefore, it appears that the interface resistance changes measured on the standard tantalum nitride resistors are caused by a hydrogen-induced change in the palladium layer. The lead frame bond data suggest that undetermined hydrogen relative to the mechanisms also causes back-side titanium/ceramic delamination and front-side titanium/palladium delaminations.

Tantalum Nitride/Titanium/Palladium and Tantalum Nitride/Titanium Resistors

To help determine what materials were being changed by hydrogen exposure, 12 Mark IV monitors were fabricated using tantalum nitride/titanium/palladium for resistors. Then, the palladium was etched off six of the monitors, leaving tantalum nitride/titanium for resistors. Four networks for each type were exposed to 100% hydrogen for 28 days, and two of each type were used as control monitors. The control resistors and the series short resistor on the tantalum nitride/tantalum monitor exposed to hydrogen showed no significant change before and after testing. Resistance of both the control and series short resistors on the tantalum nitride/titanium/

Metallization Adhesion After Hydrogen Exposure

Edge monitor lead frame bond data have been collected on some of the monitors from the three tests shown in Figure 1. Lead frame bonds of all the monitors exposed to 100% hydrogen at SNL/NM, four monitors from the 0, 10, and 100% tests, and 37 monitors from the 32-day 100% exposure test were pull-tested after hydrogen exposure (Figure 1). The data summarized in Table 3 show that the overall bond results of standard bond paths after hydrogen exposure fall within the typical production ranges, with the exception of an increase in metallization failure. This is not considered a significant problem because most of the metallization failures were high

Table 3. Ti/Pd/Au Lead Frame Pull Test Results

		Number of Leads	Avg. (lb)	Std. Dev. (lb)	Min. (lb)	Max. (lb)	Failure Mode (%)		
							B	E*	M**
Series 1: Cr/Au & Trimetal	Front Standard	24	3.37	0.55	2.5	4.34	75	0	25
	Front Check	30	0.21	0.37	0	1.09	0	0	100
	Back	54	0.1	0.46	0	3.02	0	100	0
Series 2: 0,10,& 100% H ₂	Front Standard	8	4.73	0.65	3.54	5.61	87	0	13
	Front Check	10	0.76	0.6	0	1.65	0	0	100
	Back	18	0	0	0	0	0	100	0
Series 3: 100% H ₂	Front Standard	76	3.97	0.72	2.3	5.1	80	0	20
	Front Check	95	0.23	0.45	0	1.5	0	0	100
	Back	162	3.22	1.43	0	5	75	25	0
Overall	Front Standard	108	3.89		2.3	5.1	79.4	0	20.6
Specification Requirements	Front Standard		≥ 1.5		≥ 0.75				No M
	Back				≥ 0.5				< 2.5
Typical Production Process	Front Standard	3 - 4			2.0-3.5	3.5-5.5	90-100	0-5	0-5
	Front Check	1 - 2			0.0-0.5	2.0-3.0		50-100	50-100
	Back	3 - 4			2.5-3.5	3.5-5.5	90-100	0-5	0-5

* After hydrogen: Ti-Ceramic Delaminations

** After Hydrogen: Ti-Pd Delaminations

Failure Mode Definition:

A = Broken lead away from bond zone.

B = Broken lead at bond zone.

C = Bond delamination.

E = Metallization-to-ceramic failure.

F = Beam broken at heel of bond.

M = Undesirable rate of metallization.

strength; only two of 108 leads were below the 2.5 pound specification limits (1.23 lb M and 1.24 lb M).

Trimetal Mark IV Yields

Mark IV production yields provide the best indicator of potential trimetal MCCA yields. During this evaluation period, final visual Mark IV yields have been 83.8% (5630/6719) and MCCA yields have been 82.9% (7608/9178). The trimetal MCCA visual yield should be better than the Mark IV because about one-fourth of the Mark IV rejects were for laser-drilled via or component hole problems. Mark IV edge monitor yields are over 90%, and with no back-side metallization, MCCA yields should be even higher.

MCCA Hybrid Build Test

In accordance with the evaluation plan, two electroplating runs consisting of 10 substrates of 19 TFNs for each of the 5 MCCA part numbers were made. Five hybrids were assembled from each part number. All hybrids were inspected and tested for standard MCCA procedures.

Yield data were collected for the development TFN use for the trimetal MCCA hybrid build. Those yield data are shown in Table 4. The data are not directly comparable to production yields because all parts are processed through visual and edge monitor pull testing regardless of prior inspection or known defects that would have resulted in line scrap if they were WR production. The parts were processed through a questionable plating bath, but the processing was continued because it appeared that yields would be sufficient to build five MCCA hybrids of each MCCA pattern. Most of the visual yield rejects were for conductor shorts caused by two factors that reduced conductor spacing.

Chromium/gold MCCA phototools were used on this development gold plating run. The chromium/gold phototools have lines 0.2 mils

over nominal to compensate for the gold etchback process, which tends to produce narrow lines. Electroplating bath problems produce some resist from the plating widening lines.

Five hybrids of each of the five MCCA part numbers were fabricated using the trimetal TFNs. No unusual fabrication problems were encountered. All hybrids passed the standard visual electrical tests. The trimetal memory hybrids were not processed through the attachment of actual memories because of the time involved. Two MCCA units were completed using four trimetal hybrids and chromium/gold memory hybrids. The completed units passed all standard inspection analytical tests. The data were comparable to historical chromium/gold data.

Following the evaluation, it was recommended that the MCCA requirements be changed to allow trimetal TFNs. In the Mark IV switch to trimetal, the production agency suffix on the TFN drawing was incremented to identify the trimetal networks. The radar drawings were changed to allow both types of metallization with the radar. A similar approach was recommended for the MCCA. However, it was decided not to build MCCA networks with the Ti/Pd/Au metallization system for the following reasons.

1. Everyone was not totally convinced that hydrogen has no effect on Ti/Pd metallization system.
2. The MCCA schedules were small enough not to justify more evaluation or recommend a major change in the network fabrication.

No future work is planned on this topic.

Table 4. Visual and Lead Frame Bond Yields

Pattern	Plating Run Number	Substrate Number										Overall	
		-1		-2		-3		-4		-5			
		Visual	Bond*	Visual	Bond*	Visual	Bond*	Visual	Bond*	Visual	Bond*	Visual	Bond
IO-1	946	3/9	A	1/9	A	1/9	A	1/9	R	0/9	R	6/45	3/5
	941	0/9	A	5/9	A	2/9	A	0/9	A	2/9	A	9/45	5/5
IO-2	952	2/9	A	7/9	A	0/9	A	5/9	A	3/9	A	17/45	5/5
	953	1/9	A	0/9	A	2/9	A	0/9	A	3/9	A	6/45	5/5
Data Register	934	6/9	A	4/9	A	6/9	A	3/9	A	4/9	A	23/45	5/5
	940	5/9	R	8/9	R	3/9	A	0/9	R	0/9	A	16/45	2/5
Memory	950	9/9	A	3/9	A	4/9	A	2/9	A	5/9	R	22/45	4/5
	951	1/9	A	1/9	A	2/9	A	3/9	A	2/9	A	9/45	5/5
Memory Buffer	930	8/9	A	8/9	R	7/9	A	7/9	A	9/9	R	39/45	3/5
	931	5/9	A	7/9	A	9/9	A	8/9	A	4/9	A	33/45	5/5
Overall												180/450	42/50

* A = Accept; R = Reject.

Evaluation of Proprietary Gold Electroplating Solutions for Titanium/Palladium/Gold Thin Film Network Production

KCD thin film technology engineering has investigated several proprietary gold electroplating solutions for use in the manufacture of titanium/palladium/gold TFNs. This effort was intended to (1) incorporate a plating solution chemistry for which outside technical support is available, and (2) implement a more stable (high pH) gold electroplating solution into production. From June 1980 to June 1987, nine different plating baths were used for production plating. Those baths used a derivative of phosphonic acid. That type of electroplating solution was originally selected because it was in use by other weapon complex design and production agencies and because the trend at that time was toward the use of nonproprietary, "home-made" solution chemistries. Since that time, several design agencies within the complex have begun using proprietary plating solutions because of ease of makeup and solution maintenance.

Three proprietary gold electroplating solutions from one company (Vendor A) were first considered for the evaluation because they are based on the phosphonic acid solution. However, because of their unstable bath chemistries over just a short time period, the Vendor A plating solutions and one from a second vendor (Vendor B) were determined to be unacceptable. Two solutions from Vendor B were evaluated—Solutions A and B. The second solution (B) was determined to satisfy all the general requirements.

An evaluation of solution B for use in the production of titanium/palladium/gold TFNs was then conducted to ensure against any detrimental effect on product. The evaluation consisted of processing several substrates metallized with titanium/palladium (Mark IV

WR metallized substrates were scrapped out for this evaluation) through the solution B gold electroplating process and subsequent TFN process steps. The evaluation parts were then tested for metallization adhesion (thermocompression bonding) as well as TCR/life stability and via resistance. Additionally, beam lead bonding, ribbon bonding, and capacitor soldering tests were performed on the evaluation parts. Thirty-four networks from 17 electroplating runs were used for this evaluation.

The results from the evaluation indicate the solution B electroplating process produces TFNs of quality comparable to the existing WR gold electroplating process. All TFNs passed the bonding and component attach tests (Table 5) as well as the TCR ($-105 \text{ ppm}/^{\circ}\text{C}$)/life stability test ($+0.2, -0.05\%$ after 200 hours at 150°C) conducted on the tantalum nitride resistors.

The via resistance check resulted in an acceptance rate of 96.5% for the 10 milliohm maximum requirement and an acceptance rate of 85.6% for the 5 milliohm maximum requirement for one sample. However, three other samples had a 99% + acceptance rate (Table 6). Also, the titanium/palladium/gold production edge monitor acceptance test results for calendar year 1985 compared closely with the lead frame (TC) bond test conducted on the evaluation parts. The evaluation parts had a slightly higher percentage of "E" failures than the production parts, which are believed not to be related to the gold electroplated deposit.

Because the gold electroplating solution B used in the evaluation has been in operation since August 1985, the performance of the plating solution has been observed over a period of time in a quasi-production situation. During this time period, weekly analyses have been performed on the solution gold content, pH, and specific gravity by the KCD Analytical Sciences Laboratory. Aside from additions of gold salt to replenish gold that was plated, only one chemical addition of

Table 5. Gold Deposit Bonding Results**Lead Frame Bonding Results**

Plating Solution	Side	Bond Strength (lb)			Failure Mode (percent)			
		Avg.	Min.	Max.	B	C	E	M
Solution B Gold-Plated Parts	Front	3.55	1.7	5.35	93.6	0	6.4	0
	Back	3.88	1.5	5.37	98.5	0	1.5	0
Phosphonic Acid Gold-Plated Parts	Front	3.8	0.81	6.35	96.1	1.9	1.9	0.1
	Back	4.07	0.6	6.01	Not Available	Not Available	Not Available	Not Available

Beam Lead Bonding Results

Format	Bond Strength (grams)			Failure Mode (percent)			
	Average	Minimum	Maximum	A	B	E	F
Format 70	119.6	98	150	0.2	2.2	2.2	95.4
Format 25	34.1	19.7	49.2	0	25.3	0.3	74.4

Ribbon Bonding

Bond Strength (grams)			Failure Mode (percent)	
Average	Minimum	Maximum	A	B
105.3	50	160	94.7	5.3

Capacitor Soldering Strength

Type of Capacitor	Bond Strength (lb)			Failure Mode (percent)
	Average	Minimum	Maximum	C
2076-23	14.1	11	15.6	100
2075-15	6.7	4.4	9.9	100

Table 6. Via Resistance Test Characteristics

Sample Number	Requirement	Quantity Accepted	Quantity Inspected	Percent Acceptance
1,286	10 Milliohm Max.	550	570	96.5
1,286	5 Milliohm Max.	488	570	85.6
9,871	10 Milliohm Max.	150	150	100
9,871	5 Milliohm Max.	150	150	100
9,872	10 Milliohm Max.	96	96	100
9,872	5 Milliohm Max.	96	96	100
9,873	10 Milliohm Max.	150	150	100
9,873	5 Milliohm Max.	149	150	99

conductivity salt was needed to maintain the specific gravity within the manufacturer's recommended limits.

Carbon treatment of plating solution B was effective for improving the plated pattern resolution, although minimal carbon treatment was required (96 liters of plating solution B have been carbon treated since August 1985). Also, one particulate filter change per month (two filters at a time) proved to be adequate (even during periods of plating inactivity). The level of plating activity from August 1985 through April 1986 in the solution B was 50 ampere-hours, which then adjusted to a one-year time frame would be approximately 11% for the activity in the phosphonic acid solution during calendar year 1985.

The operating parameters of both solutions are as follows:

Gold Plating Solution B

1. Gold Content 8-12 g/L
2. pH 6-8
3. Specific Gravity 1.100-1.1600

4. Operating Temperature 65°C

5. Current Density Range 2-4 ASF

Phosphonic Acid Gold Electroplating Solution

1. Gold Content 20-30 g/L
2. pH 4.0-4.4
3. Operating Temperature 70°C
4. Current Density 2 ASF

In addition to the weekly solution analysis performed on the plating solution B, other qualitative and quantitative analyses were performed. The plated gold deposit was assayed monthly and found to consistently meet the 99.9% minimum purity requirement. The Hull Cell plating test performed on the plating solution B resulted in a brighter, more uniform deposit, which is indicative of a wider latitude of the plating current densities. The plating efficiency in solution B was checked monthly and consistently averaged

90% compared to the phosphonic acid solution which ranged from 83 to 96% during calendar year 1985.

This evaluation concluded that the solution B gold electroplating process has several advantages over the existing WR gold electroplating process. These advantages are as follows:

1. Reduction of indirect labor required for solution makeup and minimization of the potential for errors in the makeup of the solution;
2. Potential for reducing plating time 50% by plating at 4 ASF instead of the currently used 2 ASF, resulting in an electroplating capacity that is double the current capacity; and more important,
3. Incorporation of a more stable (higher pH) plating solution, resulting in less consumption of gold as salvage because of less formation of gold cyanide precipitate.

In view of the comparable quality of plating obtained using solution B versus the phosphonic acid gold plating solution (existing WR process) and the additional processing advantages of solution B, it was recommended that gold plating solution B will be approved as a backup solution for the TFN gold electroplating process.

Accomplishments

Four types of MCCS capacitors were bonded to Cr/Au and trimetal monitors using the standard MCCS process. The data showed no measurable difference between the two systems.

Interface resistance was measured as a diagnostic aid to determine if hydrogen was affecting the trimetal metallization. The measurements showed that hydrogen does affect trimetal; however, in the worst case,

the MCCS resistors would change only 0.2%.

Two MCCS units were completed using four trimetal hybrids and Cr/Au memory hybrids. The completed units passed all standard inspection electrical tests. The data were comparable to historical Cr/Au data.

Gold plating solution B was evaluated for use in the production of Ti/Pd/Au thin film networks by comparing gold plating efficiency, plating solution stability, gold deposit assay, lead frame bonding, beam lead bonding, ribbon bonding, capacitor soldering, TCR/life stability, and via resistance data to the current production specifications data. The data were comparable to those from the current gold-plated thin film networks.

Future Work

No future work is planned for this project.

References

¹ R. A. Hines and M. K. Raut, Comparison of Metallization Systems for Thin Film Hybrid Microcircuits. Kansas City Division: BDX-613-2489, August 1980 (Available from NTIS).

² R. A. Hines, A Thin Film Network Test Pattern For Use With Electroplated Gold. Kansas City Division: BDX-613-2712, November 1981 (Available from NTIS).

³ L. R. Zawicki and N. C. Thomas, Improved Techniques to Monitor Thin Film Characteristics for Reliable Hybrid Microcircuit Fabrication. Kansas City Division: BDX-613-2453, February 1981 (Available from NTIS).

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