# ENGINEERING REPORT	Report #	CE23-0606
	EWOM #	N/A
	CLT #	**10825**
Evaluation of R-VPX product to VITA 72 vibration levels	**Revision #:**	**A**
	Publish Date	
	6/19/2023	

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Distribution List:

Revision History

Rev #	User	Date
PA1	GSP	6-6-2023
PA2	GSP	6-16-2023
A	GSP	6-19-2023

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List of Figures and Tables

1. Summary

1.1. Purpose of Test

Testing was performed on Amphenol's R-VPX Ruggedized VITA 46 connector to determine its ability to withstand VITA 72 vibration levels.

1.2. References

The following documents were referenced for testing in this report. Unless specified, the version in effect at time of testing will be followed.

AAO VITA 72 RVPX test plan_3-29-2023_10-19

1.3. Testing Agencies

Amphenol Aerospace

40-60 Delaware Ave

Sidney NY 13838

2. Samples and Test Sequence

2.1. Samples

Test specimens were taken from normal production lots. Specimens identified with the following part numbers were used for test. Testing was performed on 50 µin gold parts.

Sample	Part Number	Description
VITA 46 6U Daughtercard Assembly *Amphenol*		
Position P0	RVPX-P08VM2	Right Angle daughtercard 8 pos. VITA load
Position P1	RVPX-P16DM2	Right Angle daughtercard 16 pos. Diff load
Position P2	RVPX-P16DM2	Right Angle daughtercard 16 pos. Diff load
Position P3	RVPX-P16DM2	Right Angle daughtercard 16 pos. Diff load
Position P4	RVPX-P16DM2	Right Angle daughtercard 16 pos. Diff load
Position P5	RVPX-P16DM2	Right Angle daughtercard 16 pos. Diff load
Position P6	RVPX-P16DM2	Right Angle daughtercard 16 pos. Diff load
VITA 46 6U Backplane Assembly *Amphenol*		
Position J0	RVPX-J08EM2	Vertical receptacle backplane 8 pos end
Position J1	RVPX-J16MM2	Vertical receptacle backplane 16 pos middle
Position J2	RVPX-J16EM2	Vertical receptacle backplane 16 pos end
Position J3	RVPX-J16MM2	Vertical receptacle backplane 16 pos middle
Position J4	RVPX-J16MM2	Vertical receptacle backplane 16 pos middle
Position J5	RVPX-J16MM2	Vertical receptacle backplane 16 pos middle
Position J6	RVPX-J16EM2	Vertical receptacle backplane 16 pos end

Table 1: Sample Description

Figure 1: Typical Test Sample

2.2. Test sequence

Pre-Test		
Test	Exposure	Duration (hours)
Sine Sweep Resonance	1 Octave/minute 5Hz to 2,000 Hz 1 sweep per axis	~25 Minutes
Test sequence A (1 sequence per axis)		
Test	Exposure	Duration (hours)
Random Vibe L3	1 hour	1
Sine Vibe L3	1 hour	1
Shock L3	3 pos/3 neg pulses	
Total sequence A (All 3 axes)		6
Test sequence B (1 sequence per axis)		
Test	Exposure	Duration (hours)
Random Vibe L3	1 hour	1
Sine Vibe L3	1 hour	1
Shock L3	3 pos/3 neg pulses	
Total sequence B (All 3 axes)		6
Test sequence C (1 sequence per axis)		
Test	Exposure	Duration (hours)
Random Vibe L3+3dB	1 hour	3
Total sequence C (All 3 axes)		3
Test sequence D (Z axis only) HALT Test		
Test	Exposure	Duration (hours)
Random Vibe L3+3dB	12 hours	12
Total sequence D		12

Table 2: Test sequence

2.3. Fixture design / verification

Figure 2 shows the test fixture assembly and axis definitions. This shows the plug-in module clamped on the outside edges. This mimics the constraint of wedge-locks in a typical 6U operational system.

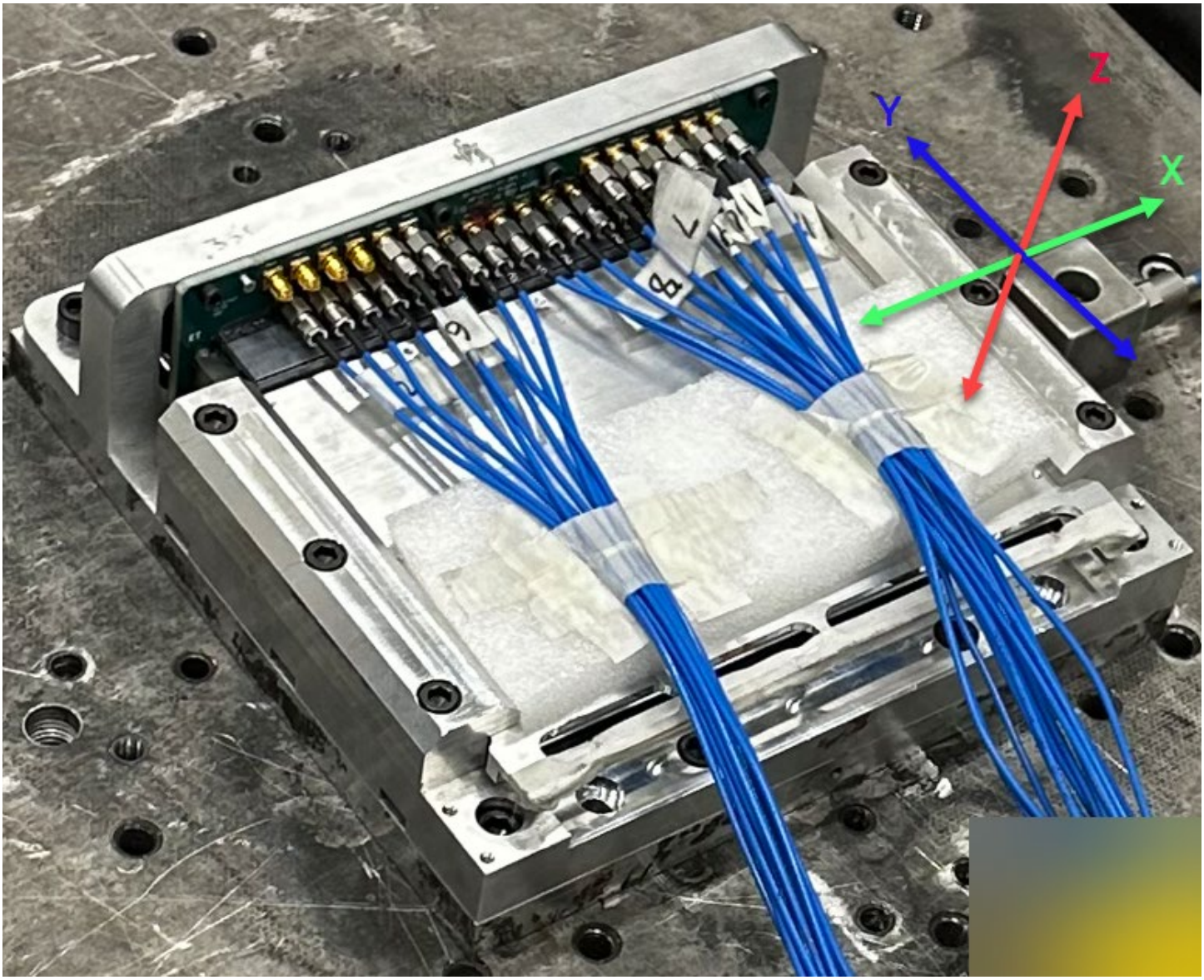


Figure 2: Axis Definitions / 6U test fixture

Figure 4 shows the sine sweep response for the Z axis. This response shows that the system is relatively inline with typical natural frequency of 6U chassis. See appendix A for remaining frequency response graphs from each axis of test.

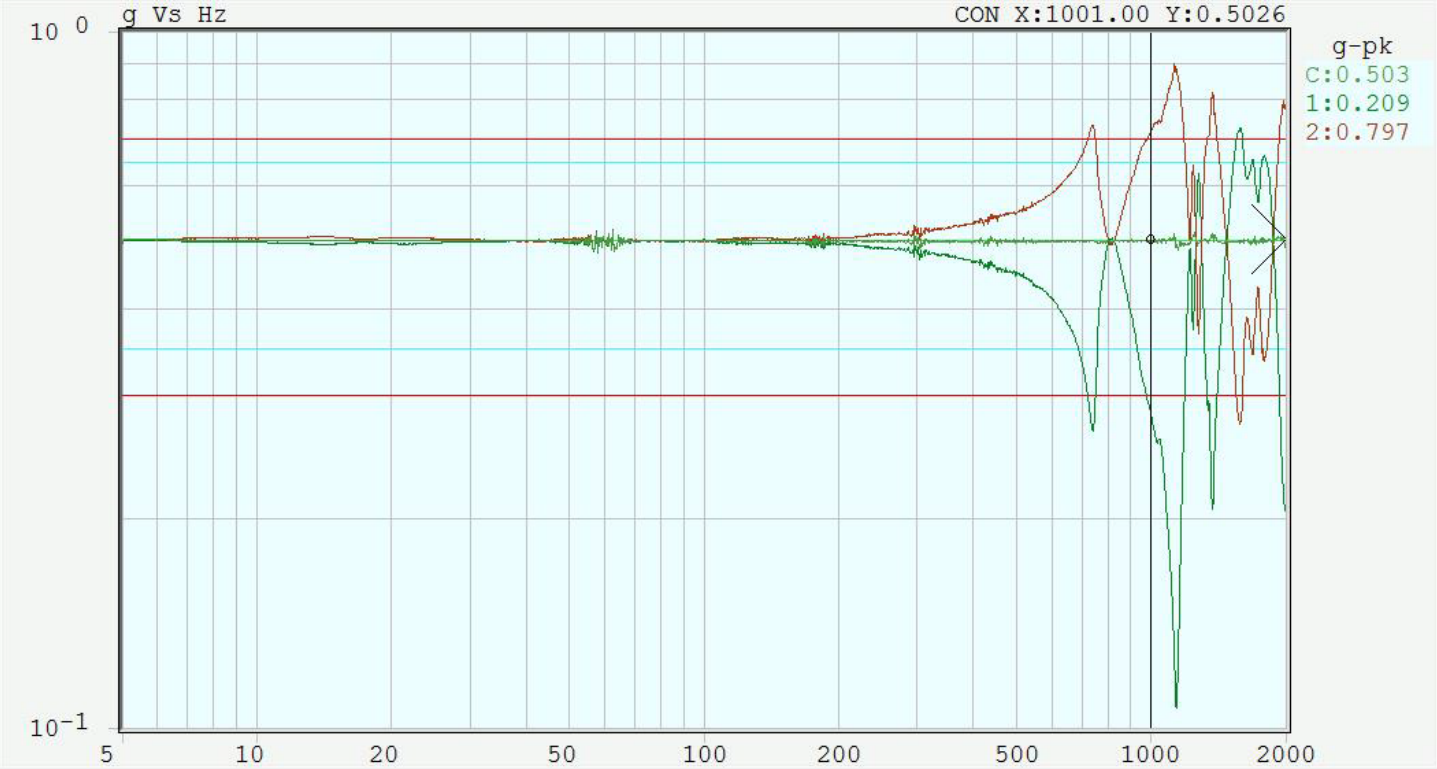


Figure 4: Frequency response Z axis

3. Summary of Testing

Pre-Test				
Test	Exposure	Duration (hours)	LLCR Result	BERT Result
Sine Sweep Resonance	1 Octave/minute 5Hz to 2,000 Hz 1 sweep per axis	~25 Minutes	PASS	PASS - No failures
Test sequence A (1 sequence per axis)				
Test	Exposure	Duration (hours)		
Random Vibe L3	1 hour	1		
Sine Vibe L3	1 hour	1	PASS	PASS - No failures
Shock L3	3 pos/3 neg pulses			
Total sequence A (All 3 axes)		6		
Test sequence B (1 sequence per axis)				
Test	Exposure	Duration (hours)		
Random Vibe L3	1 hour	1		
Sine Vibe L3	1 hour	1	PASS	PASS - No failures
Shock L3	3 pos/3 neg pulses			
Total sequence B (All 3 axes)		6		
Test sequence C (1 sequence per axis)				
Test	Exposure	Duration (hours)		
Random Vibe L3+3dB	1 hour	3	PASS	PASS - No failures
Total sequence C (All 3 axes)		3		
Test sequence D (Z axis only) HALT Test				
Test	Exposure	Duration (hours)		
Random Vibe L3+3dB	12 hours	12	FAIL	PASS - No failures
Total sequence D		12		

Table 3: Test results

3.1. Qualification test verification methods/conditions

Test	Description
Visual Inspection (VI)	Visual inspection shall be performed at a magnification of 100X or less (30-40X preferred). Failure is defined as visible lift of the daughtercard connector off the daughter-board when examined at a magnification of 100X or less.
Bit Error Rate monitoring (BERT)	Bit error rate monitoring at 7.0625 Gbps of PRBS signals sent through an Intel Stratix 10 GX signal integrity development kit. BER monitoring during all tests.
LLCR	LLCR measurements shall be performed per EIA-364-23B or MIL-STD-1344A, method 3002.1. LLCR testing will be performed before and after each of the 4 tests in Section 3. 100% of the test points should be used. Failure is defined as a resistance increase of greater than 10 mΩ on any individual contact, or greater than an average of 5 mΩ per connector module.

Table 4: Verification methods/conditions

3.2. Visual Inspection

No visible lift of daughtercard connector off the daughter board area.

3.3. Bit Error Rate monitoring

No failures observed during all 4 test sequences.

3.4. Low Level Contact resistance

The largest resistance change measured (prior to HALT testing) was 3.6 mΩ. Which constitutes passing LLCR.

3.5. SEM analysis EDS mapping

In addition to visual inspection, samples from expected high-fretting locations were sent for SEM analysis with EDS elemental mapping. As seen in figures 3.5-1 & 3.5-2, wafer 8 from P3 connector and the associated contacts in figures 3.5-3, 3.5-4, & 3.5-5 from J3, column 8 shows points of wear through the gold to the nickel. There is some minor intrusion to the copper layer on the wafer, but the wear does not extend through the nickel. There is no wear thru of the nickel on the backplane contacts. Appendix B contains all the SEM EDS maps taken.

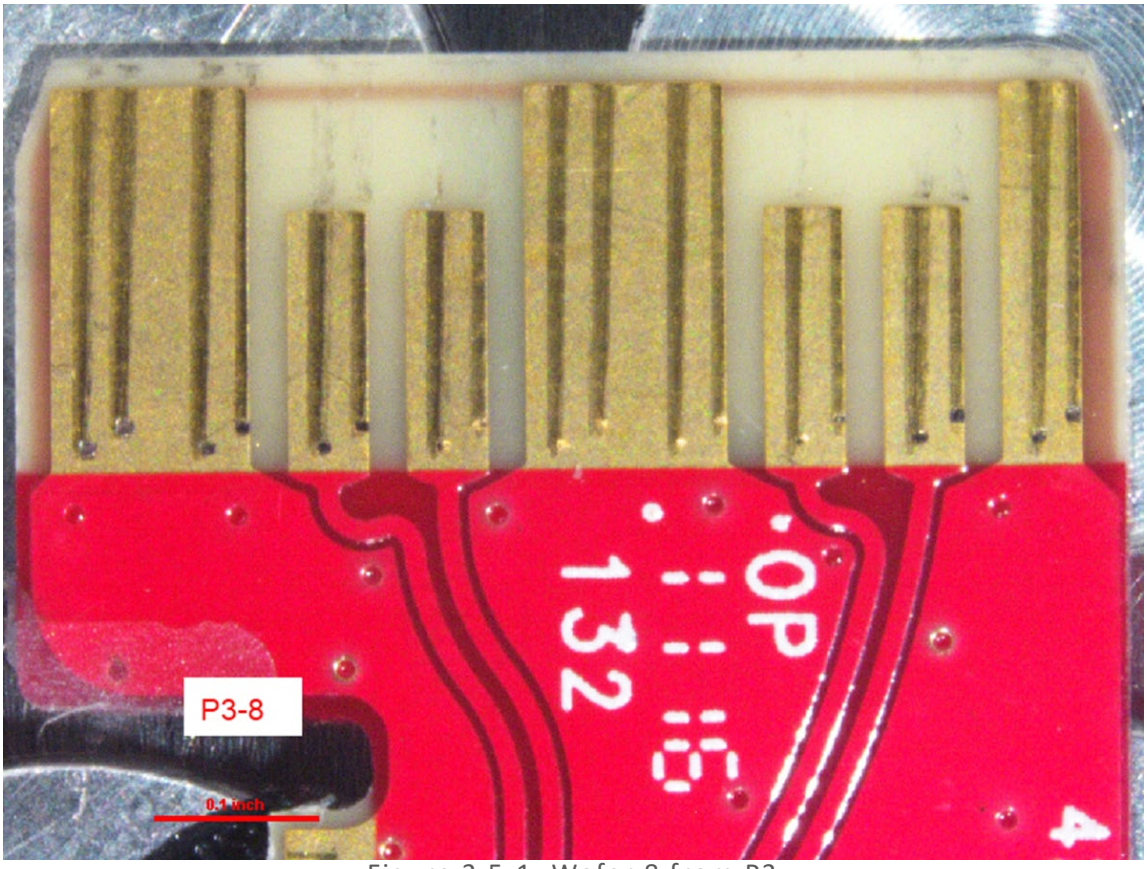


Figure 3.5-1: Wafer 8 from P3

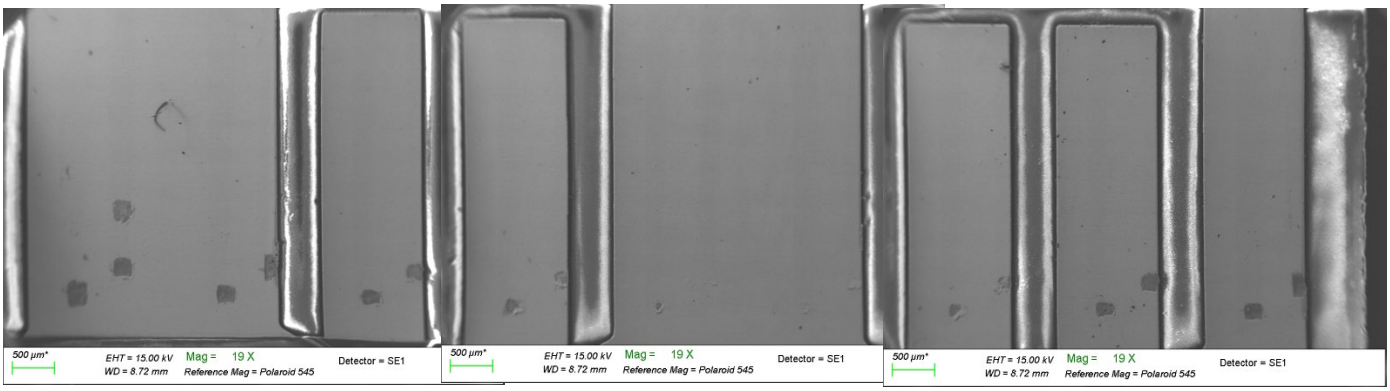
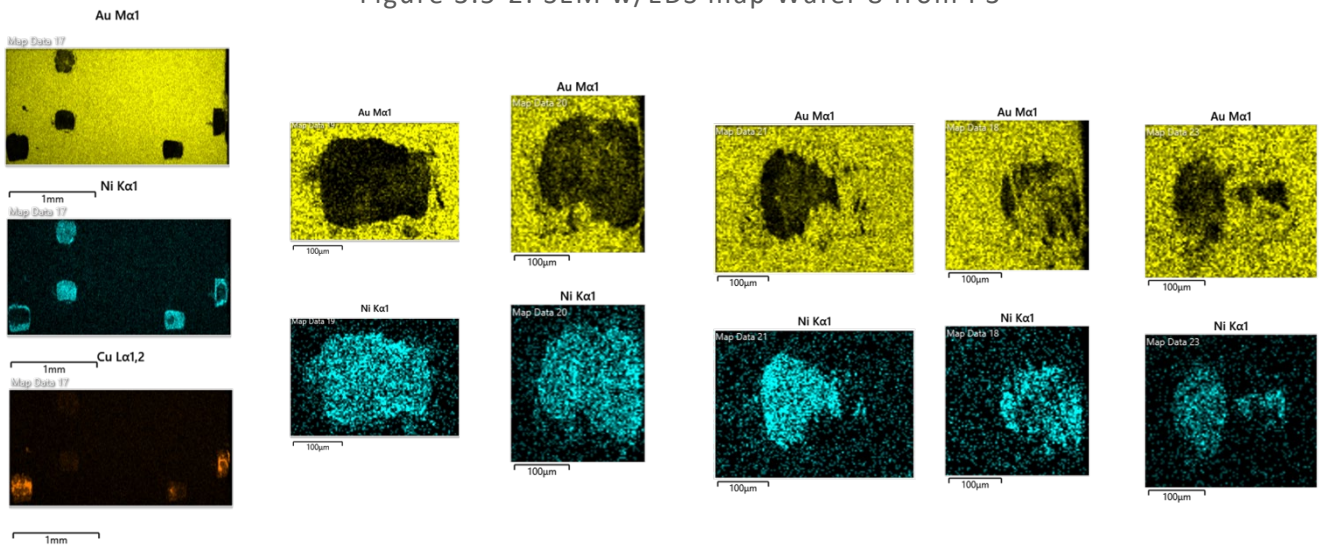


Figure 3.5-2: SEM w/EDS map Wafer 8 from P3



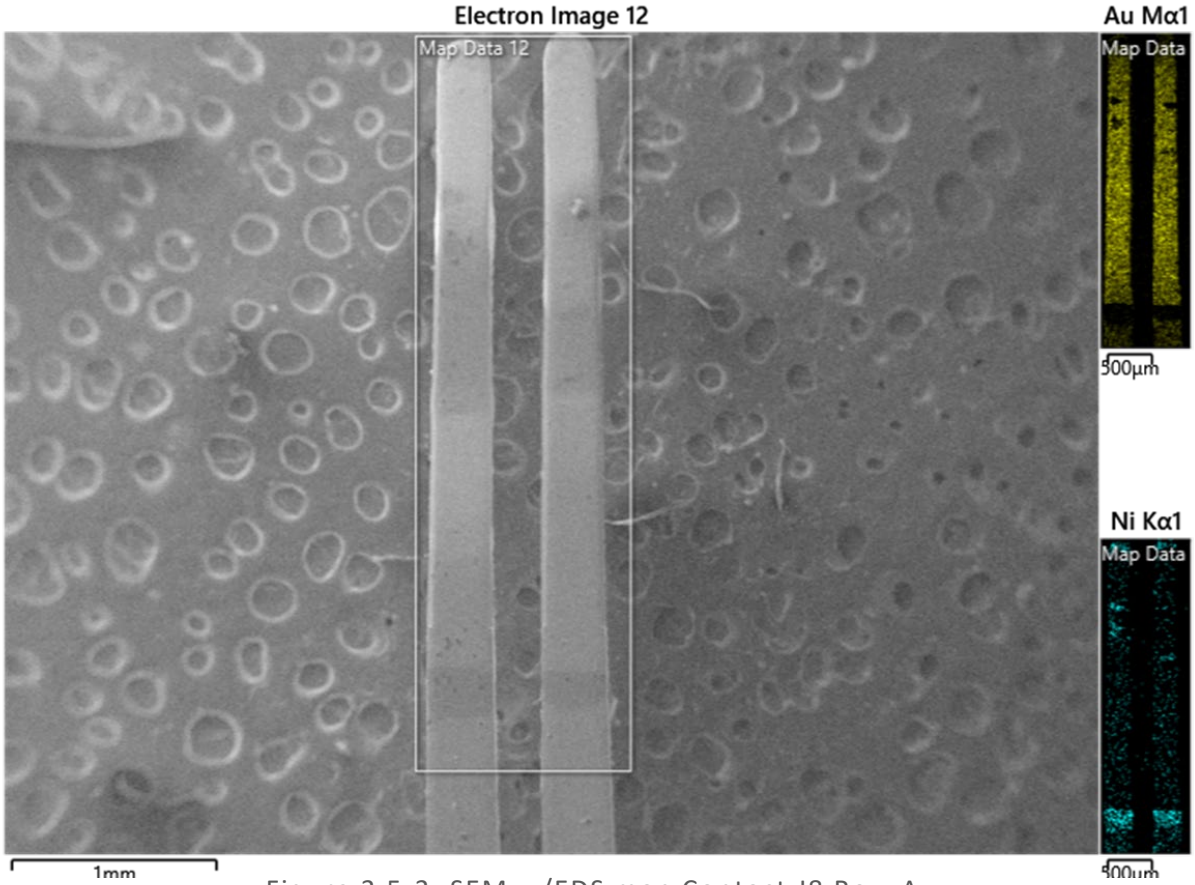


Figure 3.5-3: SEM w/EDS map Contact J8 Row A

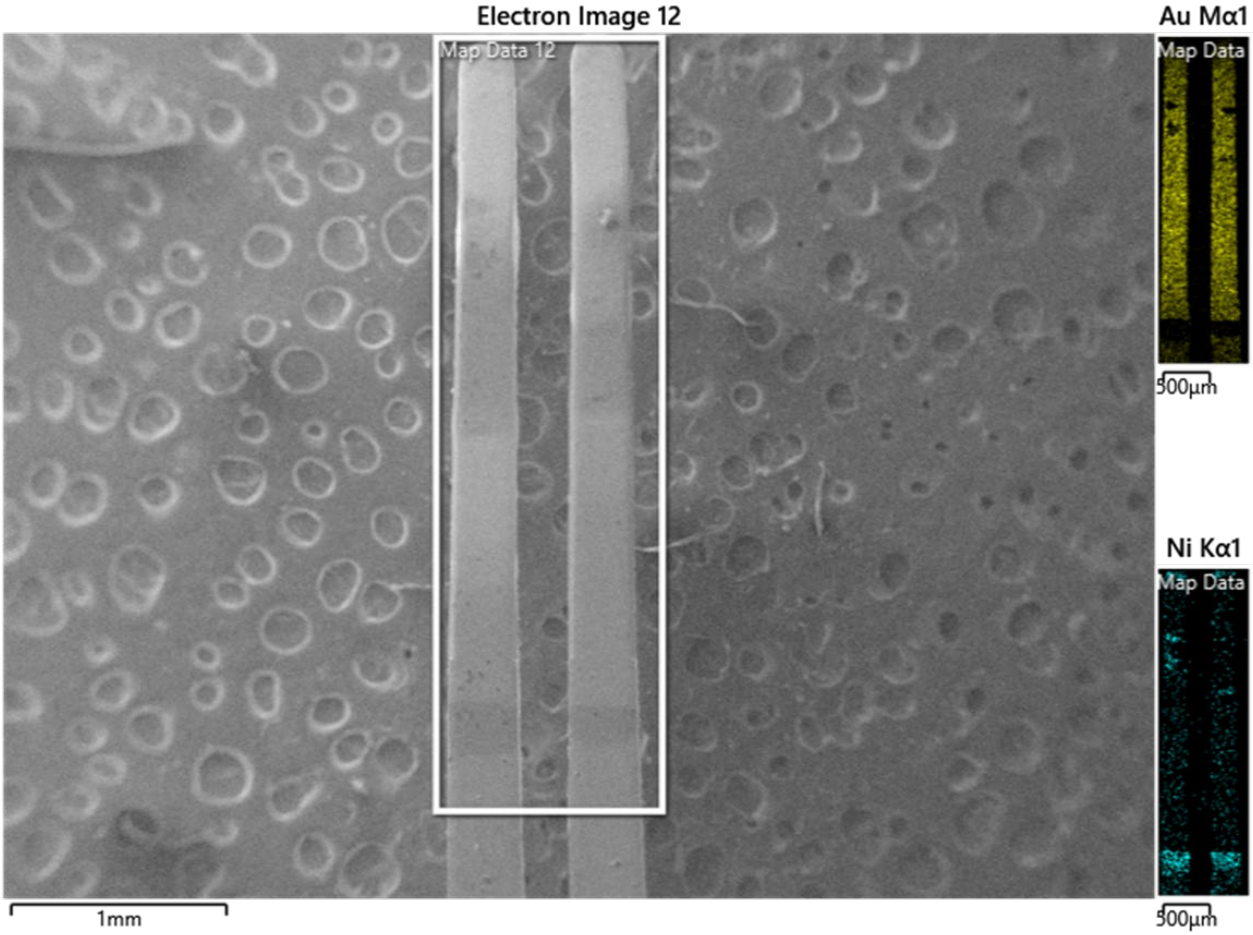


Figure 3.5-4: SEM w/EDS map Contact J8 Row E

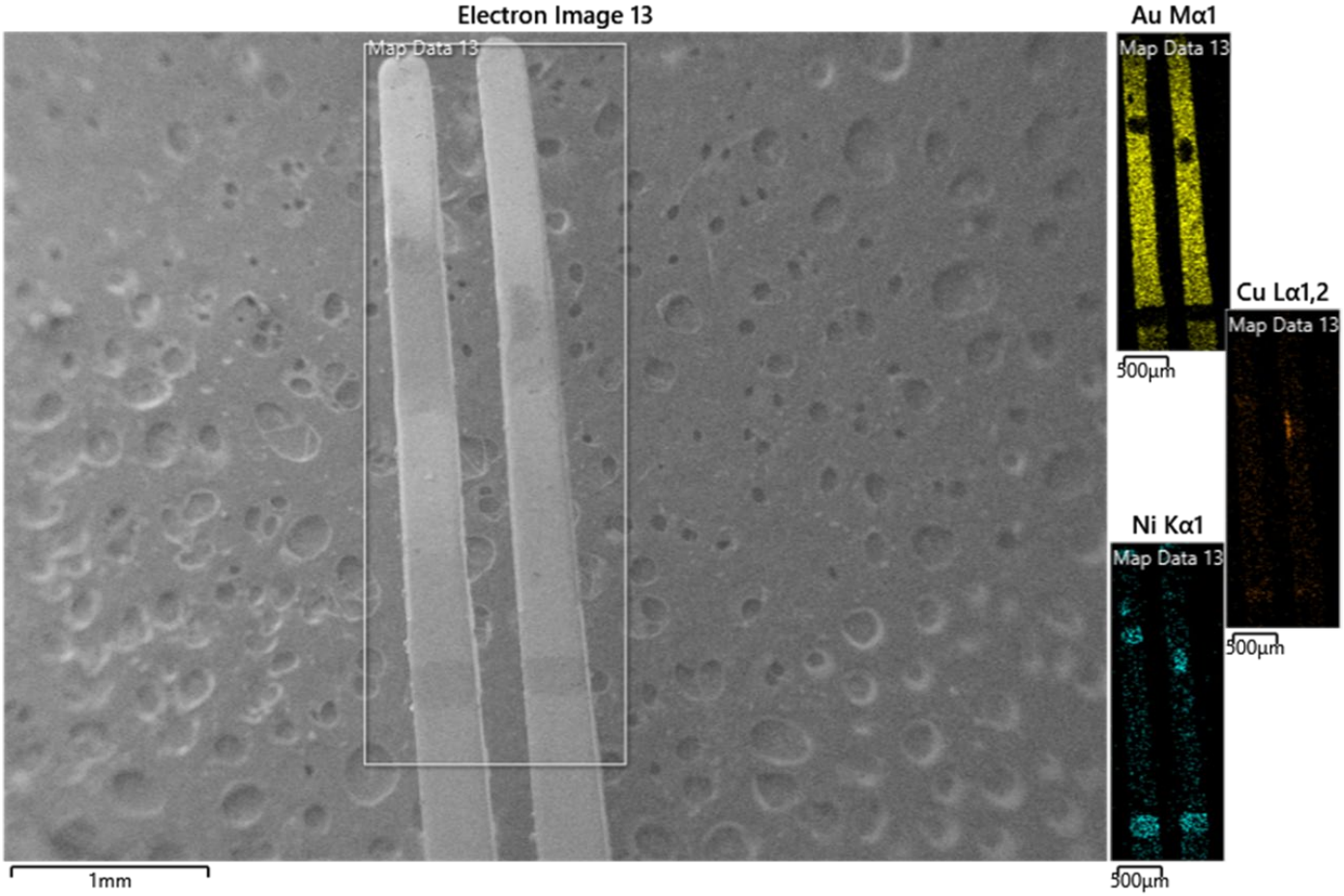


Figure 3.5-5: SEM w/EDS map Contact J8 Row I

4. Conclusions

The R-VPX connectors listed in paragraph 2.1 have passed X, Y, and Z-axis random vibration and sine vibration testing according to the 6U VITA 72 test plan, as well as mechanical shock testing to levels described in the VITA 72 study group report (Sequences A & B) on viper/RT2. The R-VPX connector module also exceeded those limits by passing sequence C. The connectors experienced high/open LLCR readings during sequence D, which constitutes failure, but this sequence was established by the VITA 72 study group as a HALT test. That, in addition to no BERT failures being detected during that (or any other) sequence, demonstrates that the R-VPX connector is at least comparable, if not superior from a ruggedness perspective to competing product, which showed BERT failures in sequence C & LLCR and BERT failures throughout sequence D. Further supporting R-VPX superiority is that the signaling speed was also more stringent on this BERT test than what the VITA 72 study group tested. Since there was no interval LLCR readings during sequence D, Amphenol will re-test at a later date, utilizing LLCR live monitoring in order to learn more about characterizing the HALT sequence LLCR failures. In addition, the test fixture design could have been more representative of an actual 6U rack in the way that the backplane support structure is attached to the base of the fixture, which would reduce the micro-motion translated to the mating interface. This will also be revised prior to the next round of testing.

Amphenol considers R-VPX qualified to the VITA 72 study group test plan, and by similarity, the same qualification now applies to our EVO and EVO2 product which utilize the same mating interface.

Appendix A Test lab report

Test Vibration Test of Vita 72 Sequence D			
Test Specification Vita 72			
Test Item Operational Requirements No cracking, breaking or loosening of connectors. Monitor for bit error Rate			
Contract # 07989VT	Report Prepared By: A.Hosier	Date: 5/10/23	Requested By: K.Tompkins

Type of Test

Broad Band Random
Test duration _1_ hours _0_ minutes.
Test performed in each of three mutual perpendicular axes.
Test performed at ambient temperature

Test Profile								
Freq. Hz	Velocity In/Sec	Displace. In D.A.	Acceler. G Pk	PSD G^2/Hz	Overall G RMS	Roll Up dB/Oct	Roll Off dB/Oct	Remarks
5				.002				
13				.04				
140				.04				
160				.1				
1100				.1				
2000				.025				

Type of Test

Swept Sine, sweep time _10_ minutes, from _5_ to _2000_ hertz.

Test duration _1_ hours _0_ minutes.

Test performed in each of three mutual perpendicular axes.

Test performed at ambient temperature

Test Profile								
Freq. Hz	Velocity In/Sec	Displace. In D.A.	Acceler. G Pk	PSD G^2/Hz	Overall G RMS	Roll Up dB/Oct	Roll Off dB/Oct	Remarks
5			.95					
15			8.628					
16			10					
2000			10					

Type of Test

Basic Shock ½ Sine

Level: 80G and 50G

Test performed in each of three mutual perpendicular axes.

Test performed at ambient temperature

Sample Identification:

SEE TABLE 1

Purpose of Test:

Determine the performance of the R-VPX connector in harsh environments typical of military/aerospace requirements.

Set-Up Details:

- The harnesses were tied to a mounting point which did vibrate with the samples.
- Contacts monitored for BERT by Engineering, during vibration.

Vibration Results:

- Post visual showed no damage detrimental to the operation of the connector.

Discrepancies:

- None

Item	Mnfg	Model	Ident. No.	Cal Date	Due Date
X Vibration, Shaker	Ling	D-390	IC-4949	NA	NA
X Power Amplifier	DTS	D24	IC-4949	NA	NA
□ Vibration, Shaker	Ling	A-395	F-1910		
□ Power Amplifier	Ling	DMA-6XE	F-1910		
X Digital Vibration Controller	UD	T2000	IC-4950	8/16/22	8/15/23
□ Digital Vibration Controller	VR	VR9500	IC-4793		
□ Digital Thermometer	Fluke	2176A	F-2254		
□ Temperature Chamber	Std Env Sys	SLHV/15.5	F-1914		
□ Video Chart Recorder	Honeywell	Minitrend	IC-4680		
□ Temperature Chamber	Std Env Sys	CLHV-10	F-2352		

☐ Video Chart Recorder	Honeywell	Minitrend	IC-4682		
☐ Event Detector	Analysis Tech	32-106	IC-4684		
☐ Event Detector	Analysis Tech	128-105	IC-4683		
☐ Shock Machine, Mechanical	AVCO	SM110-MP	F-2558		
☐ Oscilloscope, Digital	Tektronics	TPS-2024	IC-4573		
☐ Filter, Bandpass	Krohn-Hite	3362	IC-4844		
☐ Charge Amplifier	Kistler	5010B	IC-4916		
X Charge Amplifier	U-D	CVA-4	IC-3873	7/15/22	6/14/23
☐ Charge Amplifier	U-D	CVA-4	IC-4156		
☐ Charge Amplifier	U-D	CVA-4	IC-4157		
☐ Charge Amplifier	U-D	CVA-4	IC-4158		
X Accelerometer	Endevco	2271AM20	IC-5967	1/12/23	7/11/23
☐ Accelerometer	Endevco				
☐ Accelerometer	Endevco				
☐ Accelerometer	Endevco				
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Test Item(s): See Above									Test Identification Number 10825	
Test Requirement(s) No Cracking, breaking or loosening									Tested By: A.Hosier	
Date	Start Time	Stop Time	Elapsed Time	Total Elapsed Time	Test Temp	Vibe Axis	Sample No(s)	Tech	Notes (see below)	Remarks
4/14/23	1125	1225	1:00:00	1:00:00	AMB	Y	1	AH	NA	L3 Sine – Bert issue
4/14/23	1230	1330	1:00:00	1:00:00	AMB	Y	1	AH	NA	L3 Random
4/14/23	----	----	----	----	AMB	Y	1	AH	NA	80G Shock
4/14/23	0826	0926	1:00:00	1:00:00	AMB	Y	1	AH	NA	L3 Sine
4/17/23	1005	1014	0:09:00	0:09:00	AMB	X	1	AH	NA	Sine Sweep
4/17/23	1020	1120	1:00:00	1:00:00	AMB	X	1	AH	NA	L3 Sine
4/17/23	1123	1223	1:00:00	1:00:00	AMB	X	1	AH	NA	L3 Random
4/17/23	----	----	----	----	AMB	X	1	AH	NA	80G Shock
4/27/23	0901	1001	1:00:00	1:00:00	AMB	X	1	AH	NA	L3 Sine
4/27/23	1002	1011	0:09:00	0:09:00	AMB	X	1	AH	NA	L3 Random – Bert issue
4/27/23	1104	1204	1:00:00	1:00:00	AMB	X	1	AH	NA	L3 Random

4/27/23	1502	1602	1:00:00	1:00:00	AMB	Z	1	AH	NA	L3 Sine
4/27/23	1608	1708	1:00:00	1:00:00	AMB	Z	1	AH	NA	L3 Random
4/27/23	----	----	----	----	AMB	Z	1	AH	NA	50G Shock

Notes: 1. Contacts wired in series and monitored for discontinuities of one/ten micro-sec or greater. 2. Plug coupling nuts torqued and matched marked for visual indication of movement. 3. No discontinuity occurred. 4. Discontinuity occurred. 5 No coupling nut movement occurred. 6. Coupling nut movement occurred.

Test Item(s): See Above									Test Identification Number 10825	
Test Requirement(s) No Cracking, breaking or loosening									Tested By: A.Hosier	
Date	Start Time	Stop Time	Elapsed Time	Total Elapsed Time	Test Temp	Vibe Axis	Sample No(s)	Tech	Notes (see below)	Remarks
4/28/23	0701	0801	1:00:00	1:00:00	AMB	Z	1	AH	NA	L3 Sine
4/28/23	0805	0905	1:00:00	1:00:00	AMB	Z	1	AH	NA	L3 Random
4/28/23	----	----	----	----	AMB	Z	1	AH	NA	50G Shock
4/28/23	0955	1055	1:00:00	1:00:00	AMB	Y	1	AH	NA	L3 Sine
4/28/23	1056	1156	1:00:00	1:00:00	AMB	Y	1	AH	NA	L3 Random
4/28/13	----	----	----	----	AMB	Y	1	AH	NA	80G Shock
4/28/23	1224	1324	1:00:00	1:00:00	AMB	X	1	AH	NA	L3 Sine
4/28/23	1325	1425	1:00:00	1:00:00	AMB	X	1	AH	NA	L3 Random
4/28/23	----	----	----	----	AMB	X	1	AH	NA	80G Shock
4/28/23	1522	1622	1:00:00	1:00:00	AMB	X	1	AH	NA	+3 dB Random
5/01/23	0710	0810	1:00:00	1:00:00	AMB	Y	1	AH	NA	+3 dB Random
5/01/23	0911	0912	1:00:00	1:00:00	AMB	Z	1	AH	NA	+3 dB Random Failed Bert
5/01/23	1200	1300	1:00:00	1:00:00	AMB	Z	1	AH	NA	+3 dB Random
5/01/23	1400	1600	2:00:00	2:00:00	AMB	Z	1	AH	NA	+3 dB Random – 12Hr
5/02/23	0614	1358	7:44:00	9:44:00	AMB	Z	1	AH	NA	+3 dB Random – 12Hr
5/03/23	0611	0827	2:16:00	12:00:0	AMB	Z	1	AH	NA	+3 dB Random – 12Hr

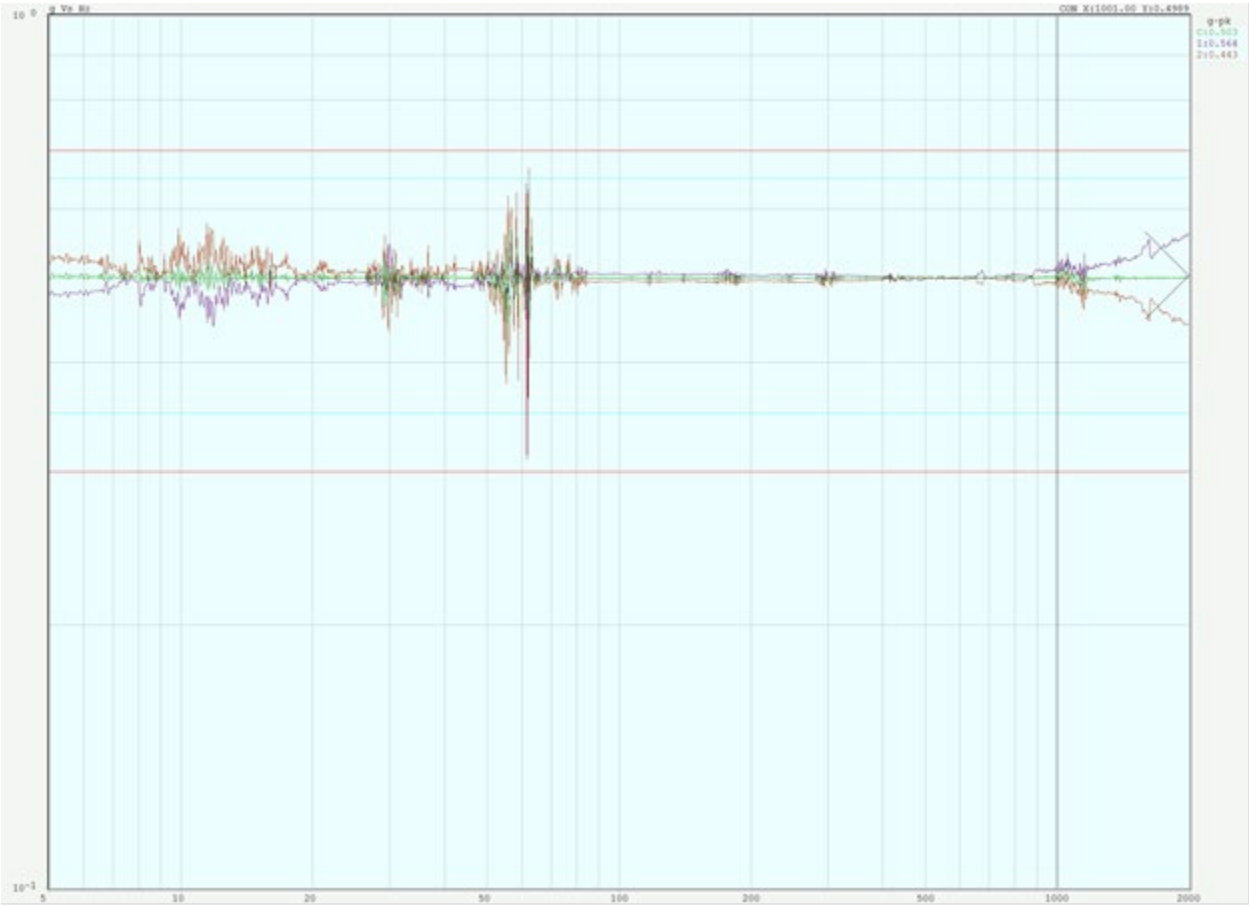
Notes: 1. Contacts wired in series and monitored for discontinuities of one/ten micro-sec or greater. 2. Plug coupling nuts torqued and matched marked for visual indication of movement. 3. No discontinuity occurred. 4. Discontinuity occurred. 5 No coupling nut movement occurred. 6. Coupling nut movement occurred.

Vibration Profile – Representative

Random

Sine

Random +3dB



X axis sine sweep just the fixture

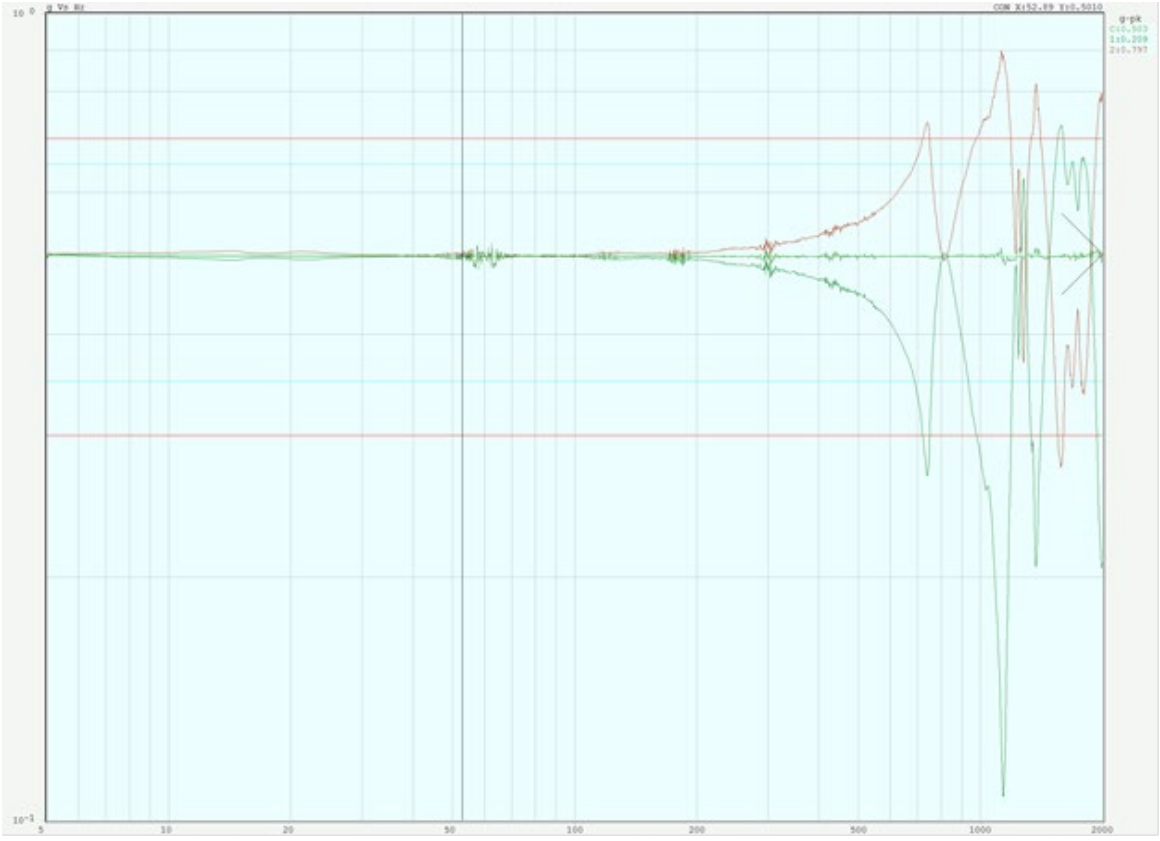
X axis sine sweep with fixture and backplane

X axis Sine Sweep, Fixture, backplane and cables

X axis Sine Sweep Whole assembly

Z axis sine sweep with just the fixture

Z axis Sine Sweep with fixture and backplane

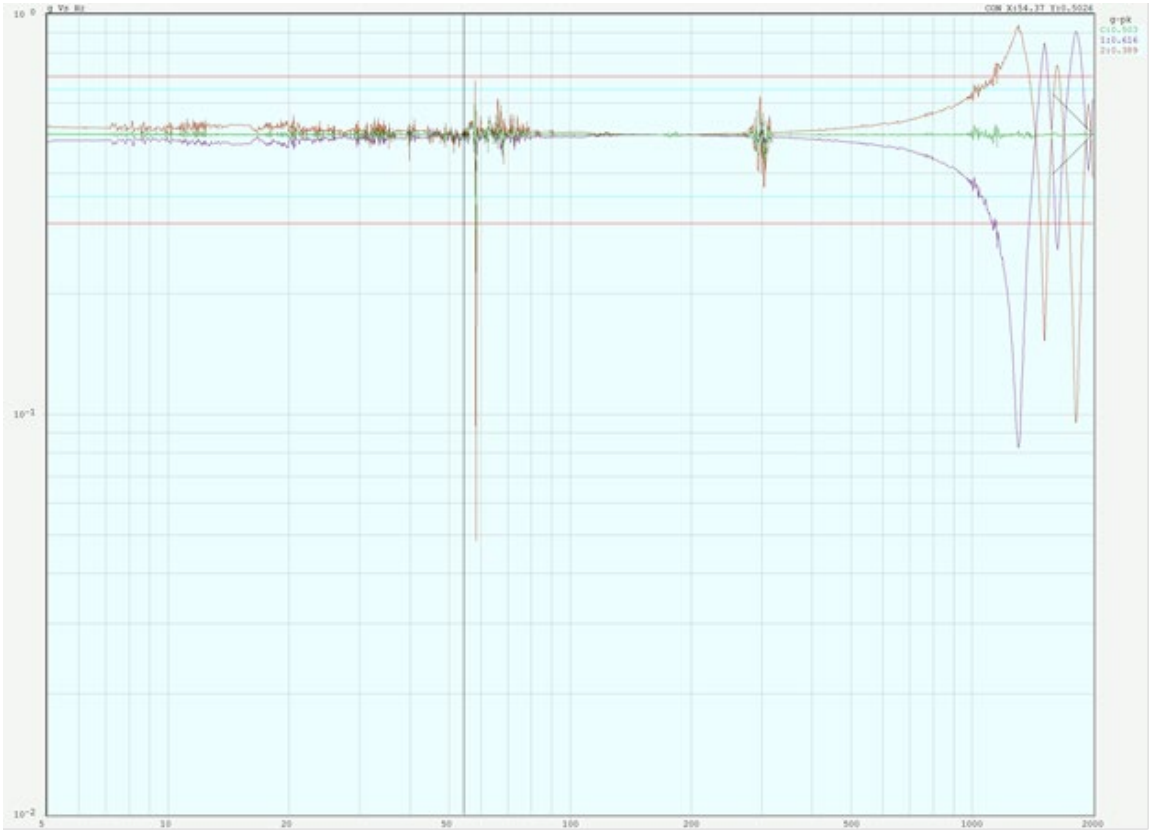


Z axis sine sweep fixture, backplane and cables

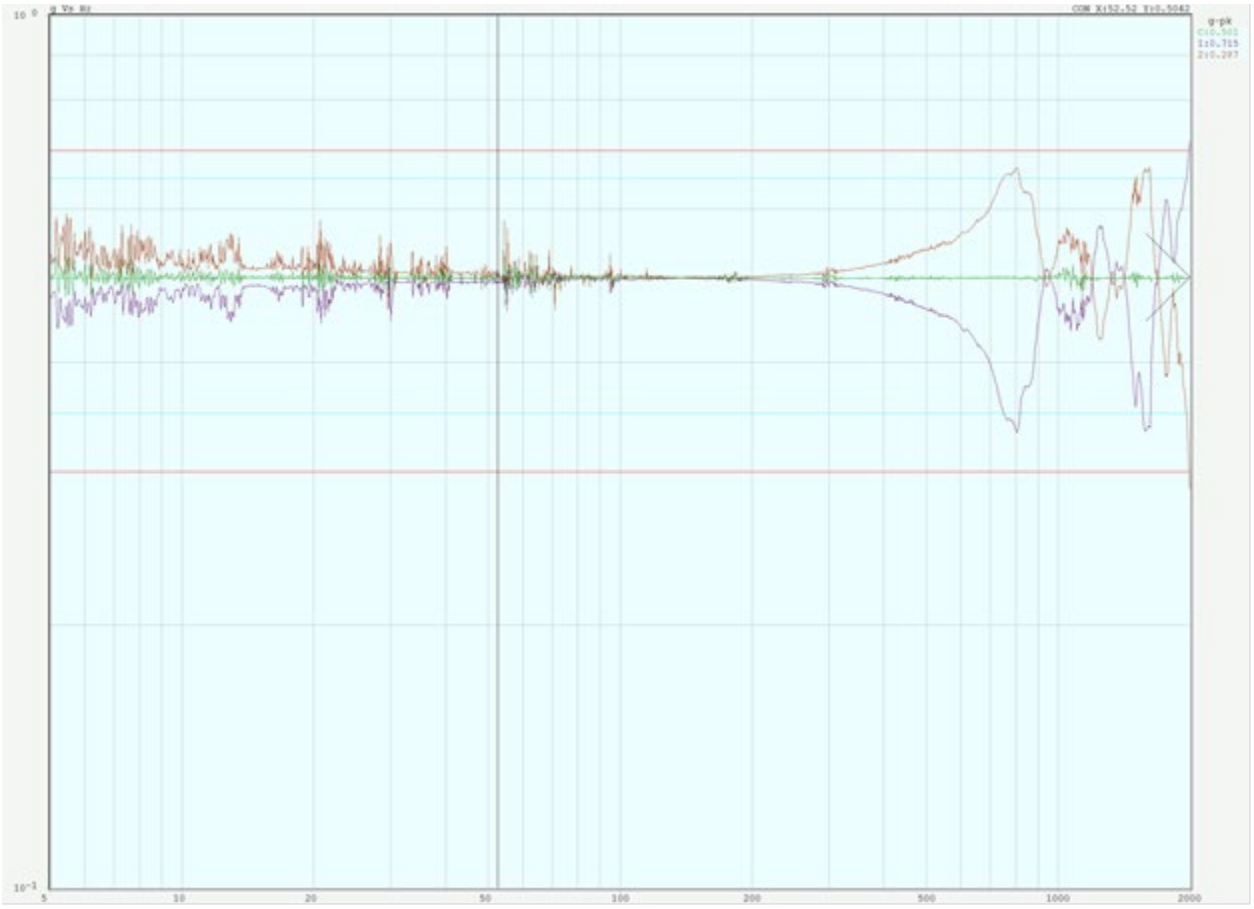
Z axis with whole assembly

Y axis sine sweep bare fixture

Y axis sine sweep fixture and backplane



Y axis sine sweep with fixture back plane and cables

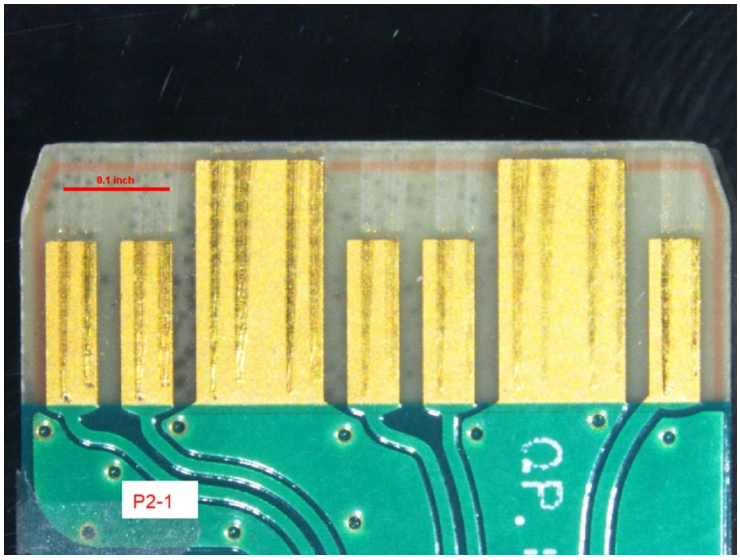


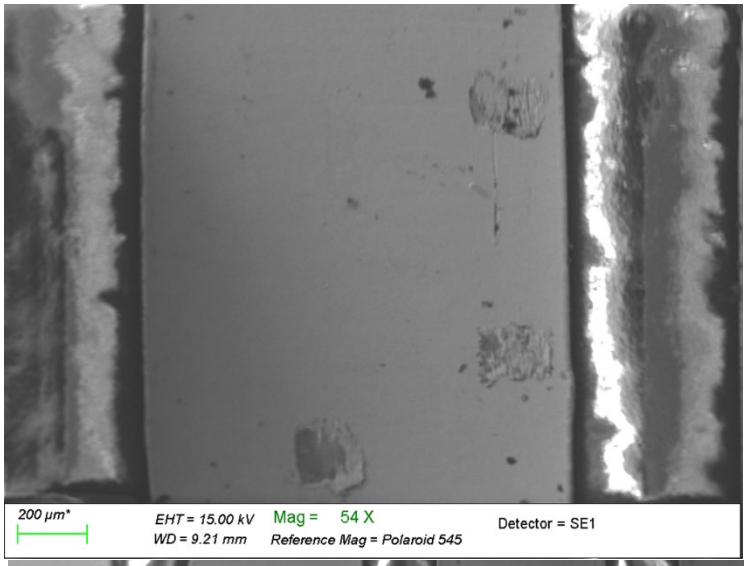
Y axis sine sweep whole assembly

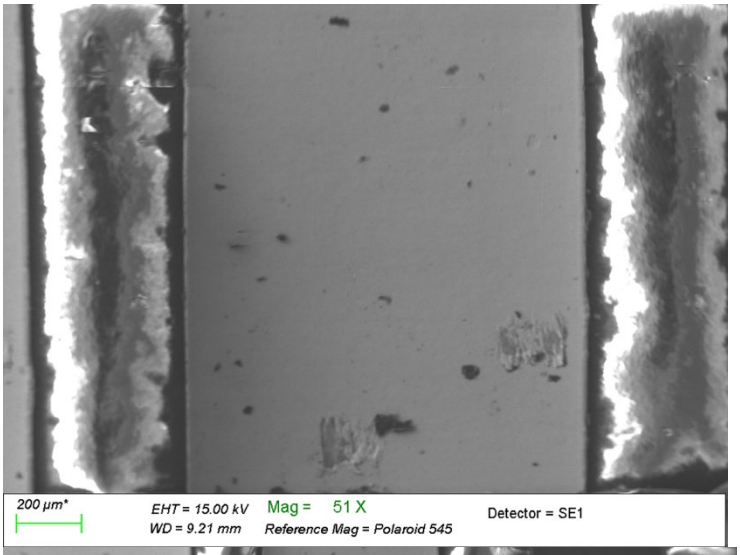
Z Axis Random First Run

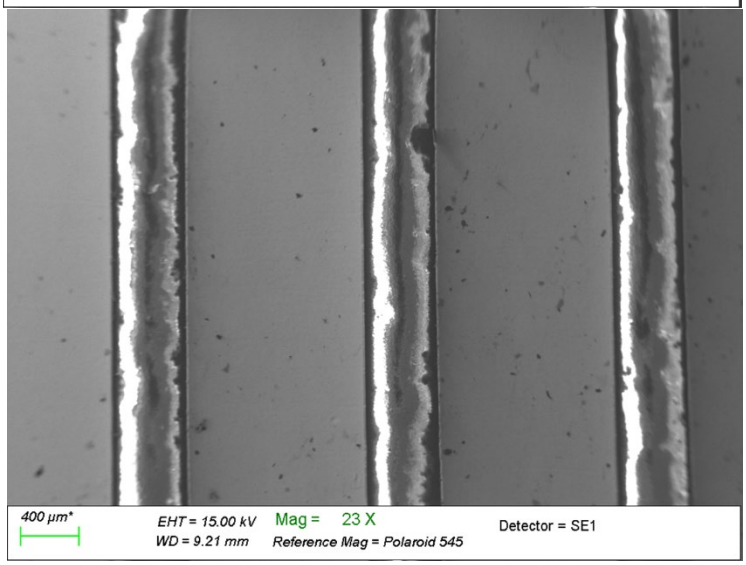
Appendix B SEM and EDS map images

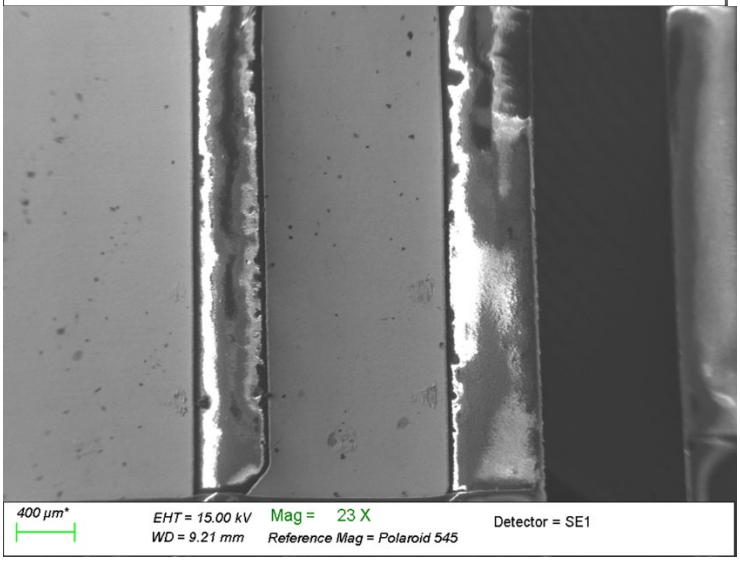
Appendix B P2-1: Position P2 wafer 1

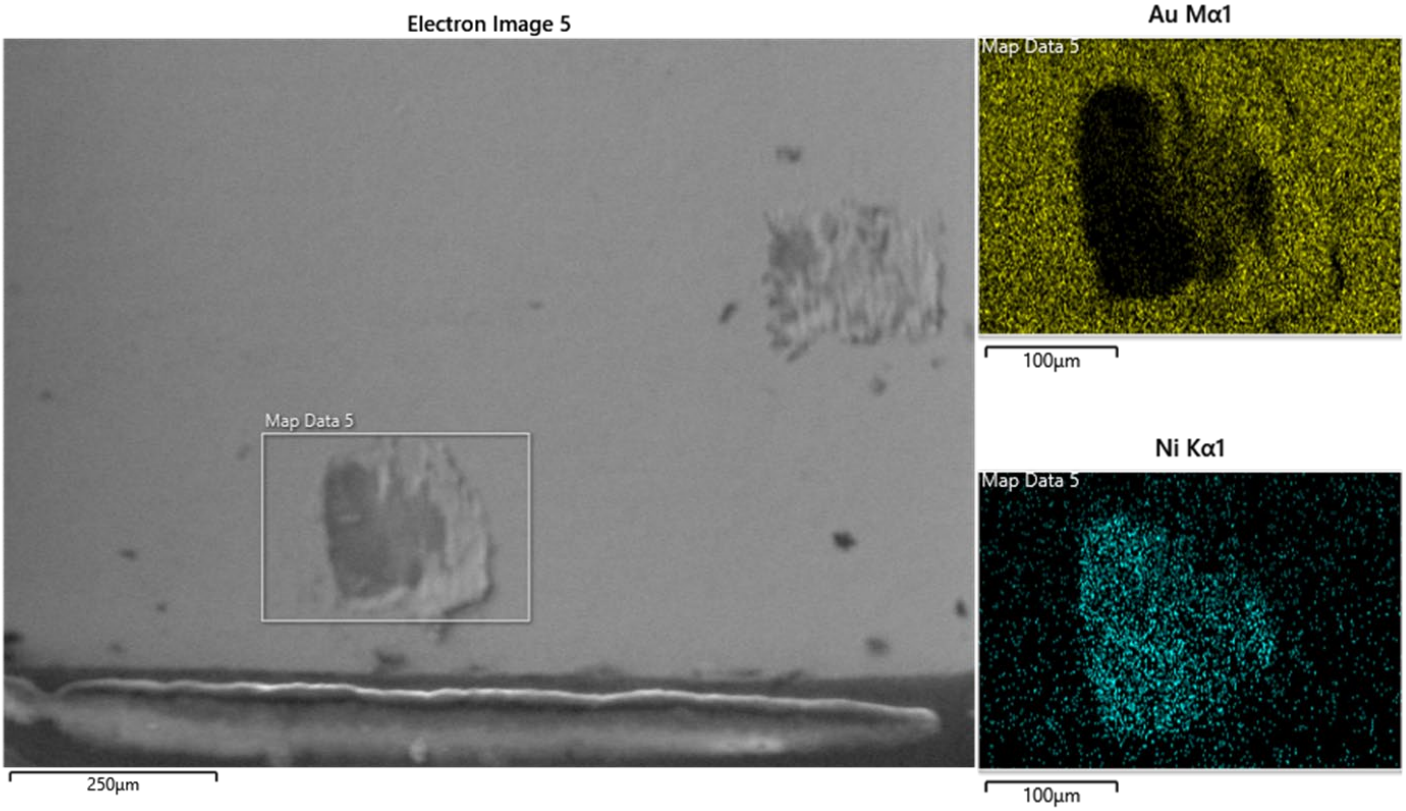


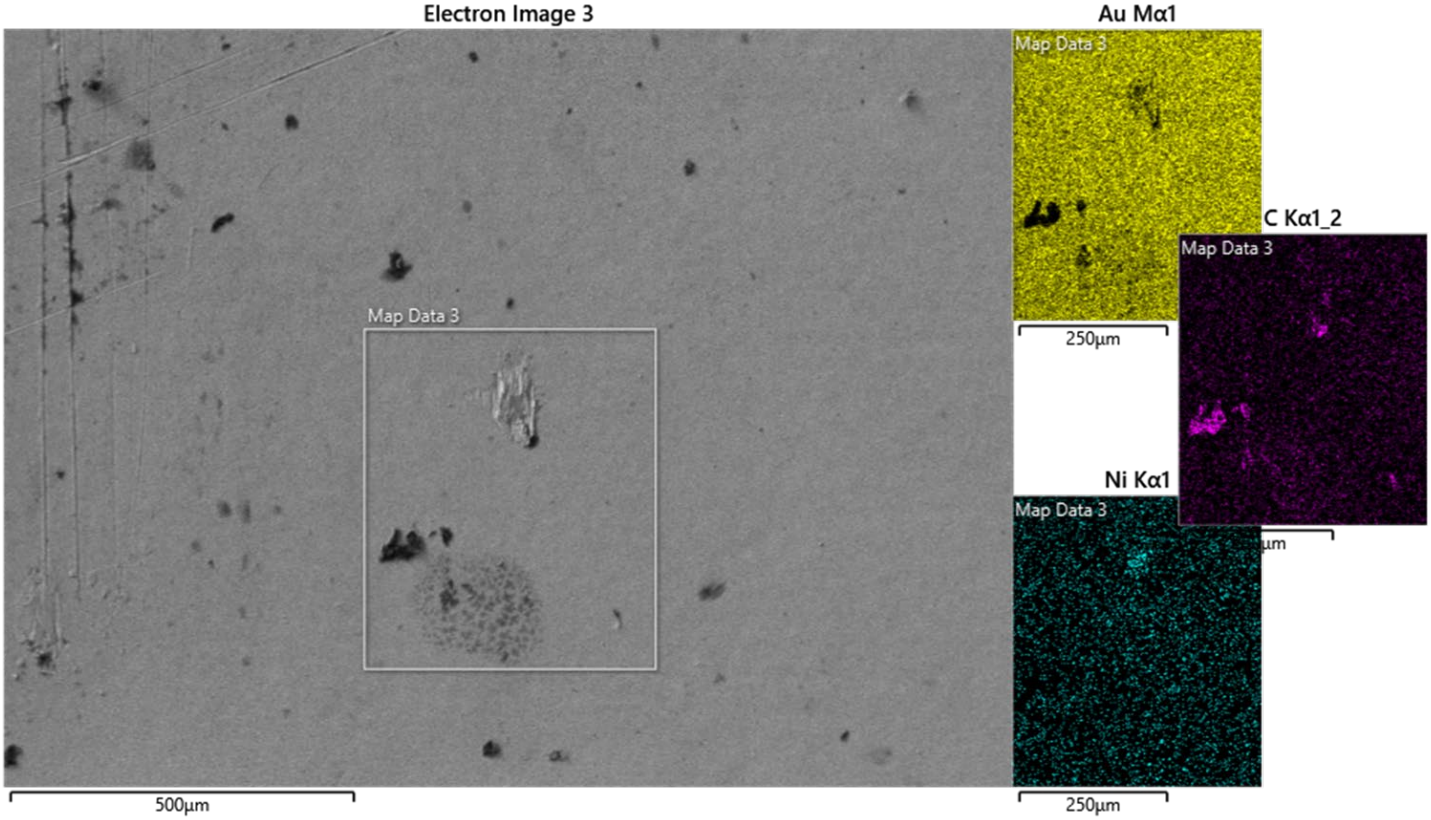




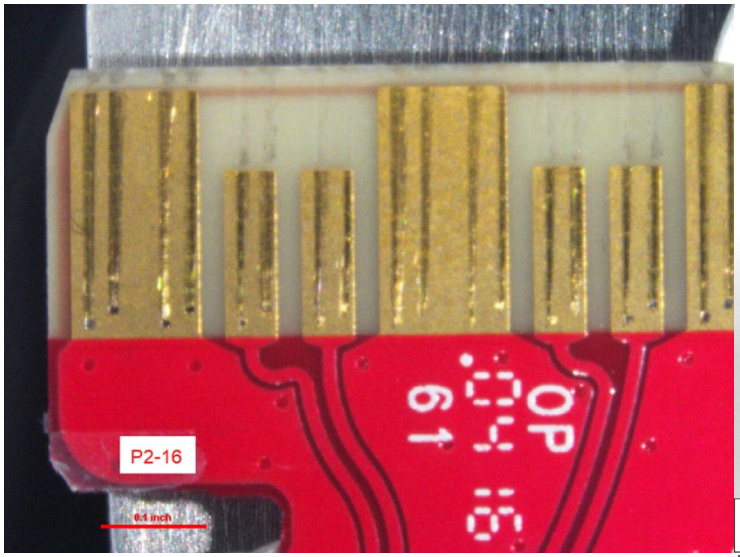


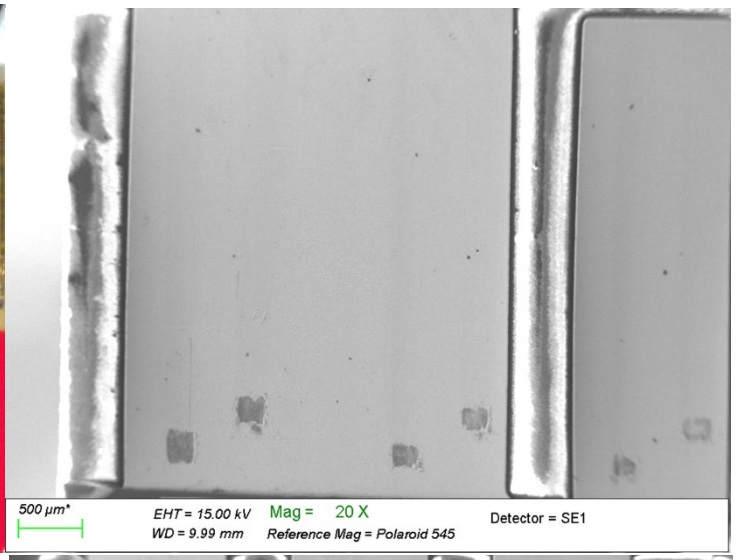


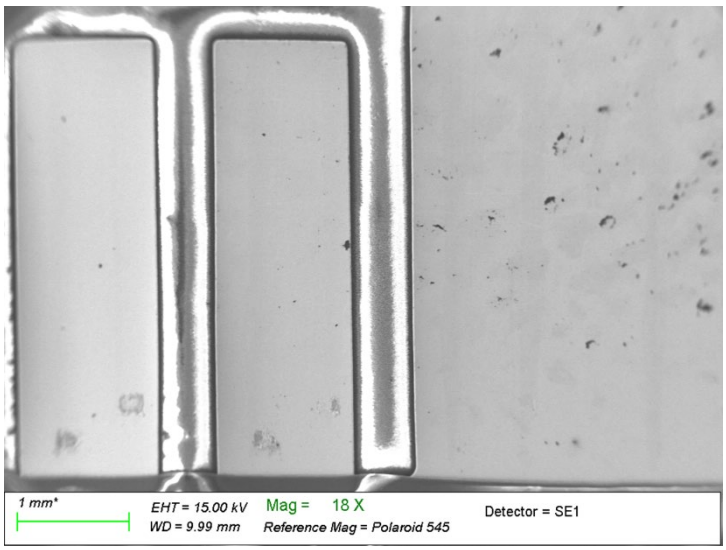


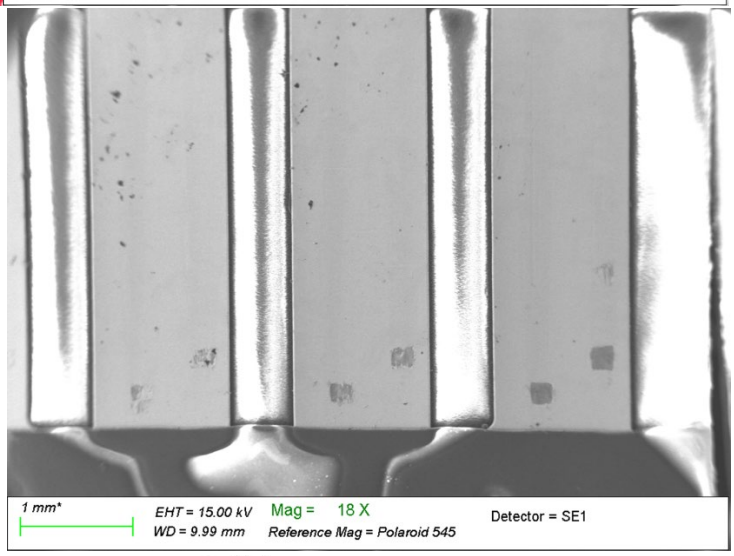


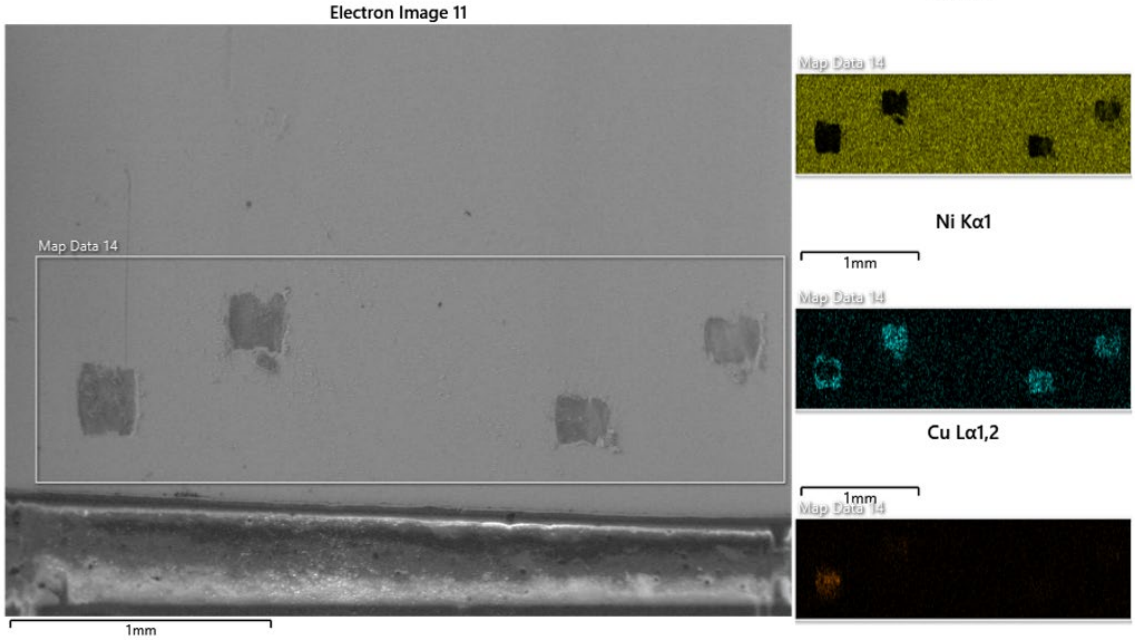
Appendix B P2-16: Position P2 wafer 16

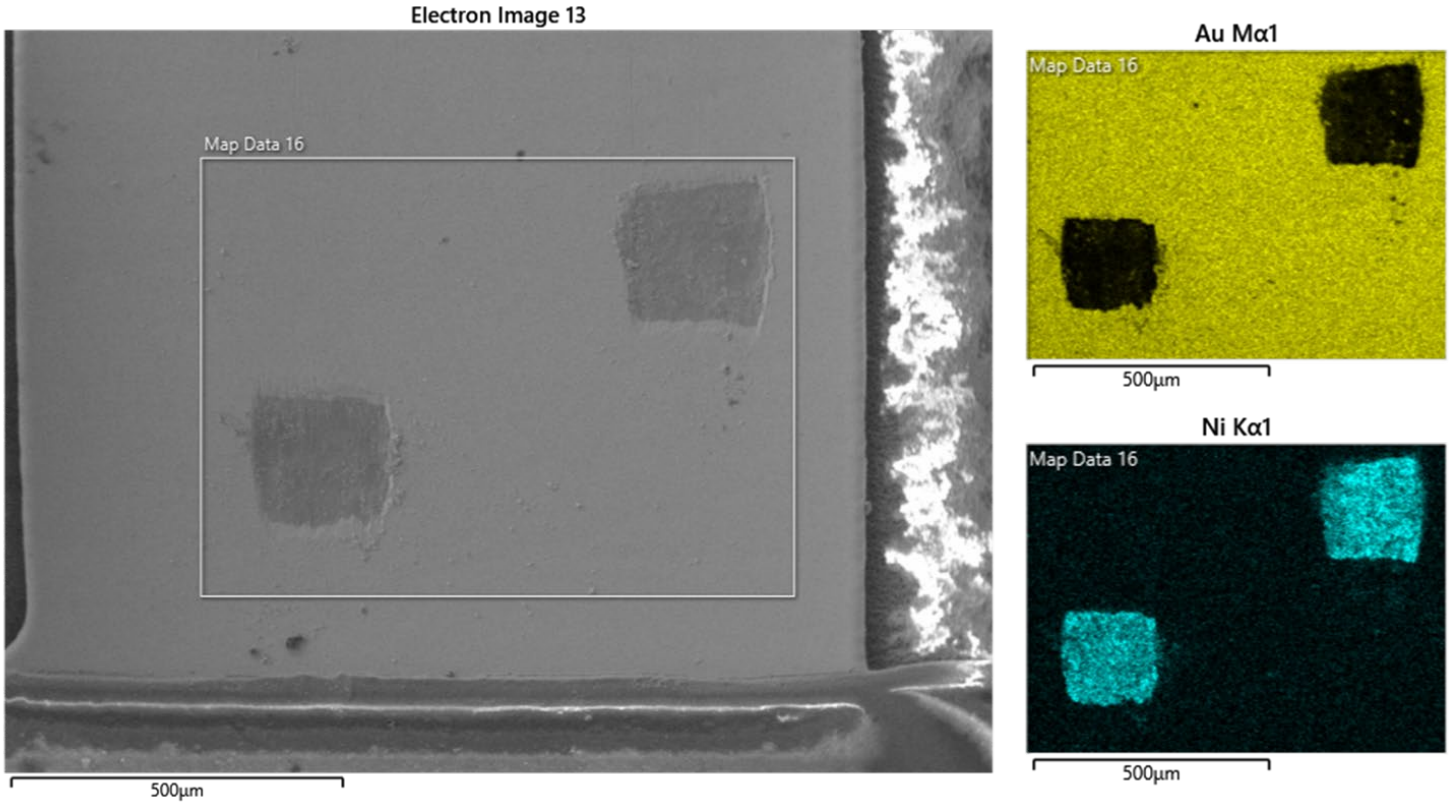




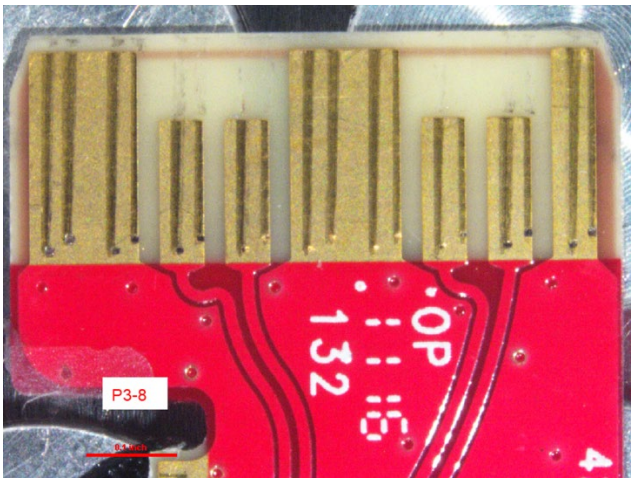


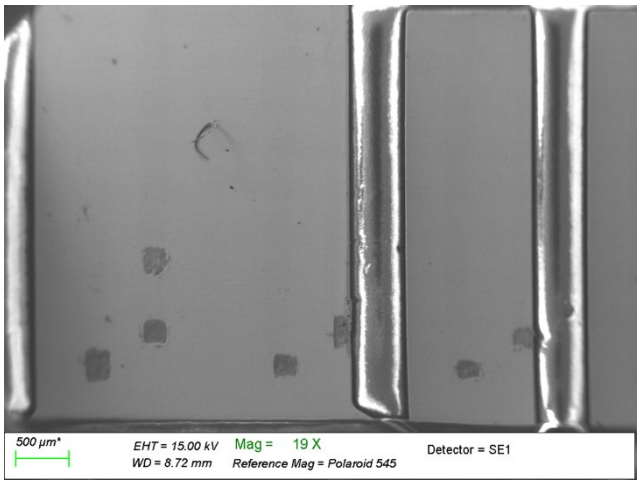


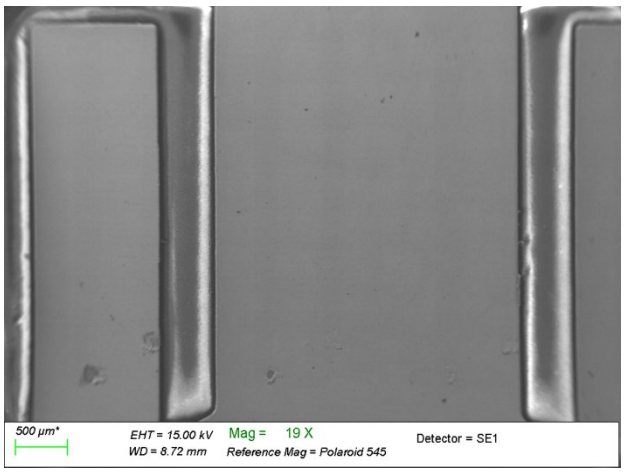


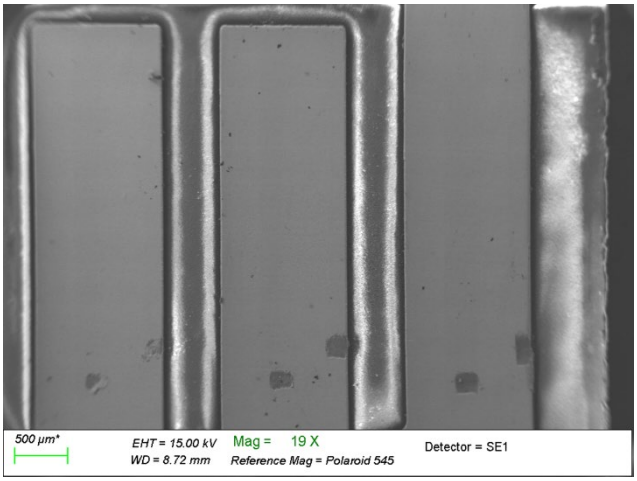


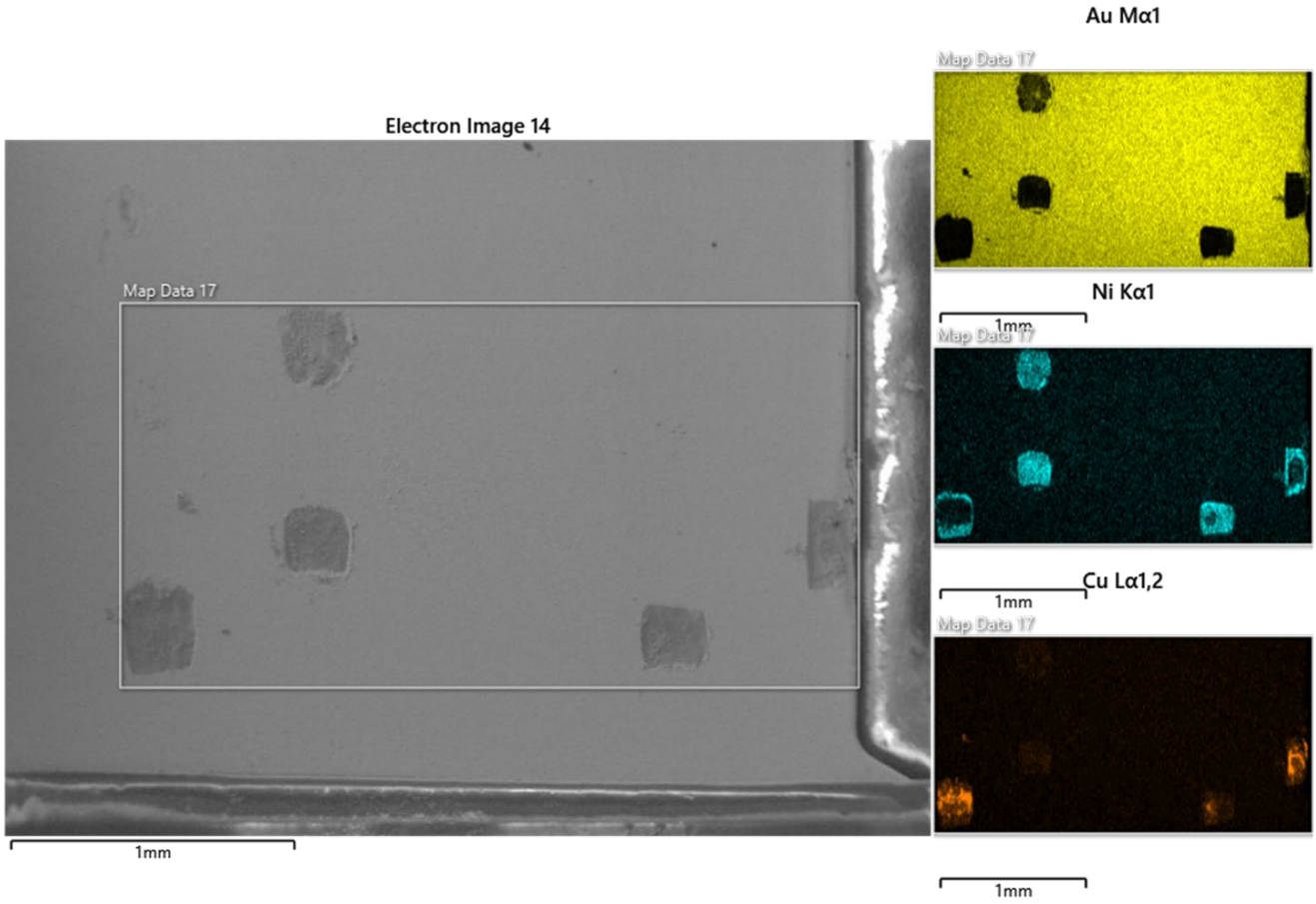
Appendix B P3-8: Position P3 wafer 8

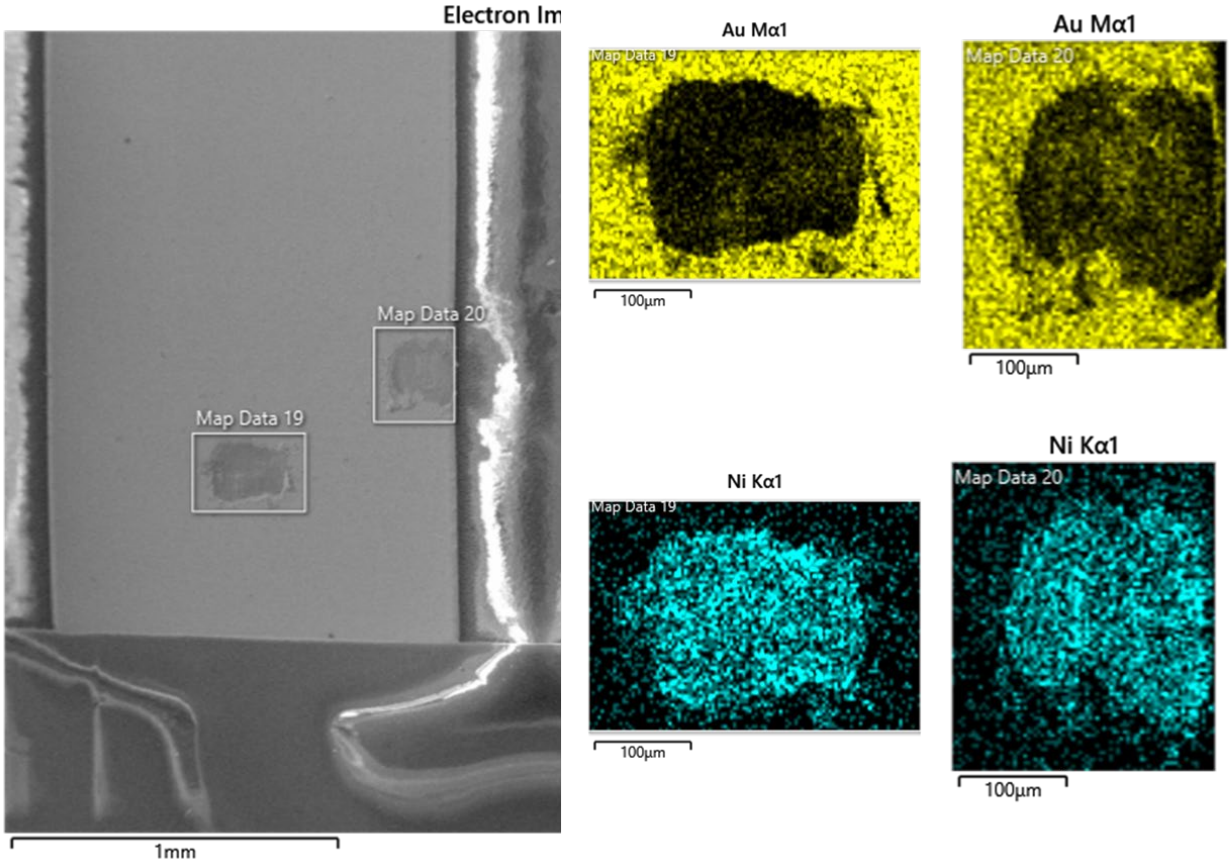


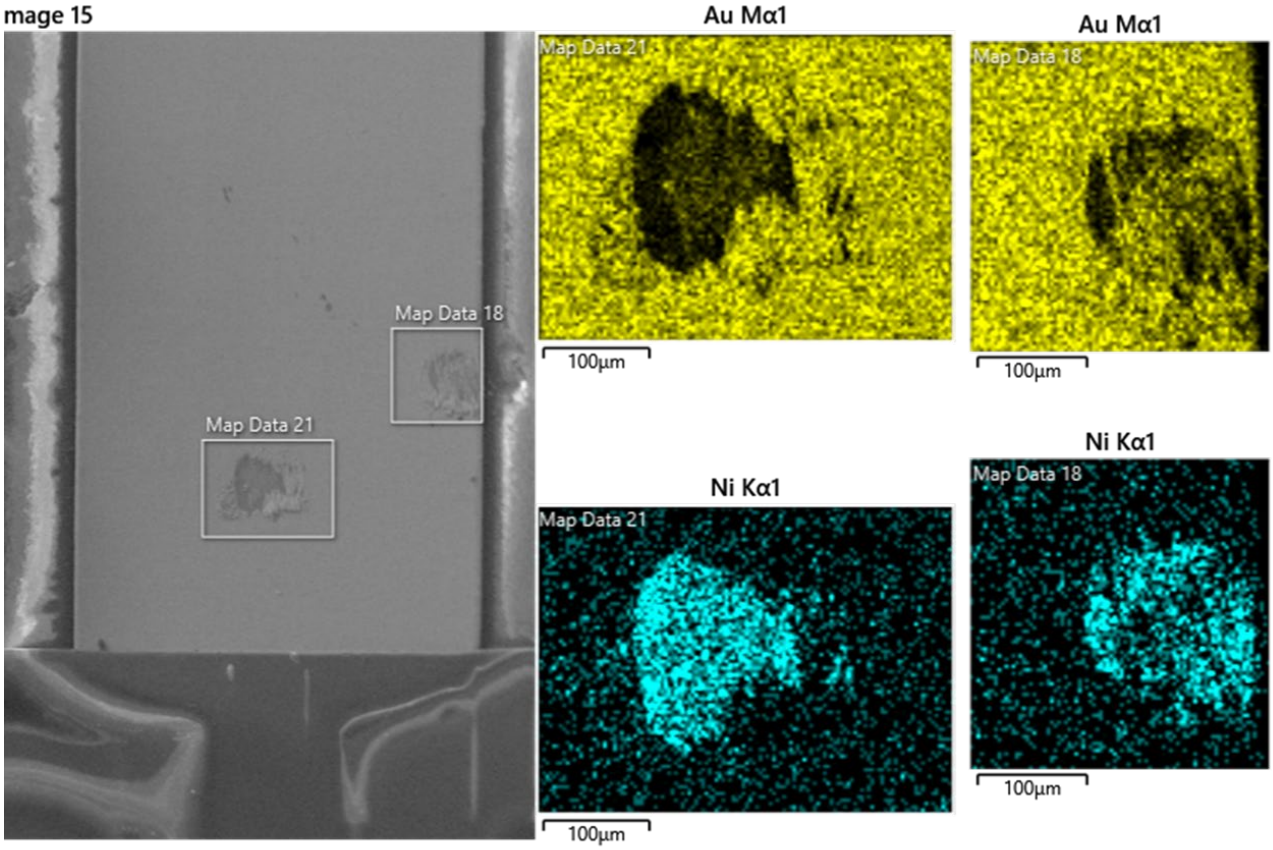


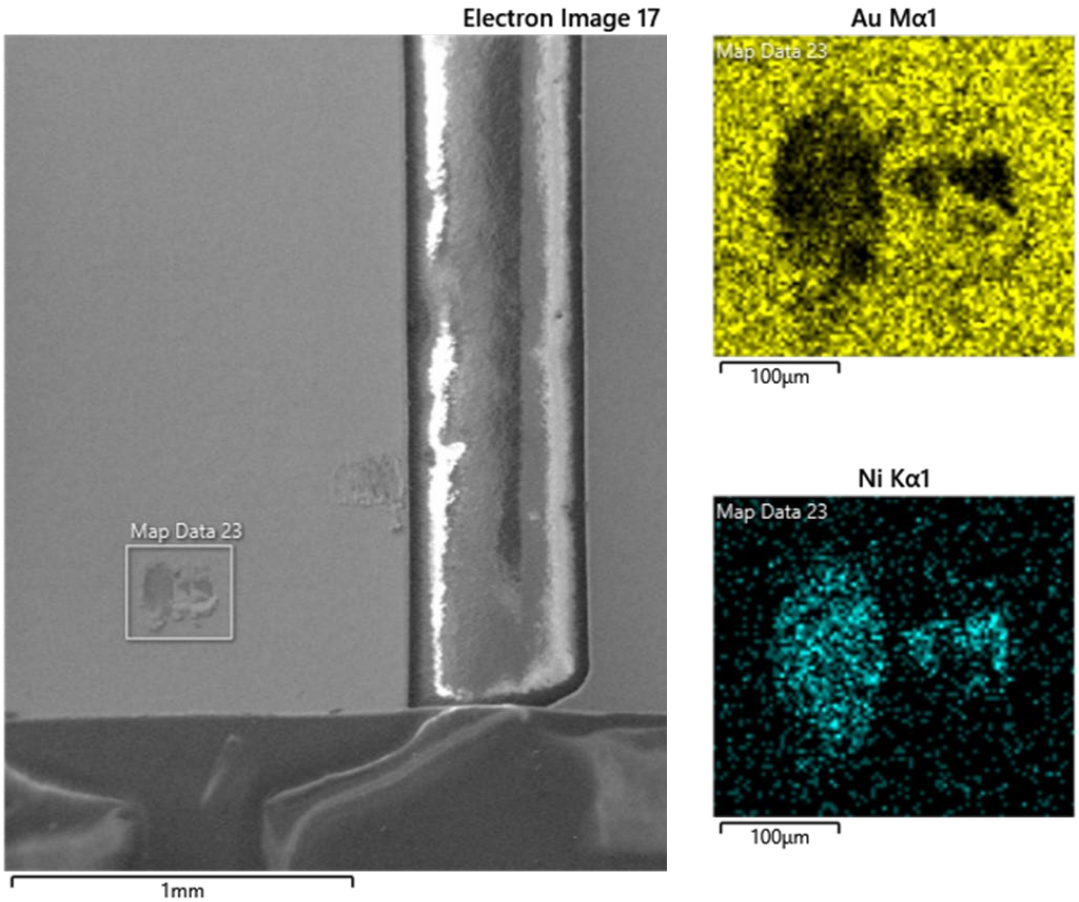




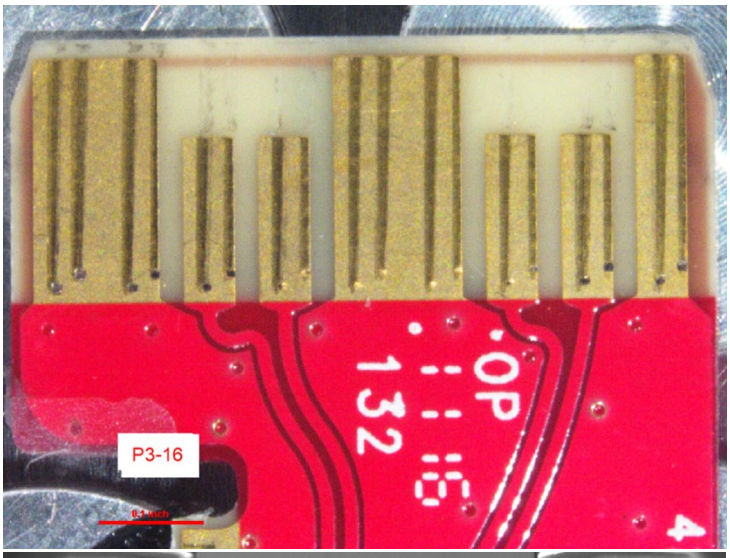


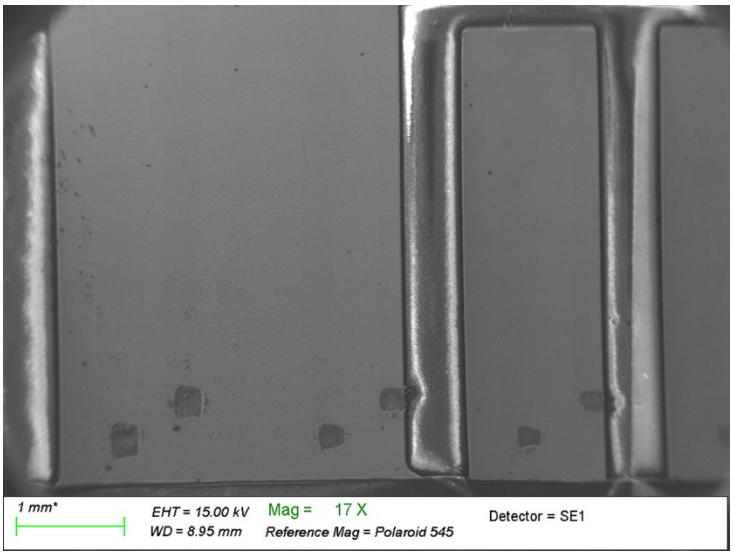


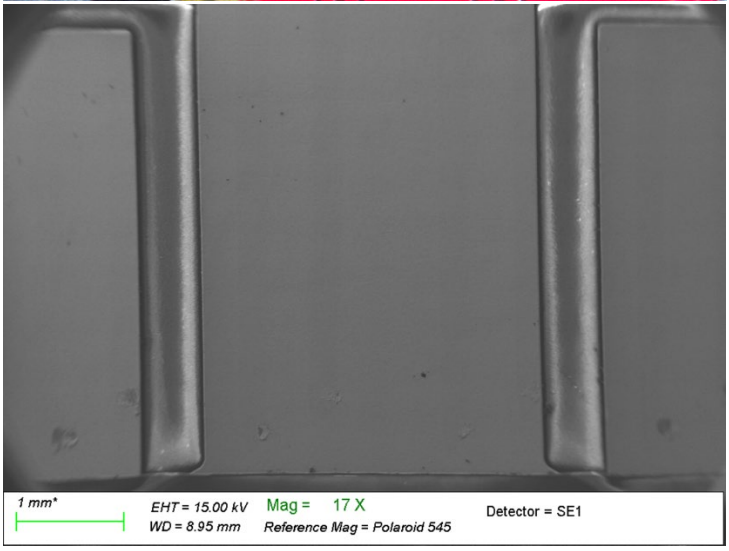


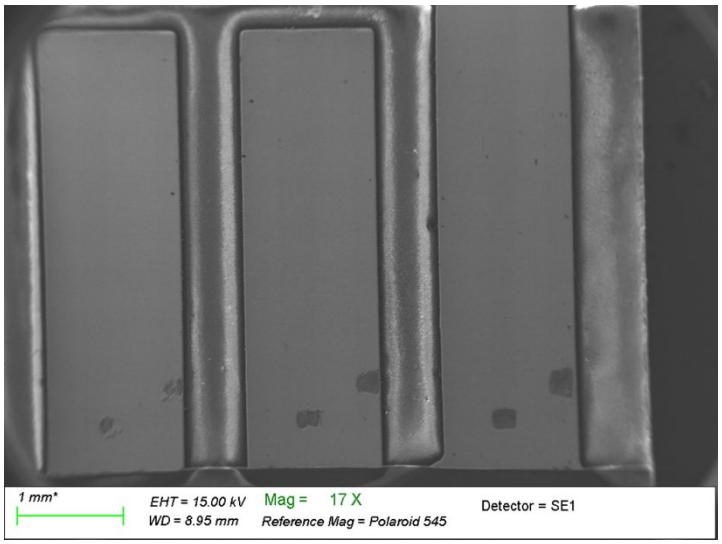


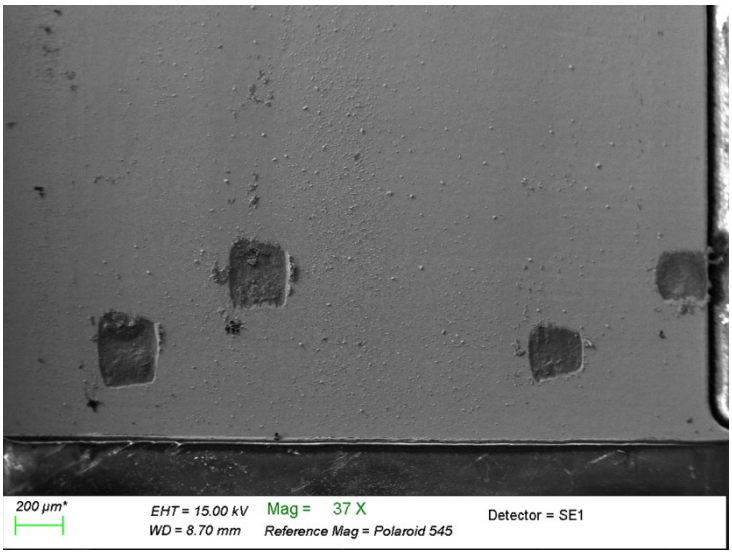
Appendix B P3-16: Position P3 wafer 16

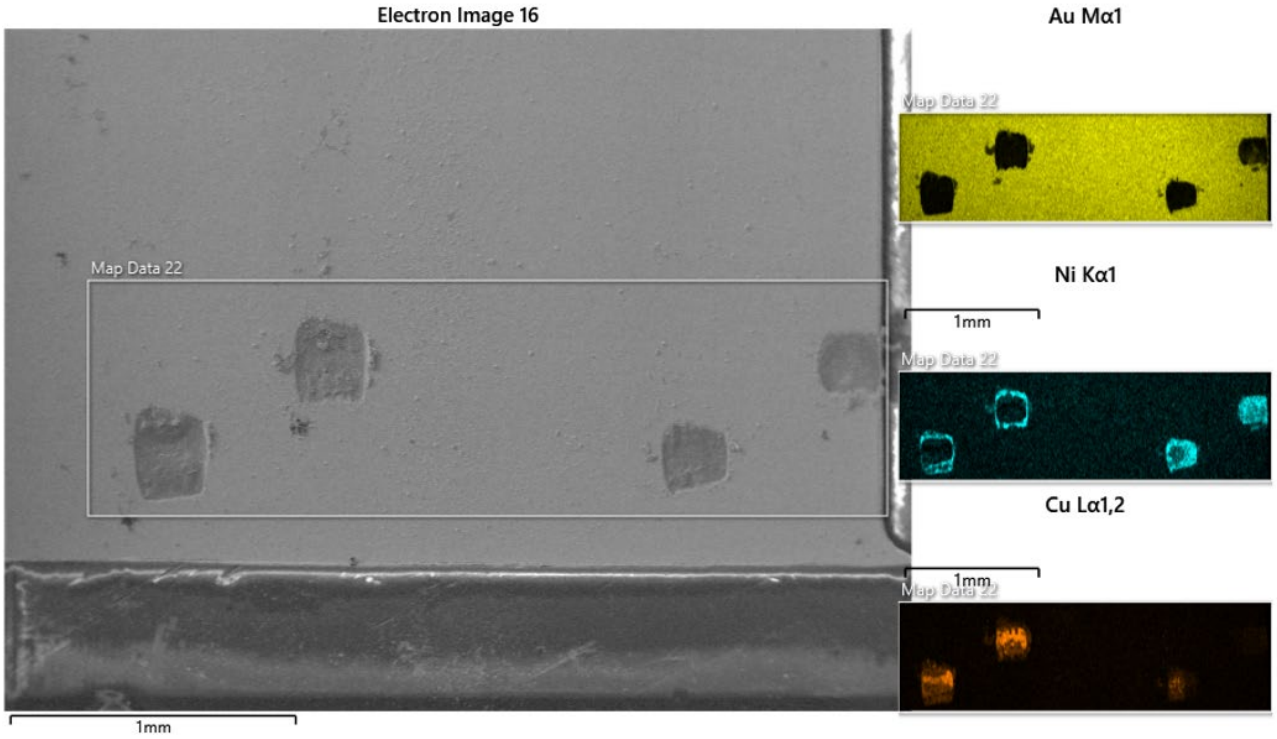


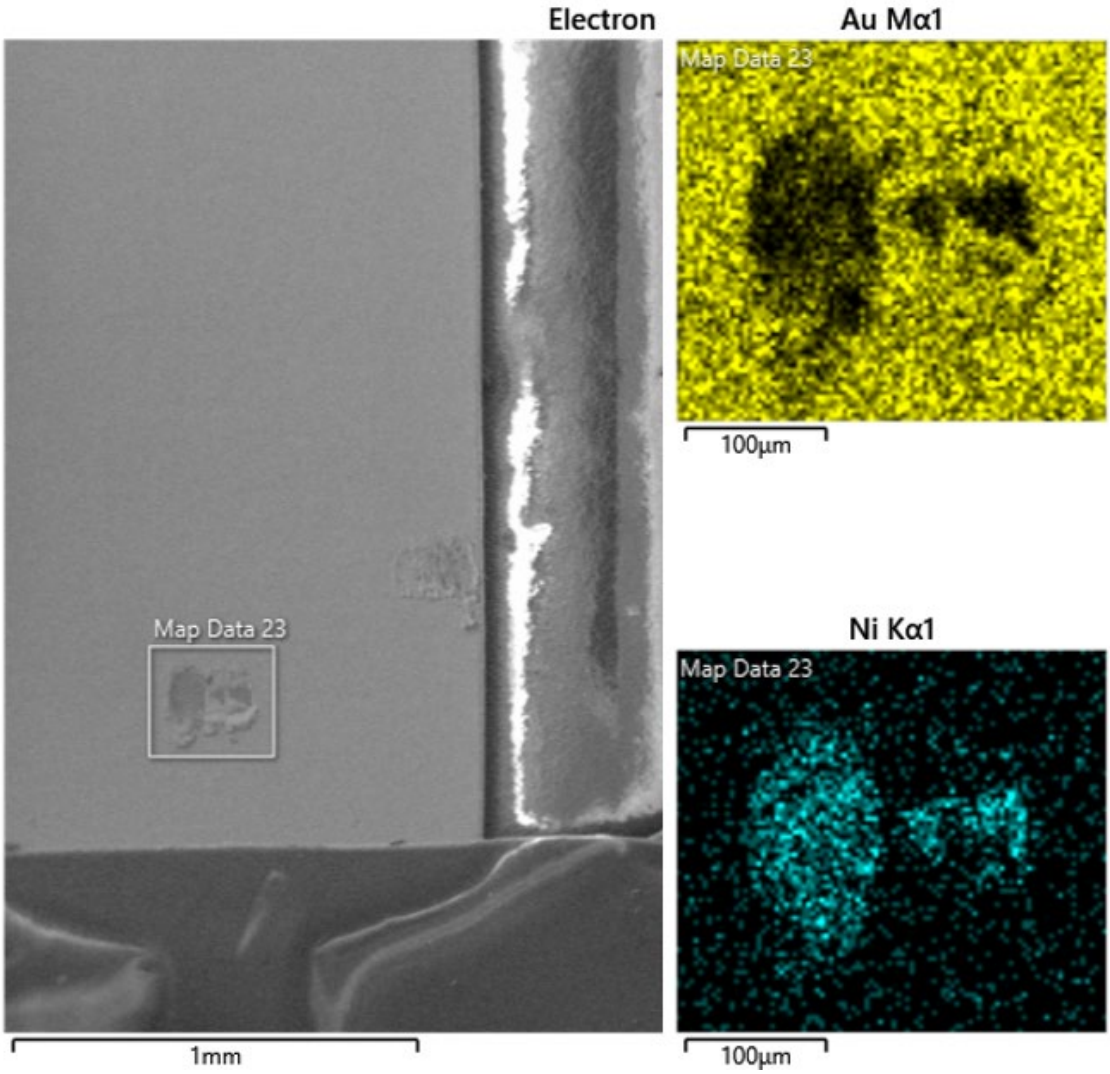


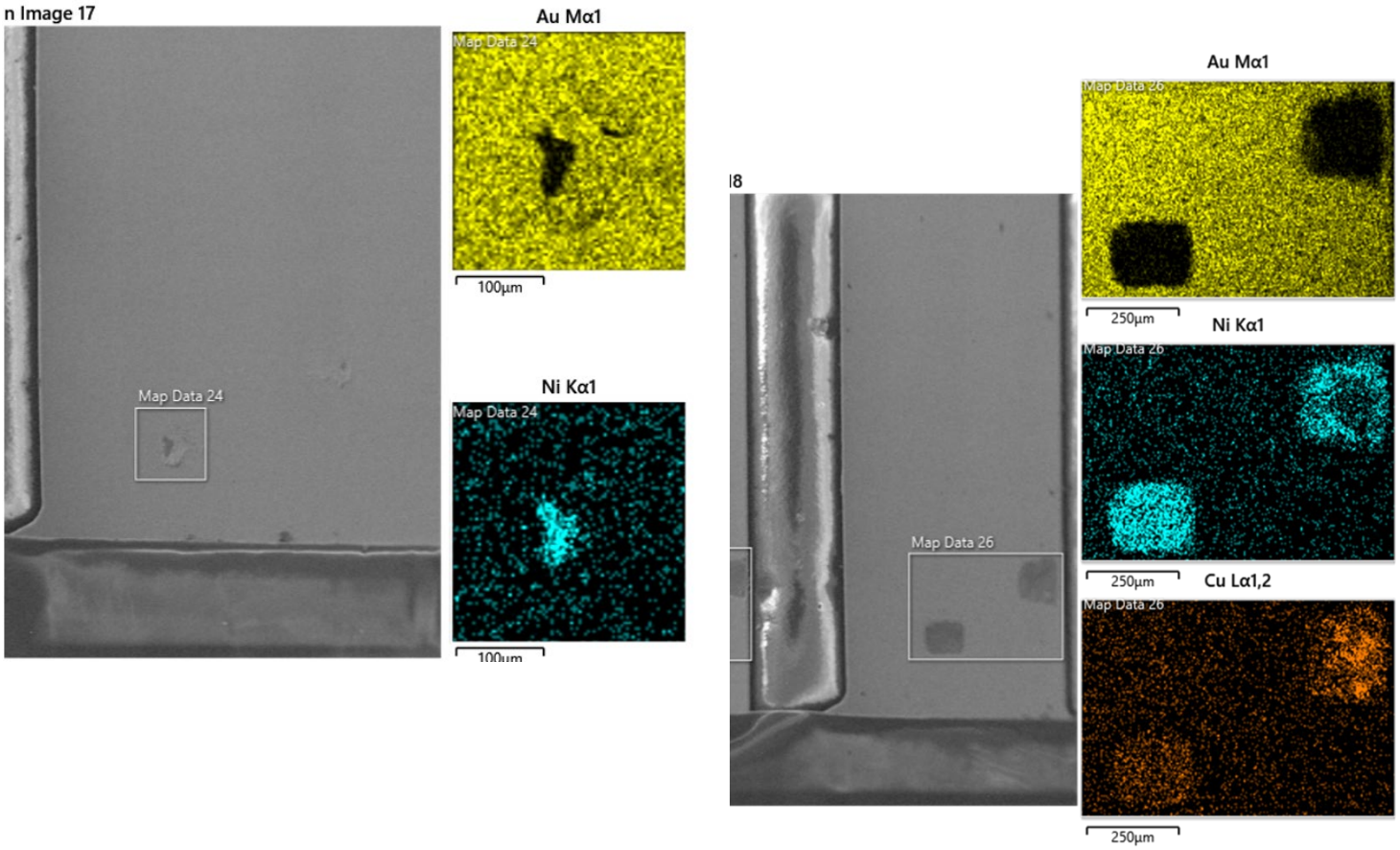


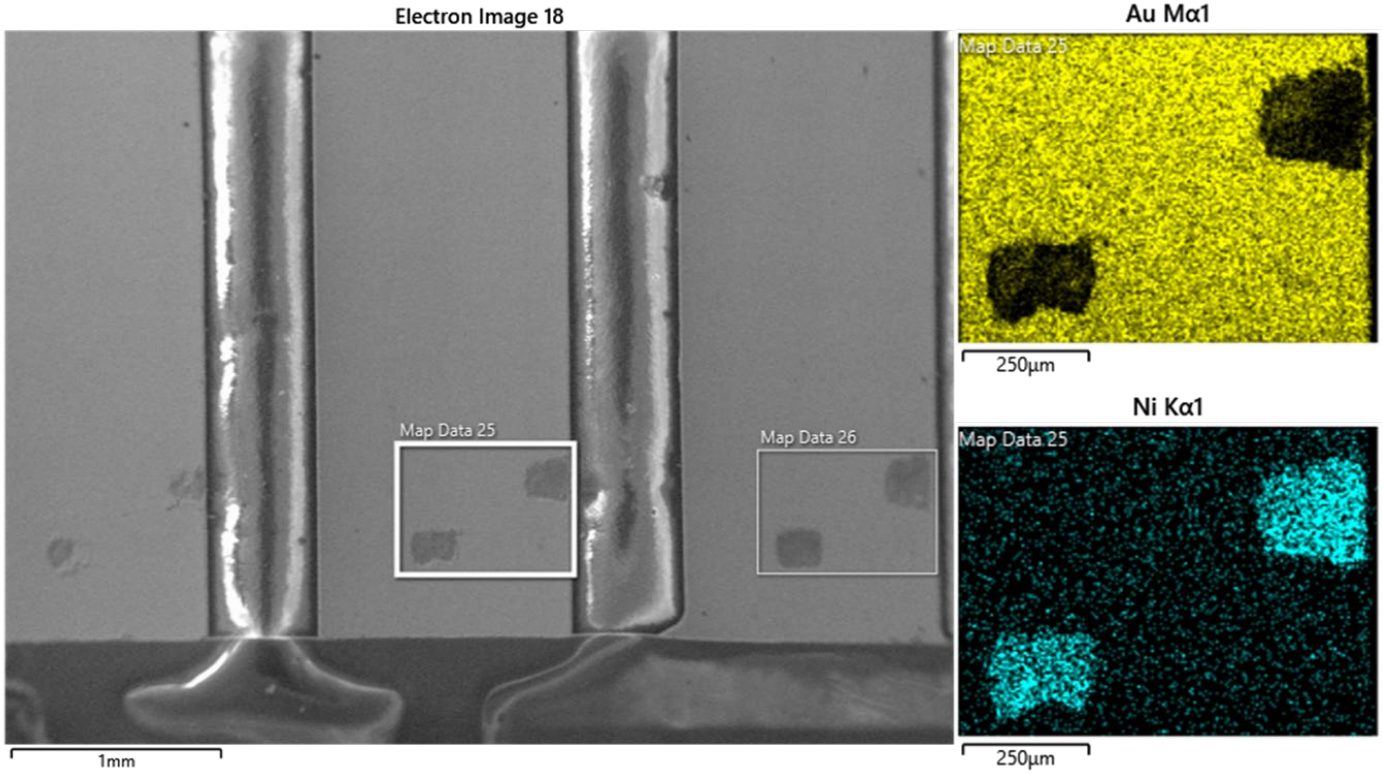




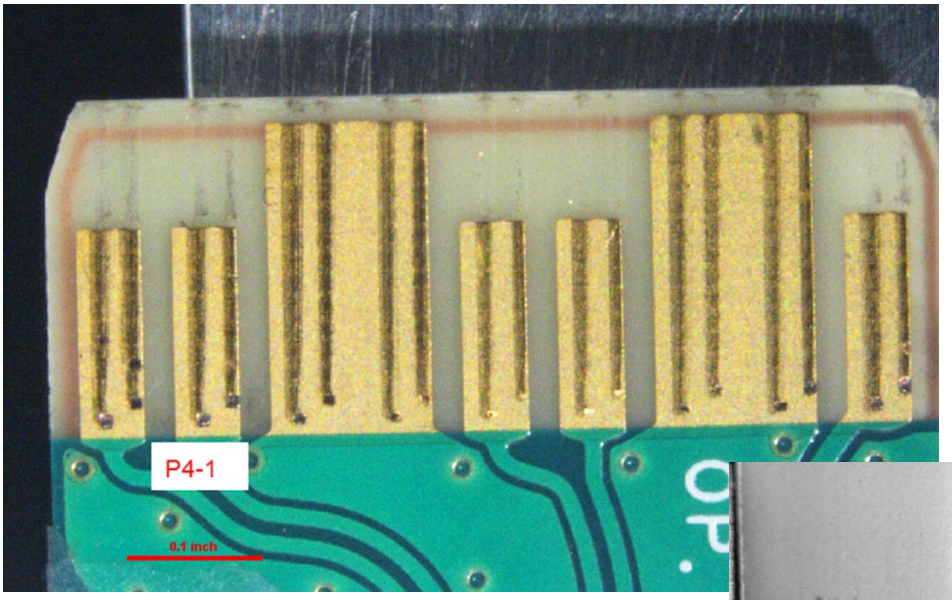


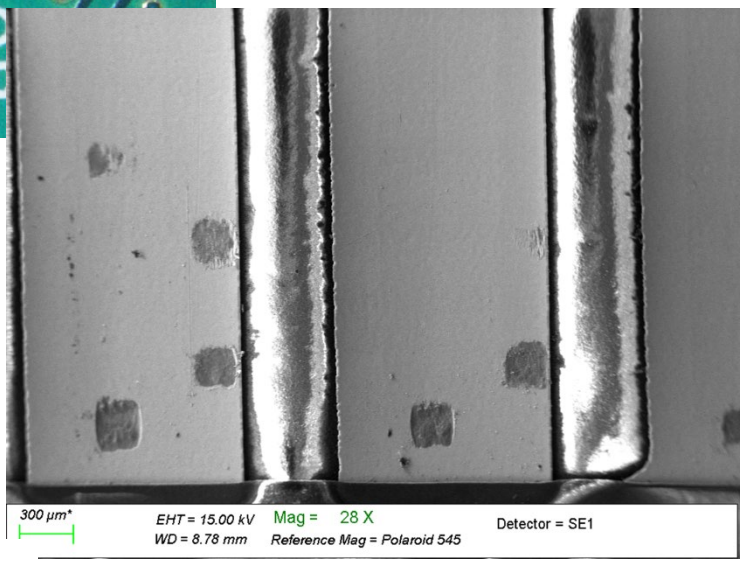


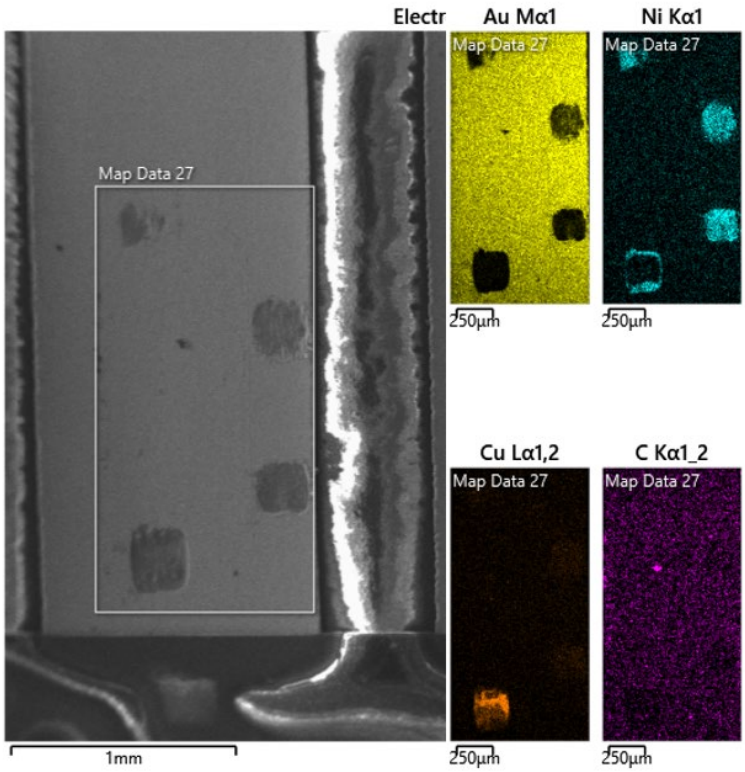


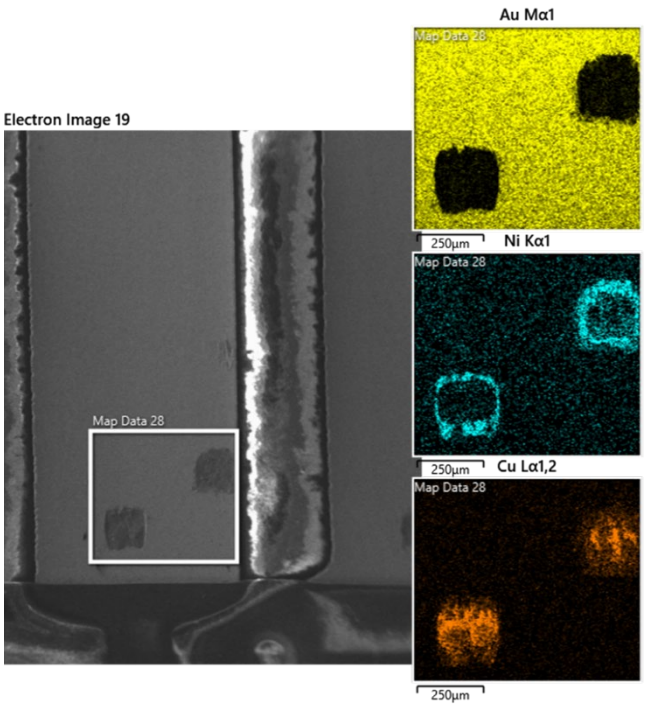


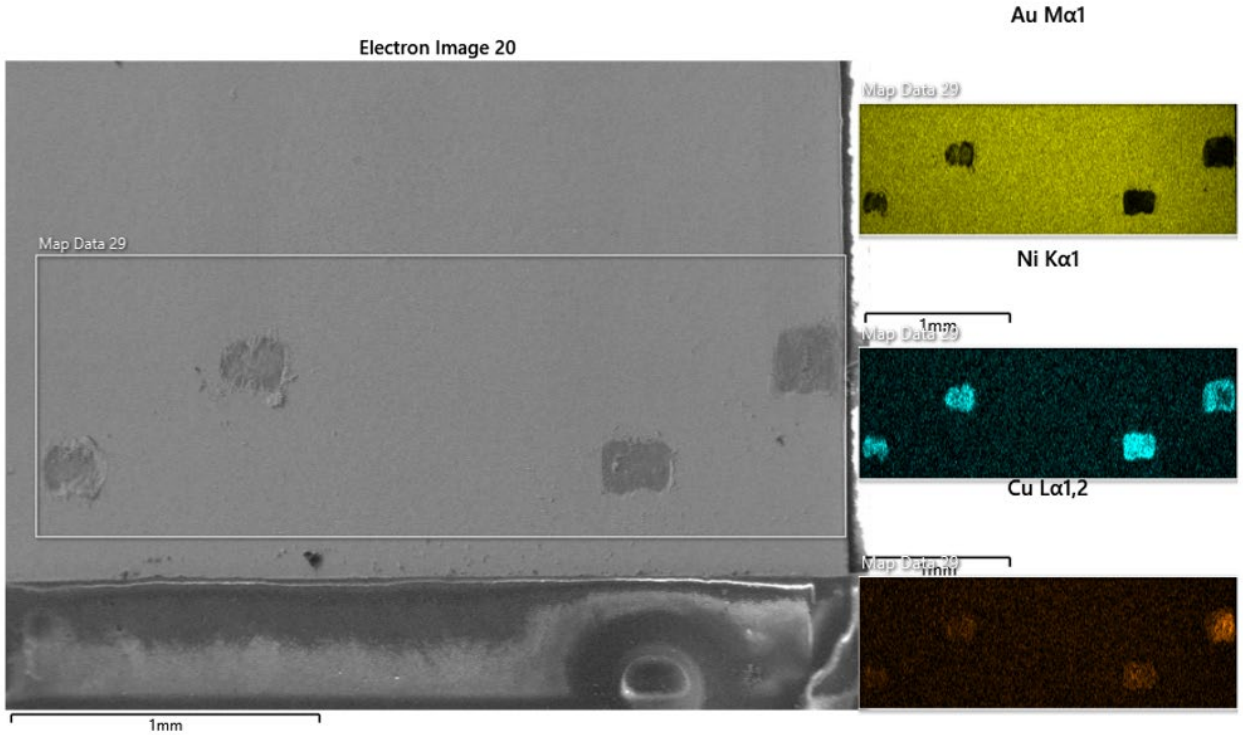
Appendix B P4-1: Position P4 wafer 1

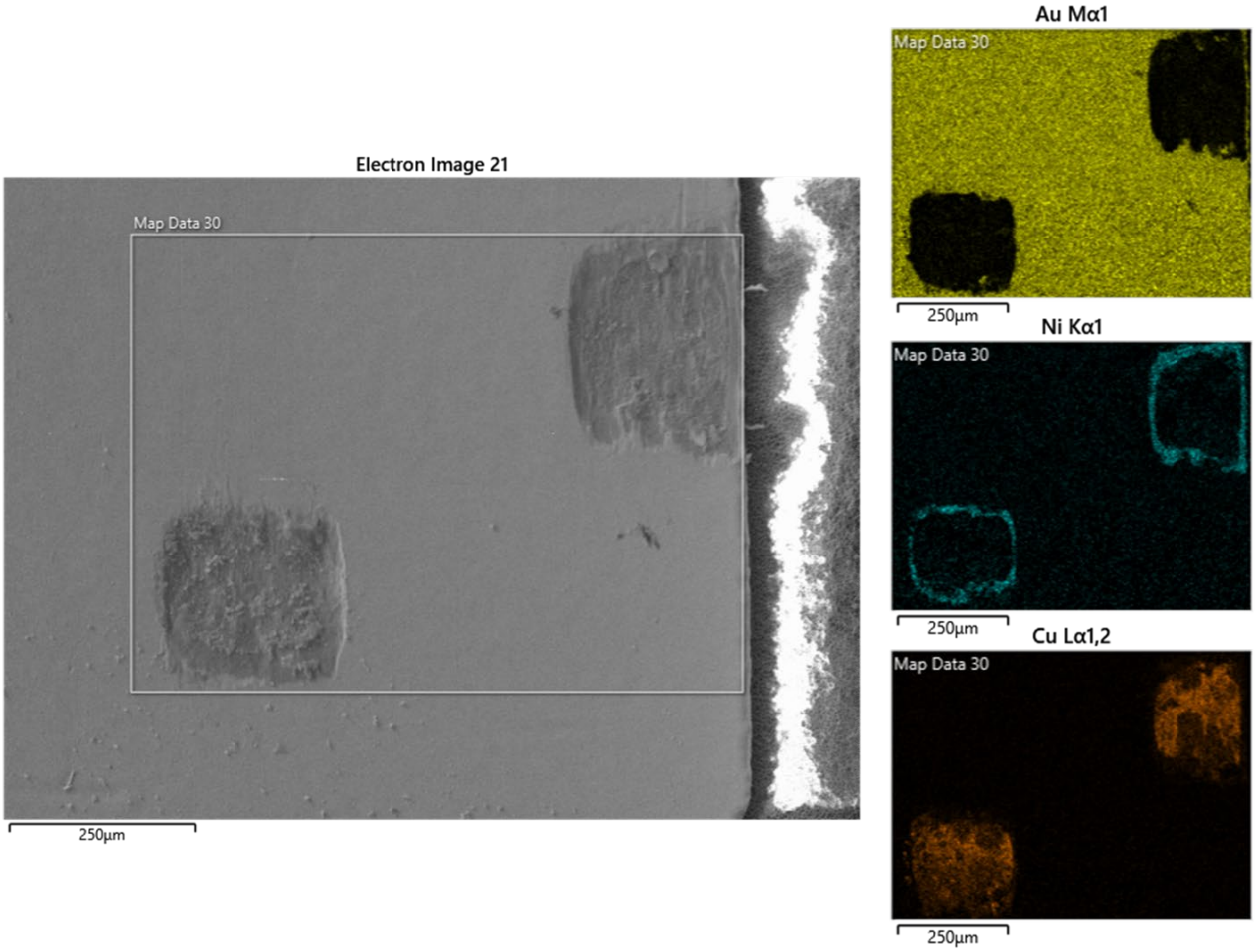




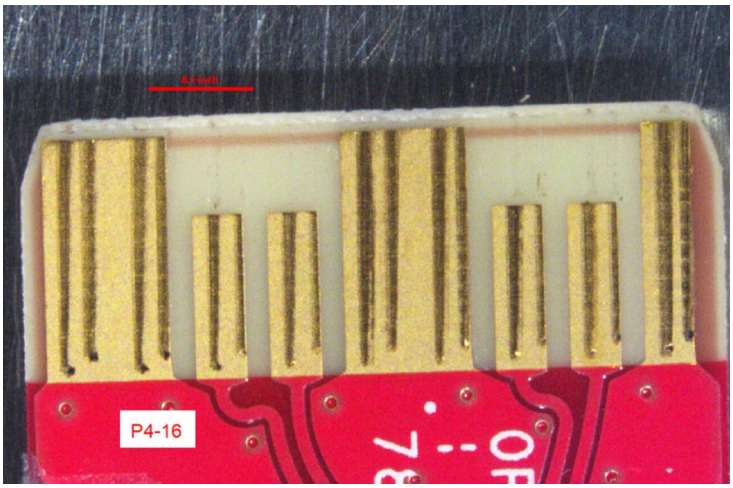


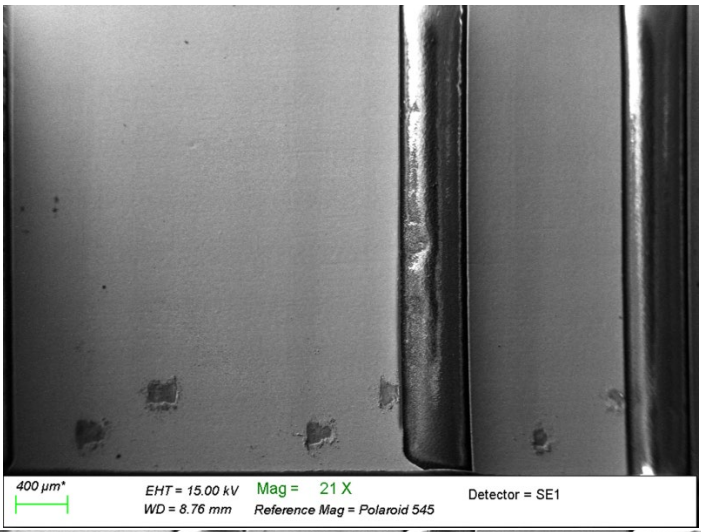


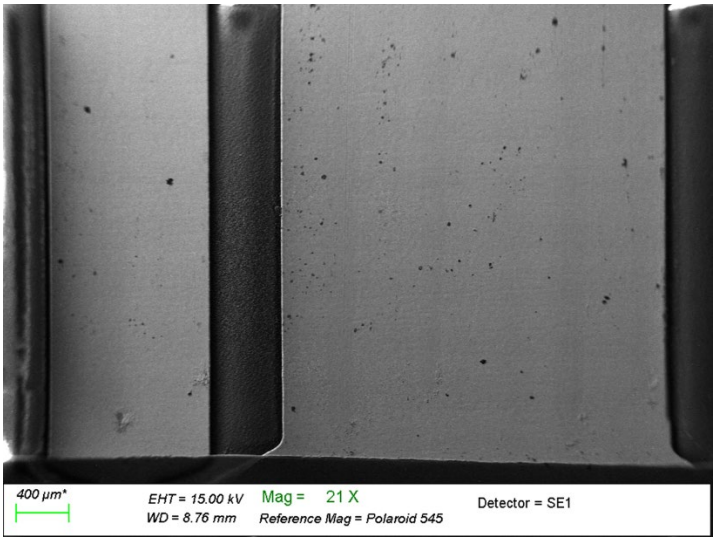


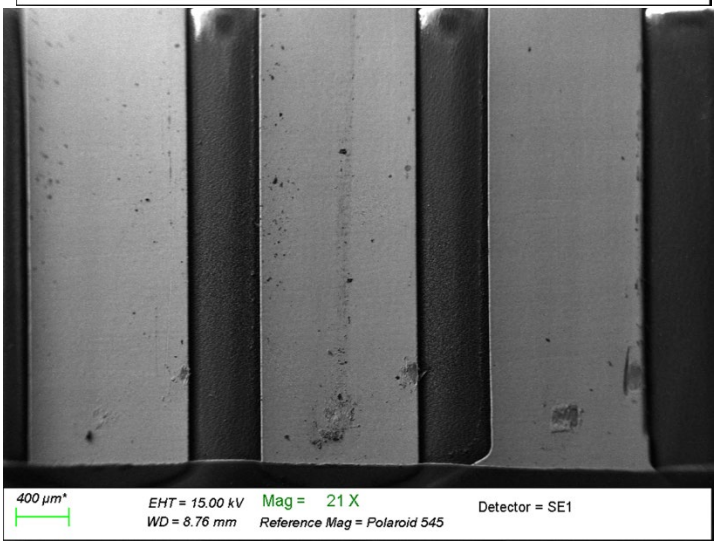


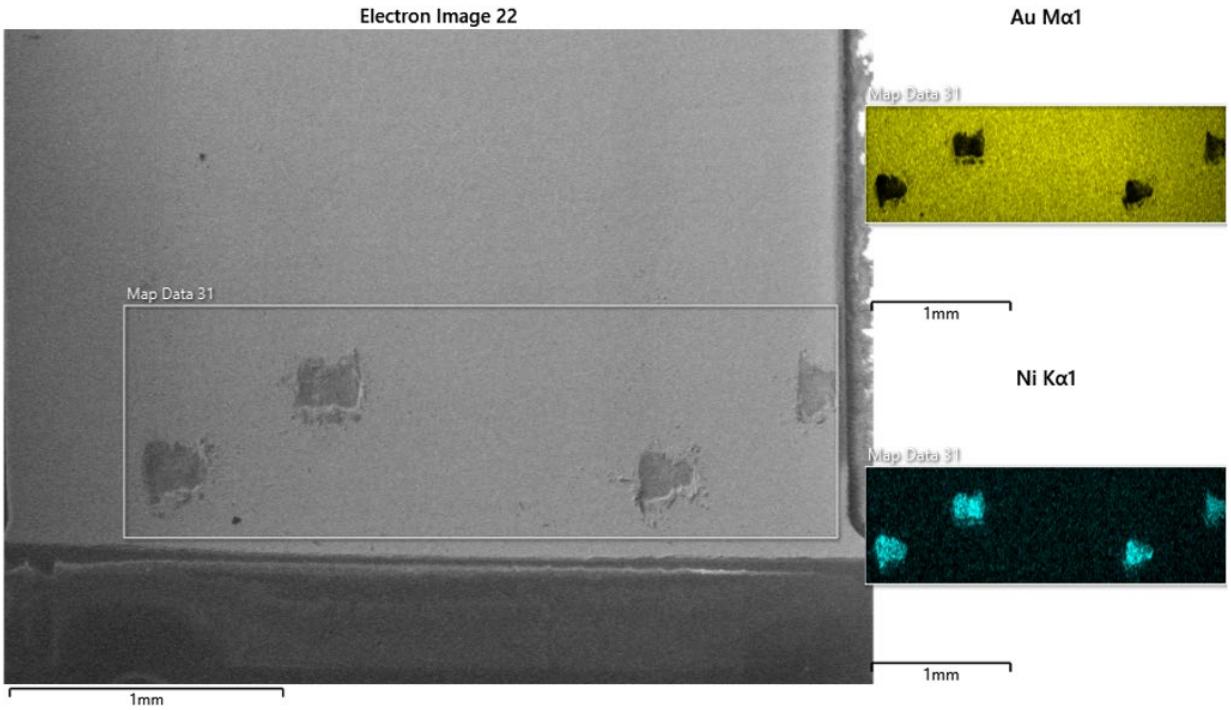
Appendix B P4-16: Position P4 wafer 16

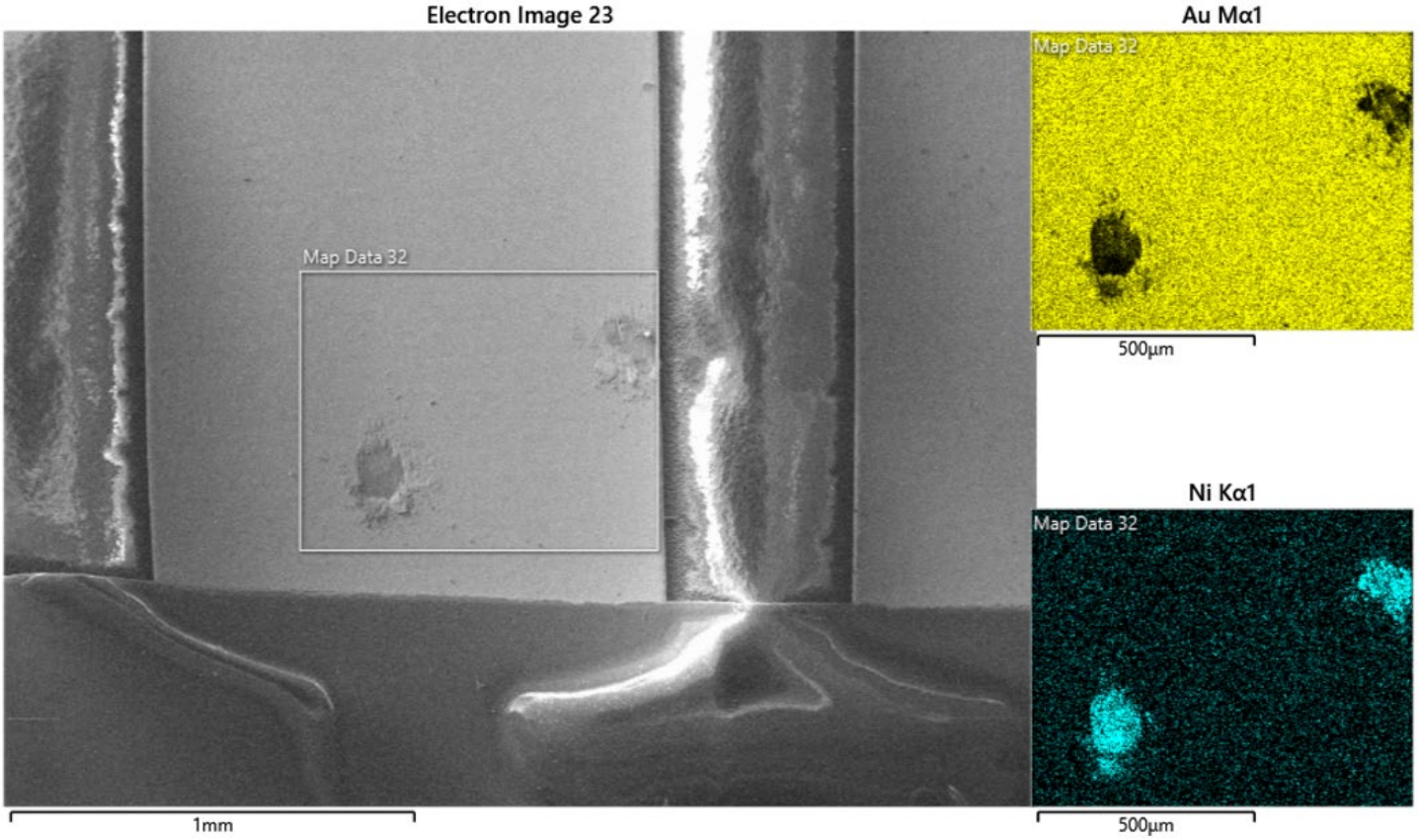


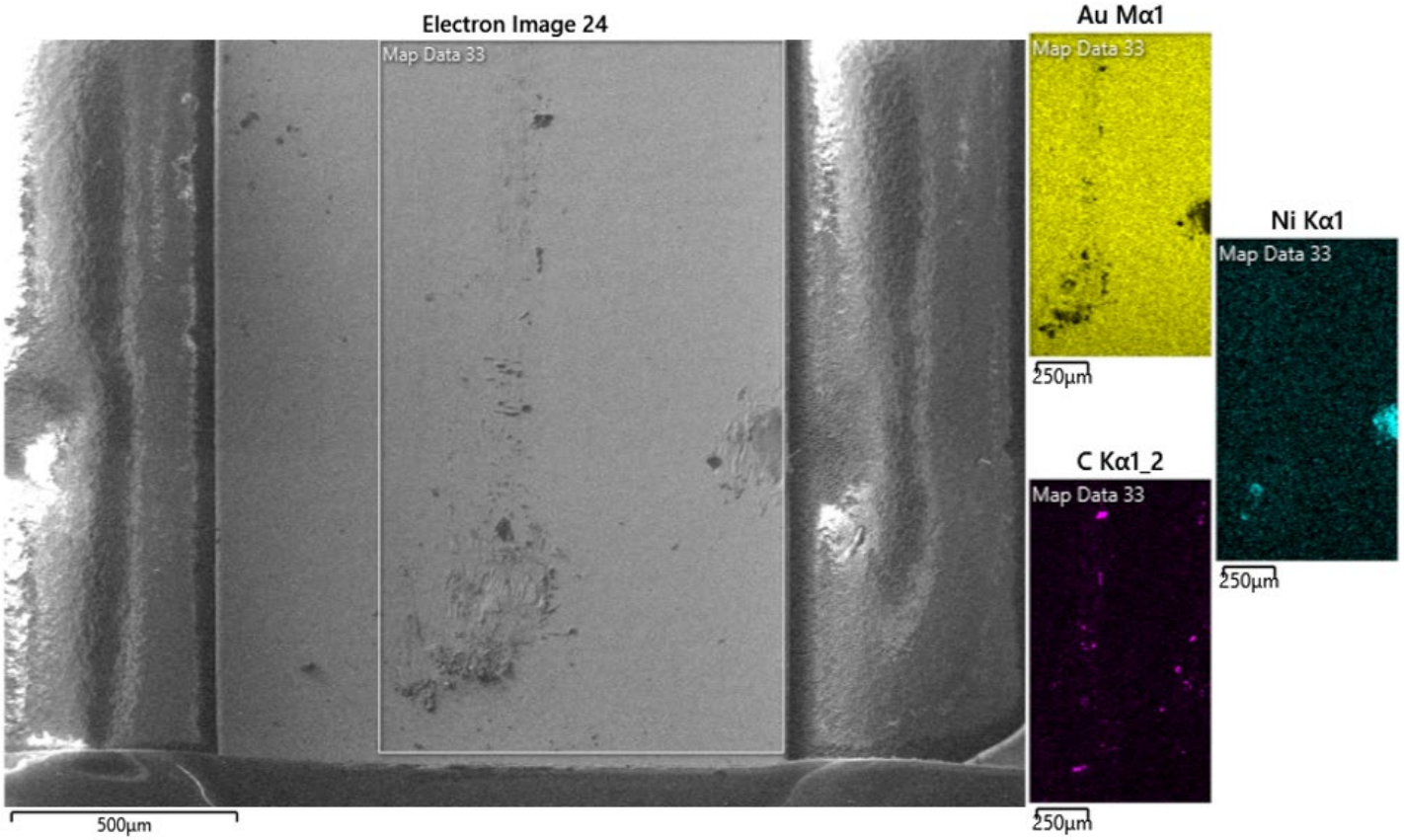




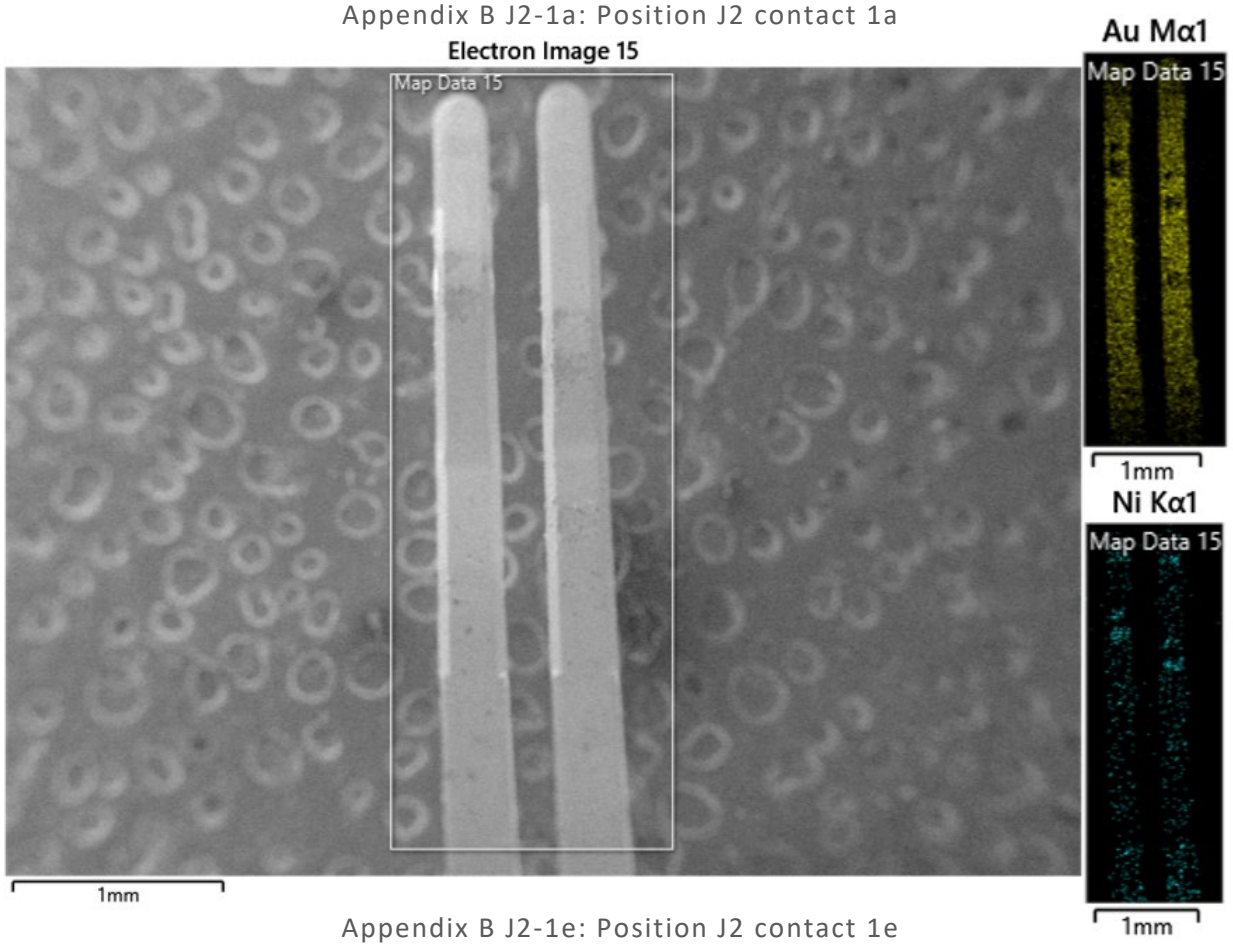




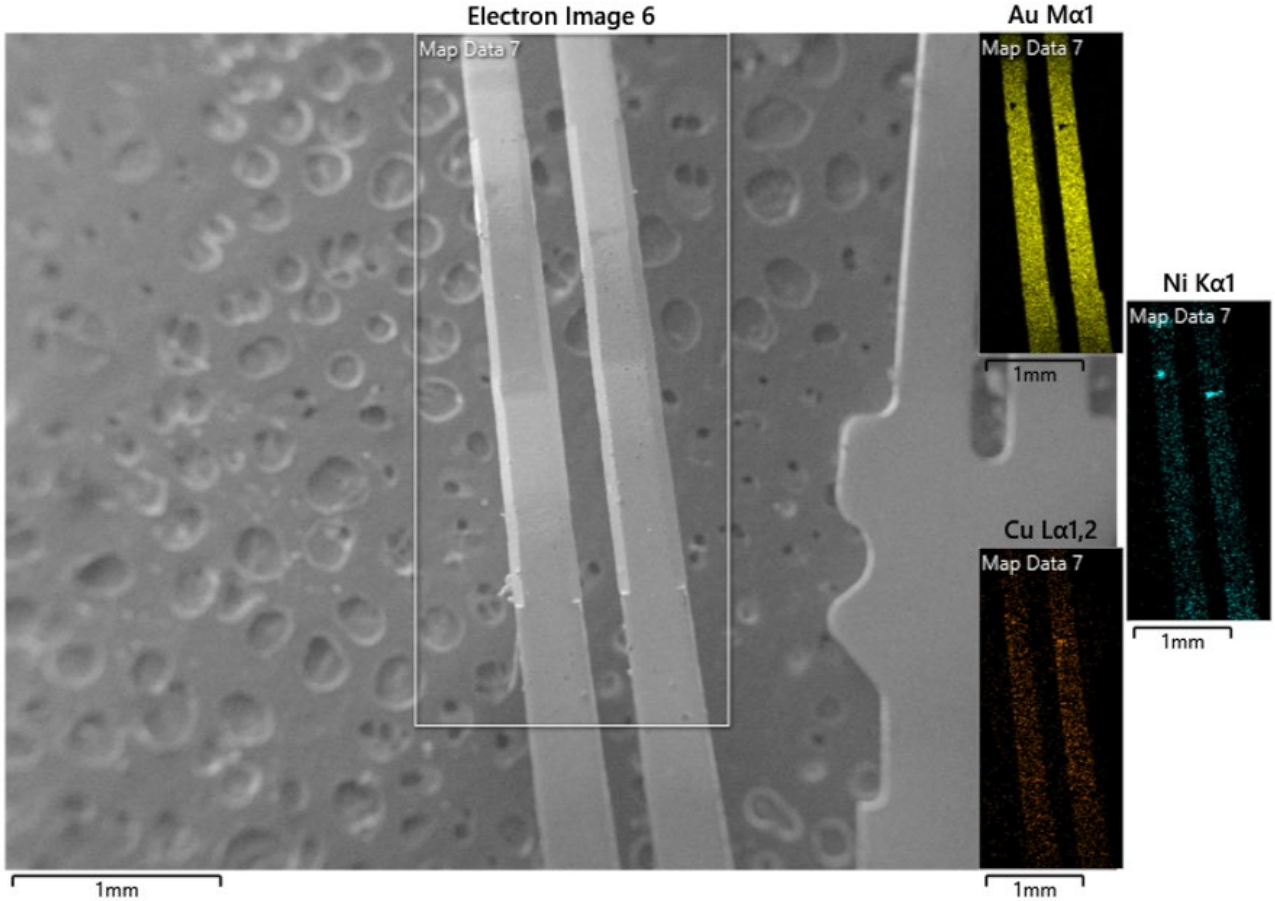




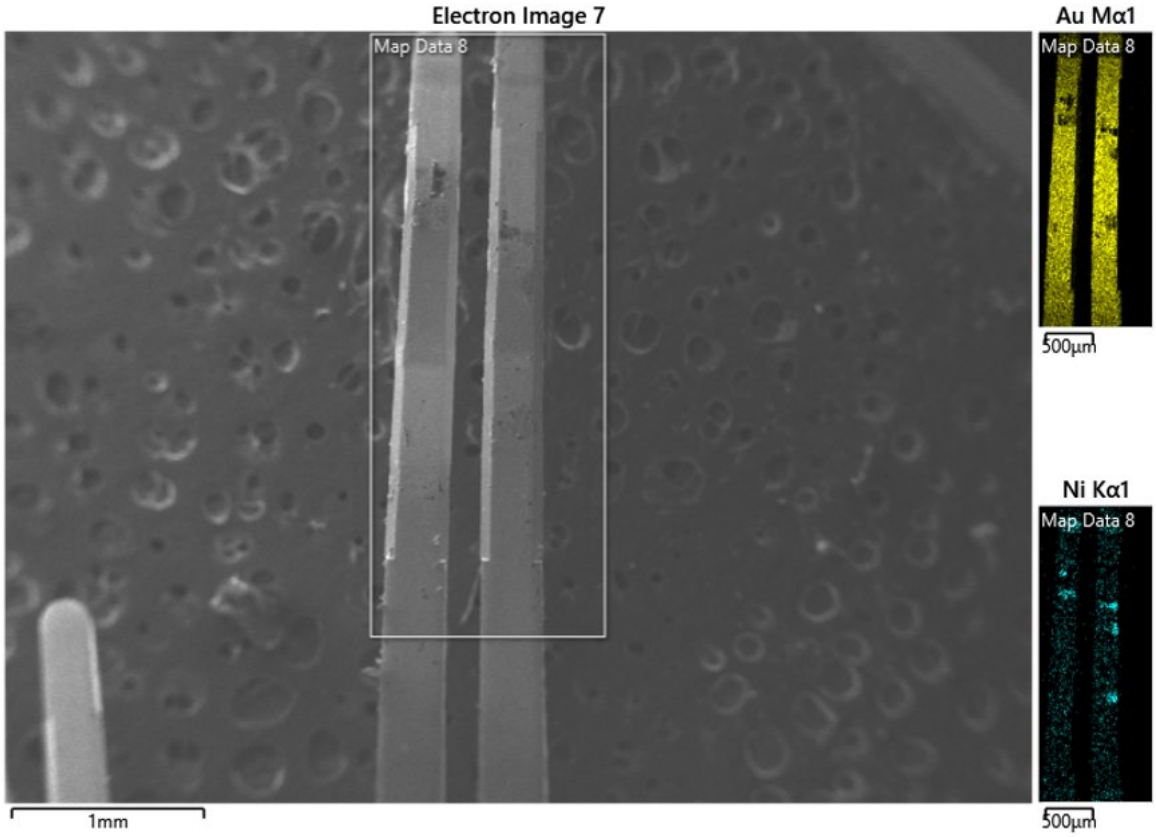
Appendix B J2-1a: Position J2 contact 1a



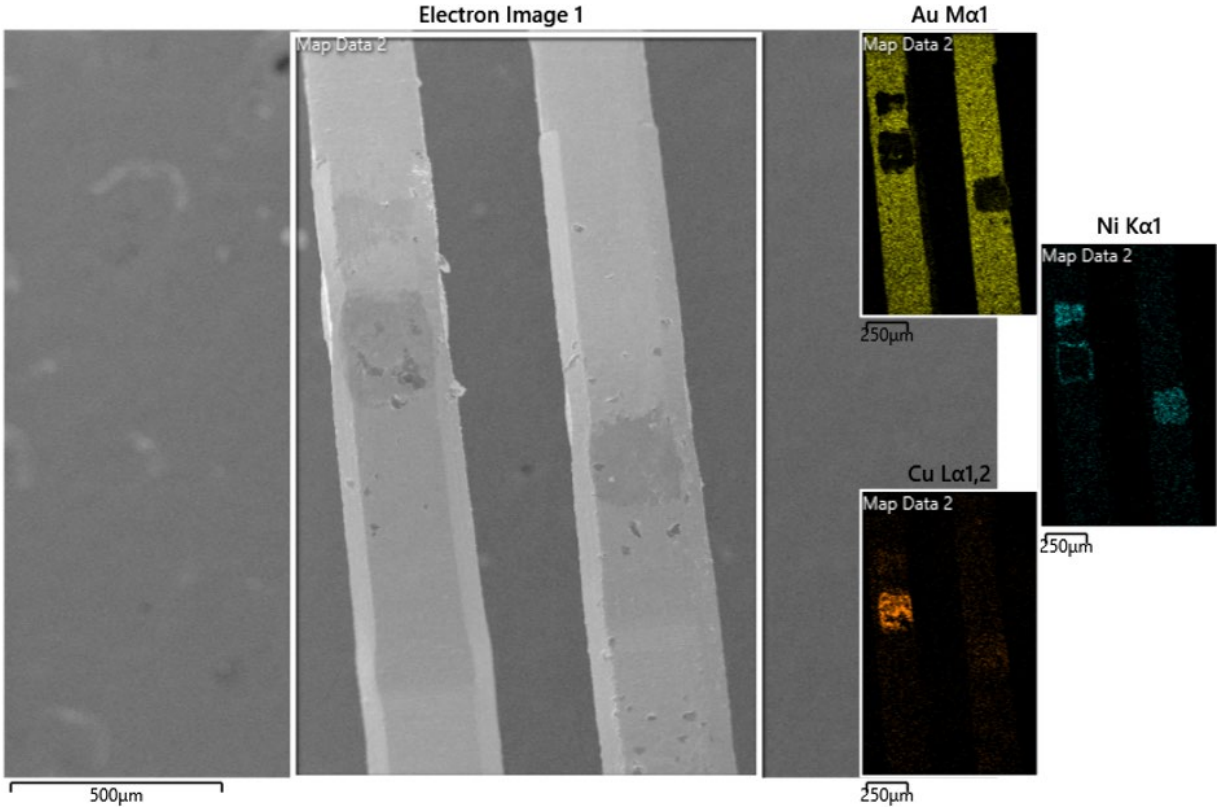
Appendix B J2-1e: Position J2 contact 1e



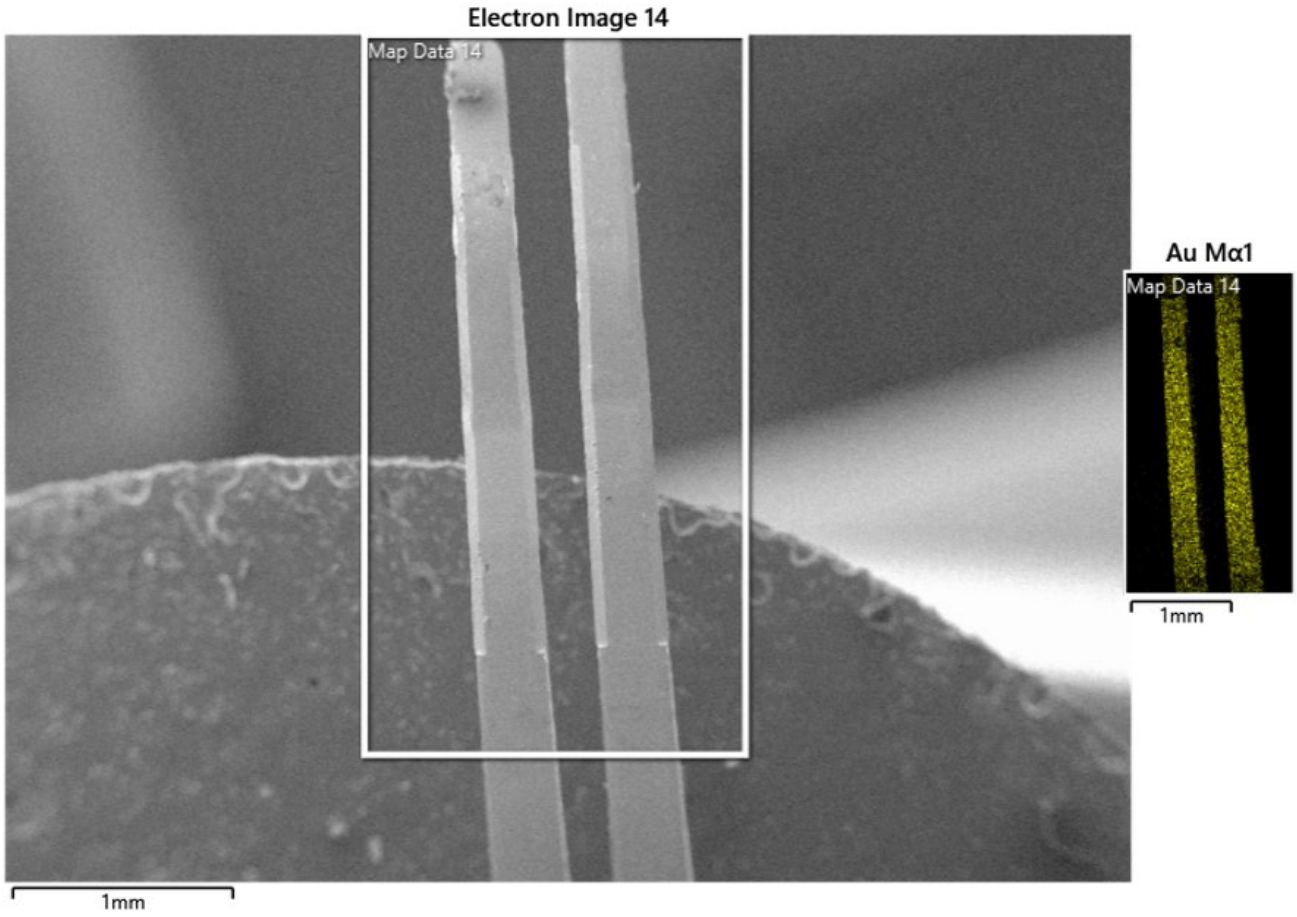
Appendix B J2-1i: Position J2 contact 1i



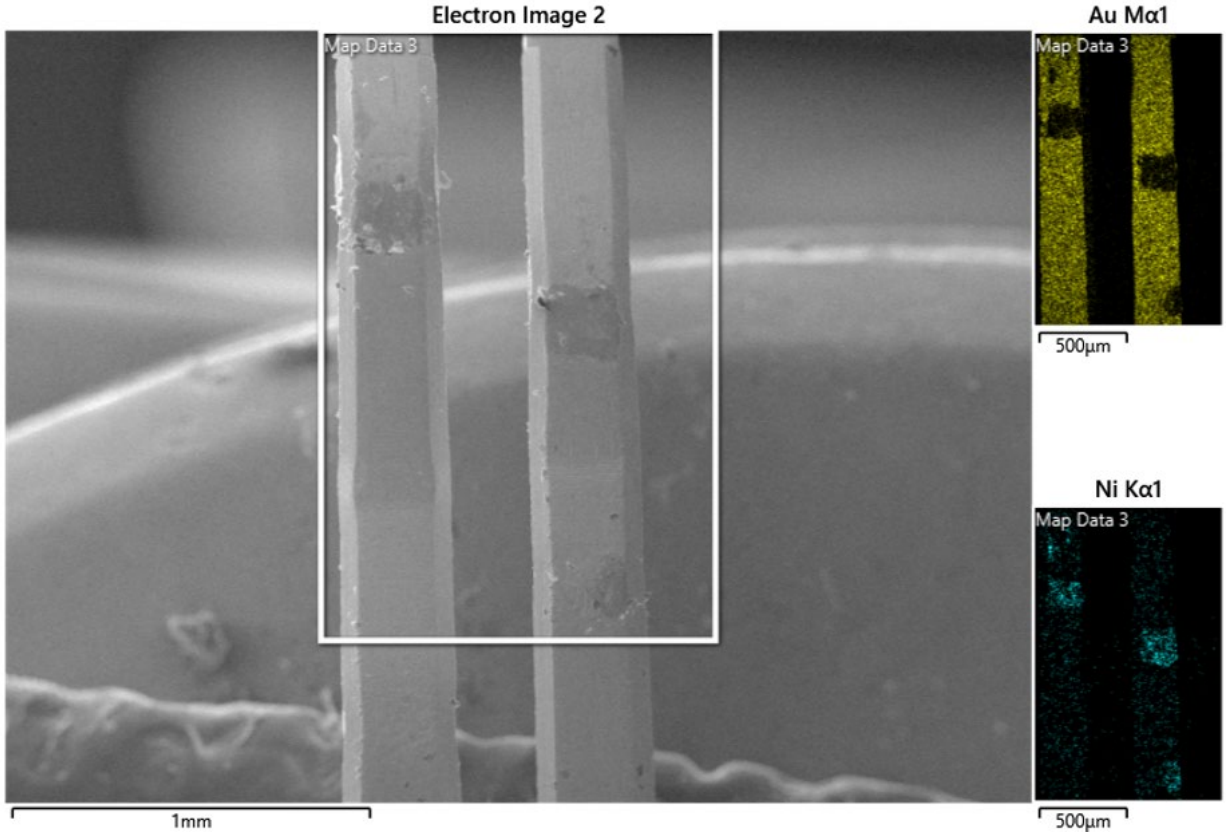
Appendix B J2-16a: Position J2 contact 16a



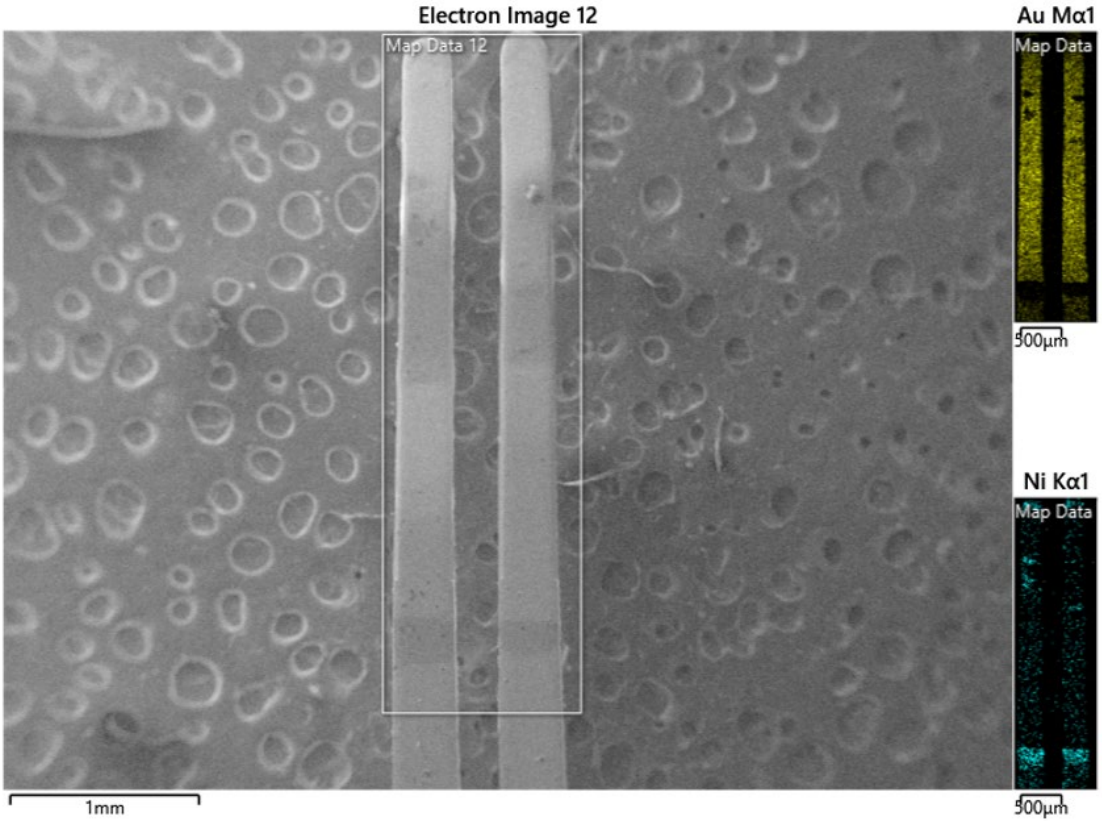
Appendix B J2-16e: Position J2 contact 16e



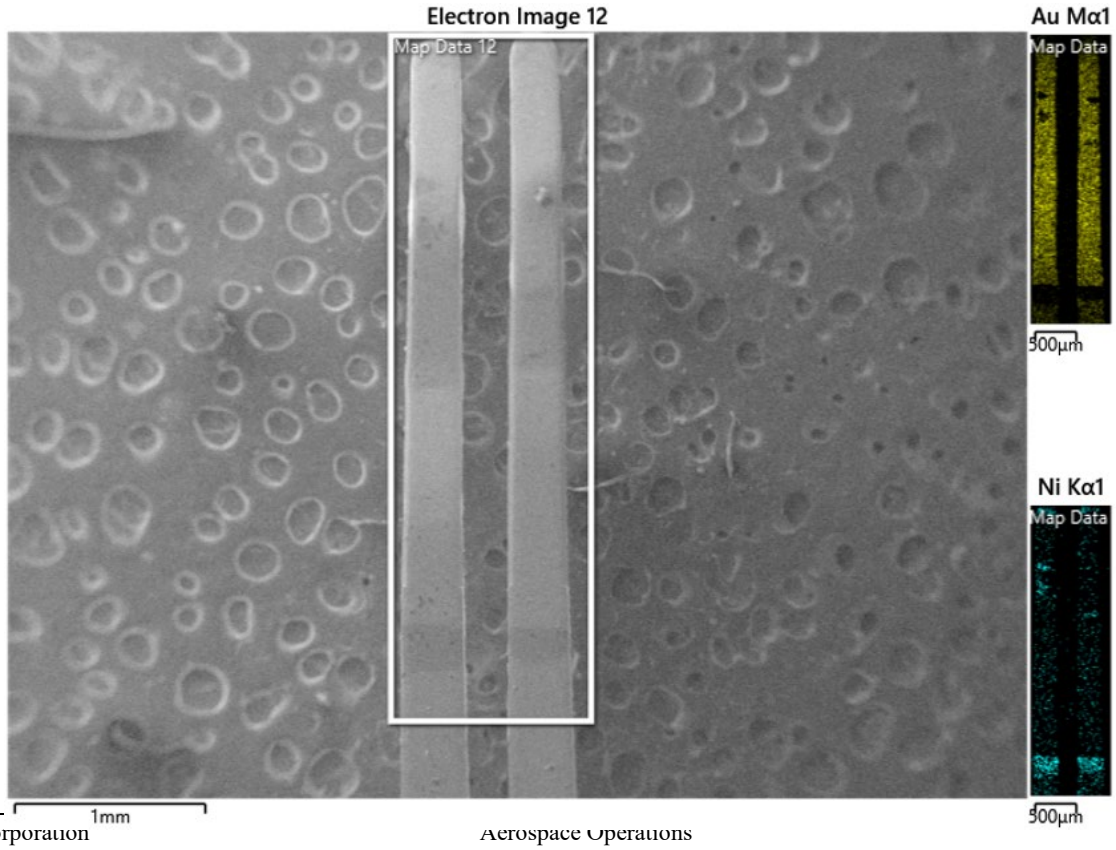
Appendix B J2-16i: Position J2 contact 16i



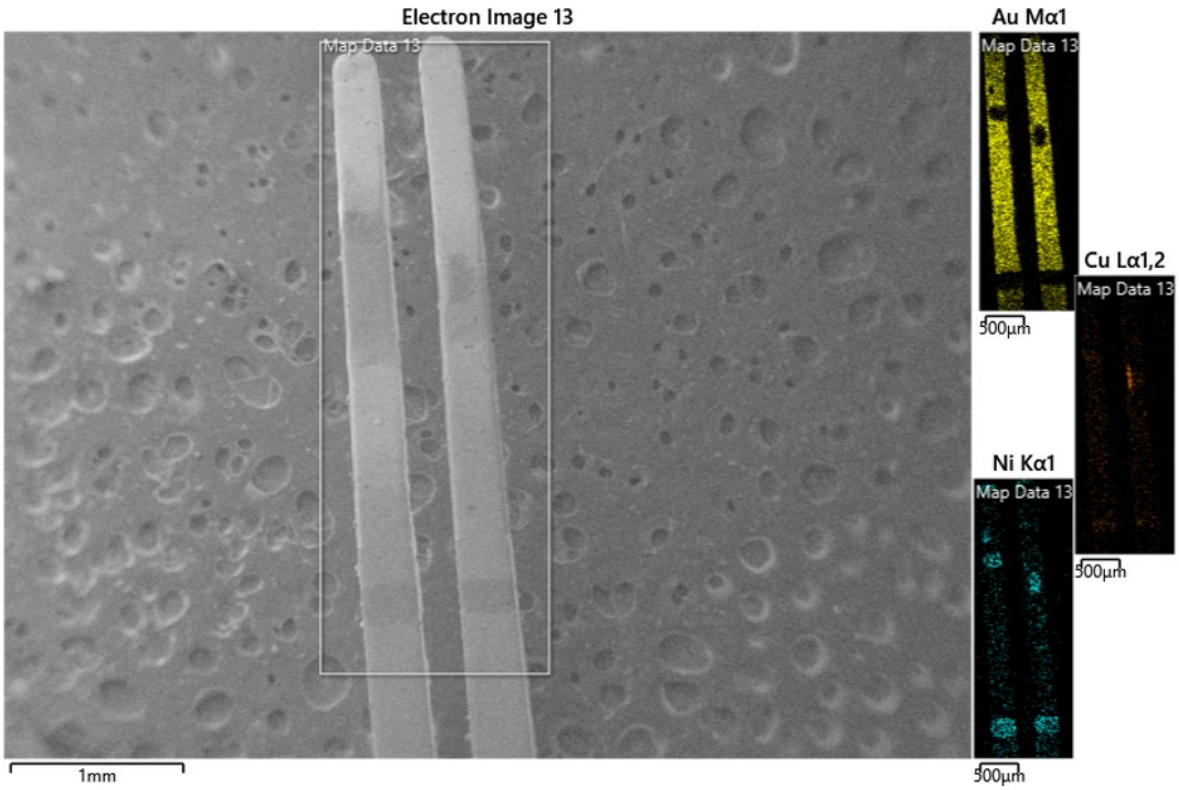
Appendix B J3-8a: Position J3 contact 8a



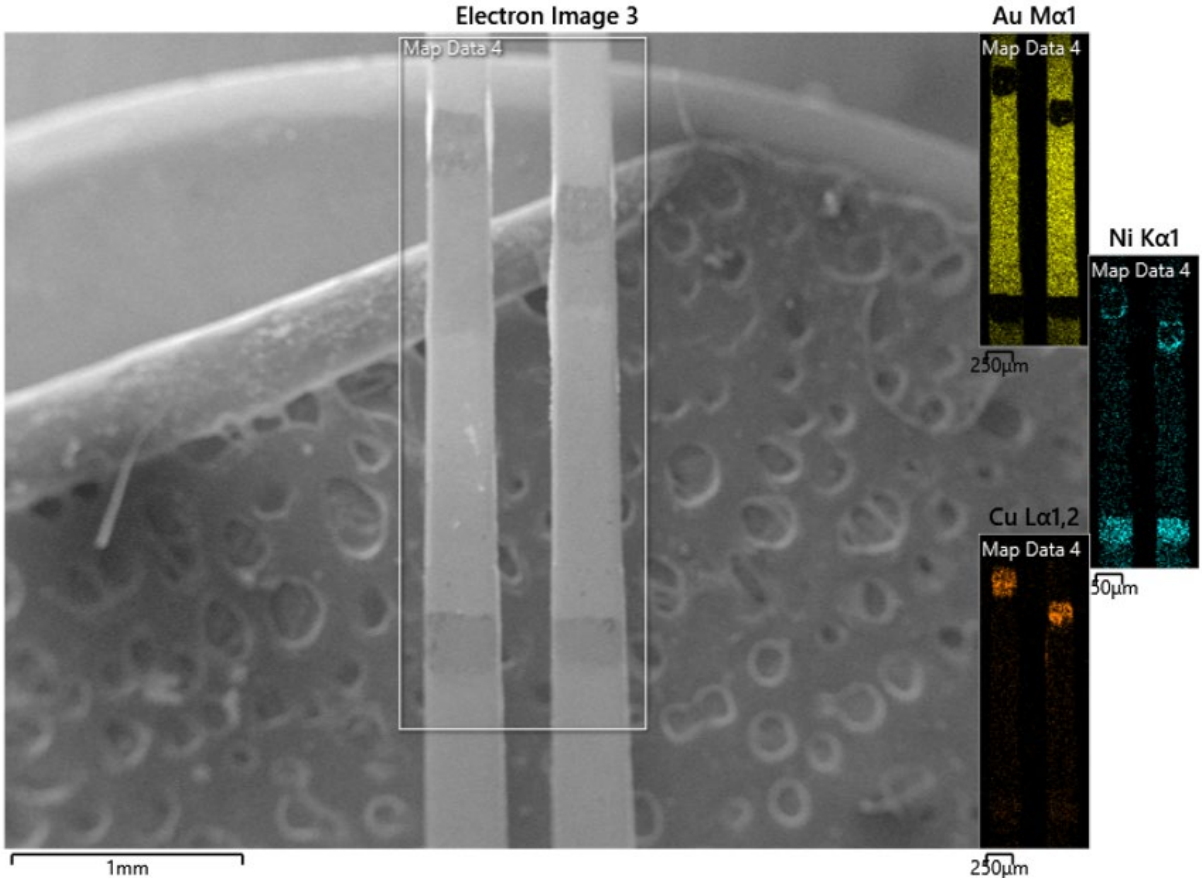
Appendix B J3-8e: Position J3 contact 8e



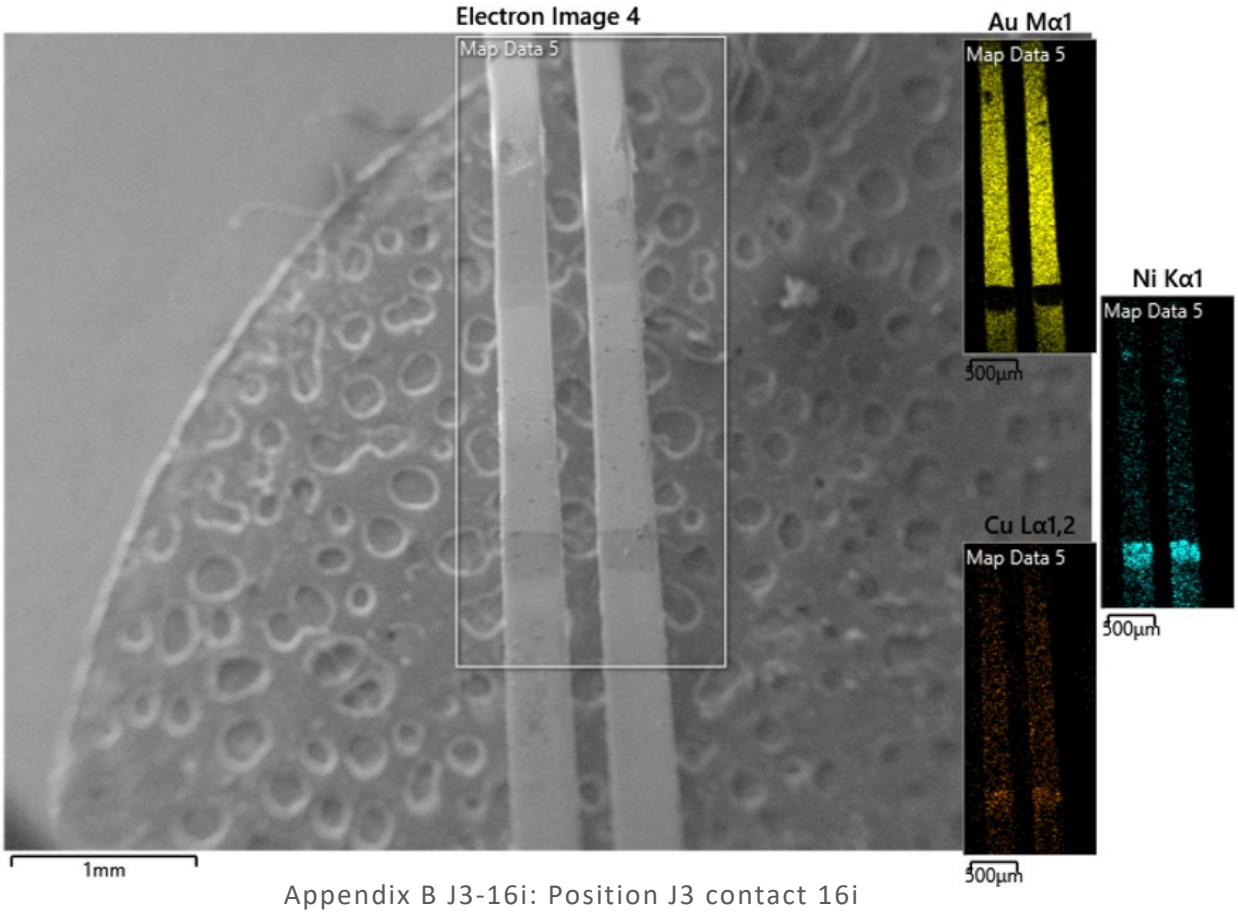
Appendix B J3-8i: Position J3 contact 8i



Appendix B J3-16a: Position J3 contact 16a



Appendix B J3-16e: Position J3 contact 16e



Appendix B J3-16i: Position J3 contact 16i