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M55302 Connector – Pin Analysis

Analysis #29858

Prepared for

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of

UC Berkeley Space Sciences Laboratory

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Three connectors, identified below were received for analysis.

Connector ID	Date Code	Lab ID
M55302/131-01	0337	M-03
M55302/132-01	0424	F-04
M55302/131-01	9849	M-98

The objective of this work was to measure the Au plating thickness of the pins and determine the elements present at their surface that could interfere with the connector performances.

Thirty-six pins, 12 per connector, were extracted from columns 1, 10, 20 and 32 and rows A, B, C and were identified with the number as A1, B1, C1 etc.

The 12 pins of each connector were divided in three groups of four pins each and subjected to the following tests:

1) Optical and Scanning Electron Microscope (SEM) inspection for surface topographic characterization followed by a 500°C air bake for 5 minutes followed by an optical inspection for pinhole count and Auger Electron Spectroscopy (AES) analysis for material characterization.

2) Auger spectroscopy of the contact area to determine the elemental surface composition.

3) A cross-section, after the samples were Ni plated, to measure the Au layer thickness.

An additional sample of three pins was etched in a 50% Nitric and 50% Acetic acid solution for 5 minutes and inspected.

The documentation for the tests performed is reported in three sections and a summary of the results in Tables I-III.

The figures for each section are as follows:

Connector	Optical & SEM	AES	Cross-section
M-03	1-10	11-27	28-37
F-04	1-10	11-25	26-36
M-98	1-14	15-31	32-41

Observations and Conclusions:

The surfaces of the M-03 and M-98 pins have many small nodules of ~3μm or less in diameter.

The M-98 pin surface in addition to vertical striations has in some cases a high density of dark appearing pits, see Fig. 5.

The surface of F-04 pins has a large number of horizontal striations and small abrasions, indicating the actual contact area, see Figs. 3, 5, 7 and 9.

After the 500°C bake in air for 5 minutes, the surface of all samples has a significant discoloration. This is an indication of impurities in the Au layer or impurities diffusing through the Au from the substrate materials.

The pinhole count, performed after the bake at 100X magnification is reported in Table I.

Only pinholes greater than 20μm in size were counted.

After the bake at the surface of all samples, Ni and Co were detected. In addition, Pb was detected on M-03 and M-98 and a large amount of K was detected on M-98.

The black spots were found rich in K.

No defects, relevant to be reported, were observed after the acid etch test.

Without any bake, all contacts analyzed have a significant amount of Cu and Sn with traces of S and Cl at the Au surface. All these elements may interfere with the electrical performance of the connector, see Table II.

A potential increase in contact resistance could be caused by fretting corrosion.

It has also to be observed that because of the geometry of the pins, the effective amount of contact is less than 10% of the available area.

The Au plating thickness is uniform in the contact area of all pins cross-sectioned and it is reported in Table III.

Although the average Au plating thickness if the M-98 pins is 20% less than that of the M-03 pins, the pinhole density of the M-03 pins is ~17 times higher.

The M-03 sample also has a thinner Ni barrier.

Table I
Pinhole Density

Unit	# of Defects				Total Area mm^2	Defects/ mm^2
	C1	C10	C20	C32		
M-03	28	7	0	34	~16	4.31
F-04	0	0	0	0	~15	---
M-98	4	0	0	0	~16	0.25

Table III
Plating Thickness in μm

Unit	Au					Ni
	A1	A10	A20	A32	Average	
M-03	1.9	2.0	2.0	2.0	2.0	~2.0
F-04	1.6	2.0	1.6	1.5	1.7	2.5-3.0
M-98	1.6	1.6	1.6	1.6	1.6	2.5-3.0

Accuracy ± 5%

Table II
Quantified Data from AES Spectra in Atomic%*

Contact	Depth (Å)	C	O	S	Cl	Cu	Sn	Au
M-03-B1	0	51.3	5.3	4.3	---	5.7	4.5	28.9
	10	31.0	3.5	3.0	0.1	5.8	5.6	60.0
	30	21.6	1.2	---	---	3.7	1.8	71.7
M-03-B10	0	49.6	4.5	3.8	0.5	5.2	3.6	32.8
	10	31.0	3.1	3.0	---	6.2	5.6	51.1
	30	9.4	1.2	---	---	4.3	2.7	82.4
M-03-B20	0	48.2	7.6	4.3	0.5	5.1	7.1	27.2
	10	20.4	5.1	3.6	0.4	5.2	8.4	56.9
	30	11.3	1.7	---	---	3.6	2.6	80.8
M-03-B32	0	48.9	2.9	4.6	---	4.3	2.8	36.5
	10	30.2	2.1	3.2	---	3.4	3.2	57.9
	30	10.5	1.3	---	---	3.2	1.6	83.4
F-04-B2	0	43.0	14.8	---	---	4.3	12.0	25.9
	10	28.4	13.3	---	---	7.1	18.9	32.3
	30	18.2	5.4	---	---	7.3	8.7	60.4
F-04-B10	0	37.2	12.5	0.4	0.8	3.6	13.2	32.3
	10	28.0	11.9	0.7	0.9	6.1	19.5	32.9
	30	17.3	5.8	---	---	7.0	11.0	58.9
F-04-B20	0	37.2	15.4	---	0.9	4.5	16.8	25.2
	10	22.5	12.5	1.2	1.2	6.0	19.9	36.7
	30	13.2	7.0	---	---	6.4	11.7	61.7
F-04-B32	0	38.8	12.7	0.6	0.5	4.0	14.3	29.1
	10	23.7	9.0	1.7	---	5.6	14.6	45.4
	30	16.1	4.2	---	---	4.6	6.8	68.3
M-98-B1	0	59.1	5.6	0.6	2.6	3.5	3.2	25.4
	10	46.3	2.3	1.3	3.0	5.0	4.0	38.1
	30	26.4	0.6	---	---	4.5	2.1	66.4
M-98-B10	0	70.6	3.4	0.4	0.8	2.5	1.6	20.7
	10	64.1	2.1	1.2	1.2	3.4	2.4	25.6
	30	56.9	1.4	---	---	3.0	2.2	36.5
M-98-B20	0	58.3	5.7	0.6	2.6	5.5	3.8	23.5
	10	44.5	3.7	1.5	2.6	5.0	5.1	37.6
	30	25.7	3.8	---	---	3.2	4.1	63.2
M-98-B32	0	68.7	4.0	0.4	1.1	3.3	2.7	19.8
	10	63.3	2.6	0.6	1.9	3.8	5.8	22.0
	30	57.6	1.5	1.0	1.3	4.6	5.3	28.7

*As needed, the most abundant element in each spectrum was adjusted so the total concentration equaled 100%.