

FLOWER OF SULFUR TEST REPORT

Customer Company : Apacer Technology Inc
Customer Address : No. 32, Zhongcheng Rd., Tucheng Dist., New Taipei City 236
, Taiwan (R.O.C.)
Laboratory Address : No.10-1, Lixing 1st Rd., East Dist., Hsinchu City 300
, Taiwan (R.O.C.)
Model Name : PX220-M280
Date Received : DEC 20, 2020
Date Tested : DEC 28, 2020 ~ JAN 6, 2021

TESTING LABORATORY IS APPROVED BY:

IECQ Certificate of Approval No.: IECQ-L DEKRA 16.0002 For Independent Test Laboratory
According to ISO/IEC 17025

ISO 9001 certificate is approved by TUV CERT certification body of TUV NORD Cert GmbH

WE HEREBY CERTIFY THAT:

The test(s) shown in the attachment were conducted according to the indicating procedures. We assume full responsibility for the accuracy and completeness of these tests and vouch for the qualifications of all personnel performing them.

	Name	Signature	Date
Test Engineer	Leo Yao	<i>Leo Yao</i>	Jan 18, 2021
Manager	Lingsing Su	<i>Lingsing Su</i>	Jan 18, 2021

Note :

1. This report will be invalid if reproduced in part or altered in any way.
2. This report refers only to the specimen(s) submitted to test, and is invalid if used otherwise.
3. This report is ONLY valid with the examination seal and signature of this institute.
4. The tested specimen(s) will only be preserved for thirty days from the date issued, if not collected by the applicant.



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1. GENERAL INFORMATION

1.1 DESCRIPTION OF UNIT

SAMPLE QUANTITY : 7 pcs

CUSTOMER PROVIDE INFORMATION :

SAMPLE NAME & SAMPLE QUANTITY

TV # ID	Model	P/N NO.	S/N NO.	QUANTITY
#01	PX220-M280	B92.225KHD.002NA	122048500914	1 Pcs
#02			122048500915	1 Pcs
#03			122048500916	1 Pcs
#04			122048500917	1 Pcs
#05			122048500918	1 Pcs
#06			122048500919	1 Pcs
#07			122048500920	1 Pcs

2. BAKING PROCESS

2.1 DESCRIPTION OF TEST EQUIPMENT

Test Equipment	Model	Brand	Calibration Date
Hot-Flowing Oven with N ₂	YB1	Homsum	Jul 30, 2020

2.2 LABORATORY AMBIENCE CONDITION

Temperature : 23 ± 5°C

Relative humidity : 50% ± 10% (RH)

2.3 PROCEDURE SETUP AND PROCESS CONDITION

Test temperature : 85°C

Test duration : 24 hours

Nitrogen gas has been applied in oven; gaseous pressure: 10 psi and flowing rate: 1 L/min (LPM). The oven has an opening with exhaust function.



The organic solvent and VOC could be evaporated and removed after pre-baking with nitrogen flowing process. To avoid the volatile gas which reduce the partial pressure of sulfur vapor in FoS chamber during sulfur corrosion test.

3. FLOWER OF SULFUR TEST

3.1 DESCRIPTION OF TEST MATERIAL

Test Material	Purity	Brand
Sulfur (S)	>99.0%	Merck Ltd.
Potassium Nitrate (KNO ₃)	>99.5%	Merck Ltd.

3.2 DESCRIPTION OF TEST EQUIPMENT

Test Equipment	Model	Brand	Calibration Date
Hot-Flowing Oven	HT-150	Dr-Storage	Apr 23, 2020
FoS Chamber	30cm	TAI FONG	N/A

3.3 LABORATORY AMBIENCE CONDITION

Temperature : $23 \pm 5^{\circ}\text{C}$

Relative humidity : $50\% \pm 10\%$ (RH)

3.4 REFERENCE DOCUMENT

The test is based on modified ASTM B809-95@85°C. ASTM B809-95: *Standard Test Method for Porosity in Metallic Coatings by Humid Sulfur Vapor ("Flowers-of-Sulfur")*.

3.5 TEST SETUP AND TEST CONDITION

Test temperature : FoS chamber maintained at $85 \pm 2^{\circ}\text{C}$.

Test duration : 8 days

3.6 RESULTS OF TEST

Please refer to **Attachment 1** for the results of visual inspection.

** If there is no specified area from customer. We will usually selected the various components, including resistor, capacitor, IC, LED, gold finger, connector pins, PCB pad and so on, especially for the failure units with creep corrosion occurrence. (e.g. IC LeadFrame, PCB pad without soldering...)*

Please refer to **Attachment 2** for the results of functional test.

4 CORROSIVE REACTIVITY ANALYSIS

4.1 DESCRIPTION OF TEST MATERIAL

Test Material	Purity	Brand
Copper Coupon	99.99%	Surepure Chematal Inc.
Silver Coupon	99.95%	Surepure Chematal Inc.
Acetone	>99.5%	Merck Ltd.
Potassium Chloride (KCl)	>99.5%	Merck Ltd.
Silicon Carbide Grind Paper	N/A	Buehler

4.2 DESCRIPTION OF TEST EQUIPMENT

Test Equipment	Model	Brand	Calibration Date
Potentiostat/Galvanostat	VersaSTAT4	P.A.R.	May 07, 2020

4.3 LABORATORY AMBIENCE CONDITION

Temperature : $23 \pm 5^{\circ}\text{C}$

Relative humidity : $50\% \pm 10\%$ (RH)

4.4 REFERENCE DOCUMENT

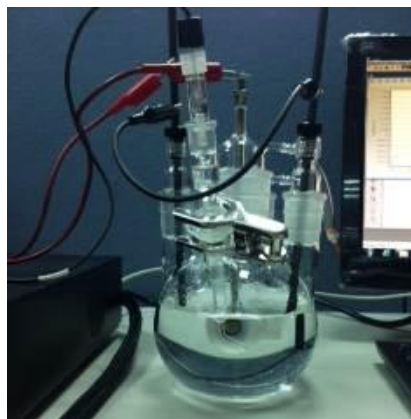
- (1) Coulometric Reduction Analysis is based on ASTM B825-02: *Standard Test Method for Coulometric Reduction of Surface Films on Metallic Test Samples.*
- (2) Classification of Severity Levels is based on ISA 71.04-2013:
“ISA Standard – Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants”; Instruments Society of America (ISA); 2013.

ISA Standard 71.04-2013			
Severity Level	Reactivity Level	Cu Corrosion Rate	Ag Corrosion Rate
G1	Mild	< 300 Å / month	< 200 Å / month
G2	Moderate	< 1000 Å / month	
G3	Harsh	< 2000 Å / month	
GX	Severe	> 2000 Å / month	

The corrosive reaction rate will be measured in the accelerate corrosion chamber. And then the expected thickness of silver corrosion can be ensured ISA 71.04 G3 compliance for 2 years.

4.5 TEST SETUP AND ANALYSIS CONDITION

Photo and diagram of Coulometric Reduction setup as below:



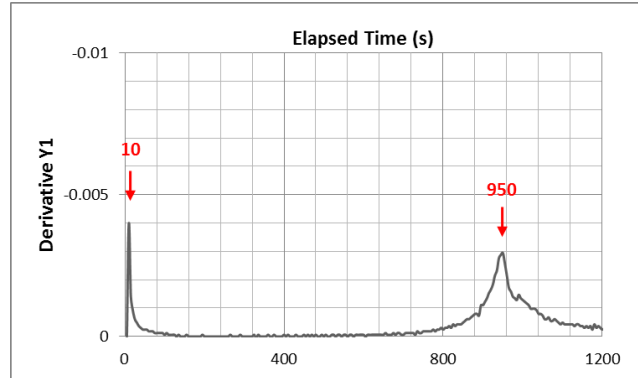
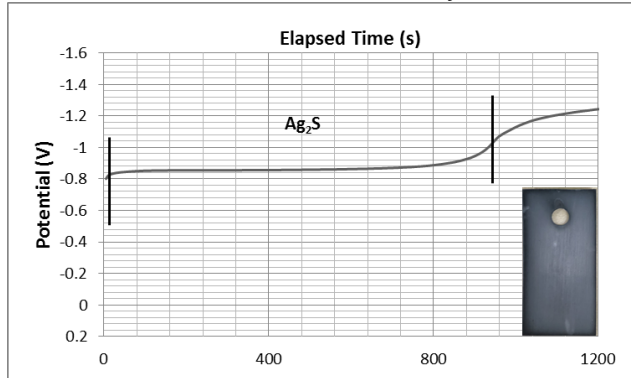
Coulometric Reduction Analysis

4.6 COULOMETRIC REDUCTION ANALYSIS

Corrosive Reaction Thickness Measurement

Coulometric/Cathodic Reduction Plots Analysis: Ag

Reduction Current Density: - 0.50 mA/cm²



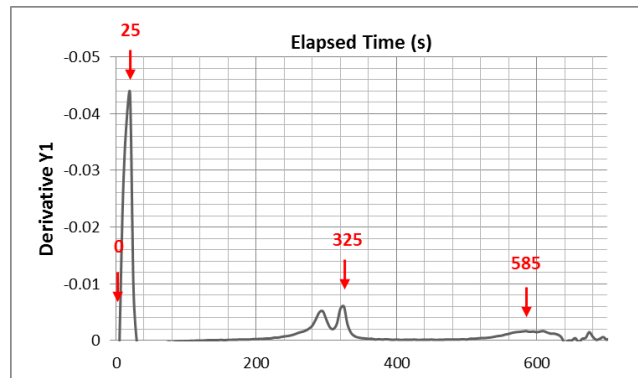
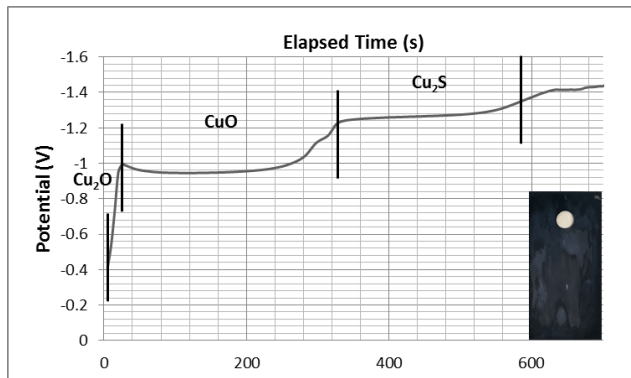
Reduction Curve

Differential Analysis

Silver Corrosion Product	Seconds	Thickness, angstroms	Exposure Days	Silver Corrosion Rate, angstroms/day
AgCl	0	0	1	8244
Ag ₂ S	940	8244		

Coulometric/Cathodic Reduction Plots Analysis: Cu_Day0-Day1

Reduction Current Density: -2.00 mA/cm²



Reduction Curve

Differential Analysis

Copper Corrosion Product	Seconds	Thickness, angstroms	Exposure Days	Copper Corrosion Rate, angstroms/day
Cu ₂ O	25	618	1	12142
CuO	300	3864		
Cu ₂ S	260	7660		

4.7 RESULTS OF ANALYSIS

The Results of Corrosive Reaction Thickness Measurement as below (using Coulometric Reduction Analysis).:

Duration	Corrosive Reaction Thickness (Angstroms, Å)						
	Silver (Ag)			Copper (Cu)			
	AgCl	Ag ₂ S	Total Ag	Cu ₂ O	CuO	Cu ₂ S	Total Cu
Day0-Day8	0	65,952	65,952	4,944	30,912	61,280	97,136

ISA 71.04 G3 Severity Level	Expected Film Thickness for Corrosion	
	Silver (Ag)	Copper (Cu)
1-year warranty (12 months)	24,000 Å	24,000 Å
2-years warranty (24 months)	48,000 Å	48,000 Å
Accelerated Corrosion (8 days)	65,952 Å	97,136 Å
Assessed Simulation Time in G3	2.74 year	4.05 year

5. SUMMARY OF TEST

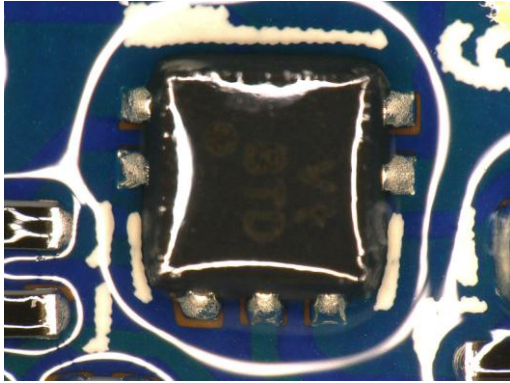
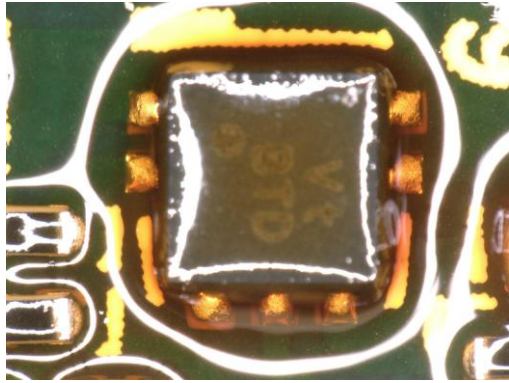
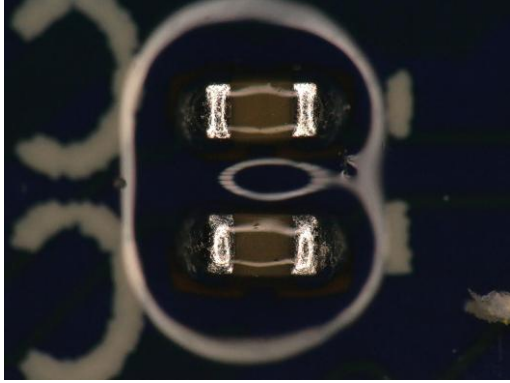
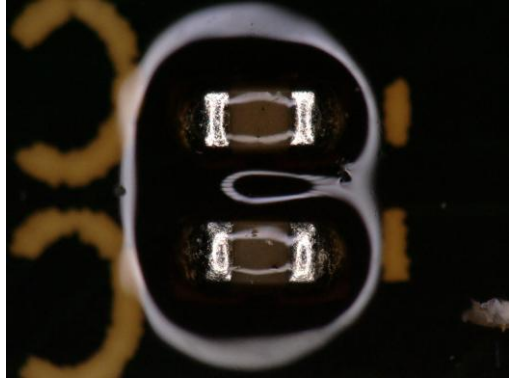
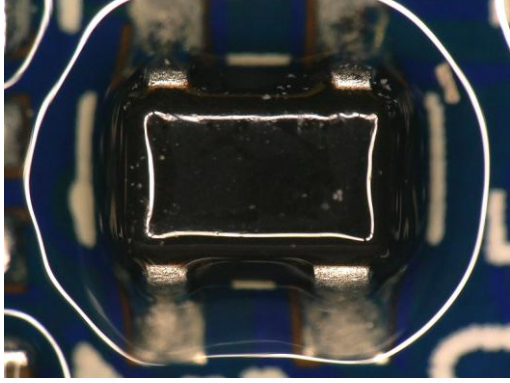
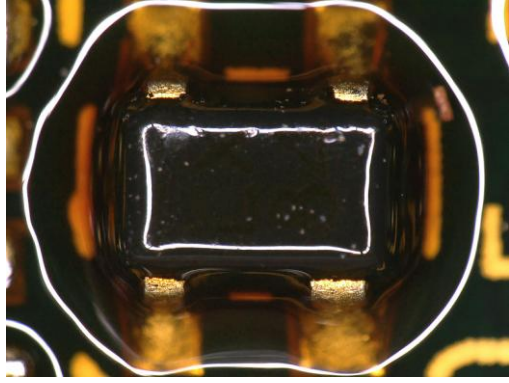
- The results of visual inspection shown "**Passed**" in this test run. (Criterion: Severe creep corrosion is "Failed" that bridge feature will induce electrical short)
 - * No obvious corrosion was observed in this test run.
 - * However, the function test will determine the final result which is "Passed" or "Failed".
- The results of functional test shown "**Passed**" in this test run. (Criterion: No performance deviations observed)
- The corrosion thickness growth with **8 days accelerated test** can be satisfied the **ISA 71.04 G3 severity level** with **2.74-year warranty** and **4.05-year warranty** for silver and copper, respectively. **Therefore, the expected thickness of silver corrosion can be ensured ISA 71.04 G3 compliance for 2 years in this test run.**

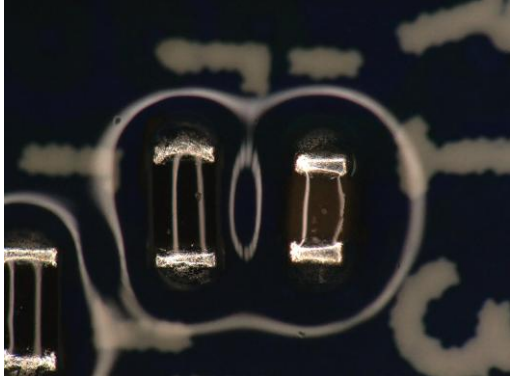
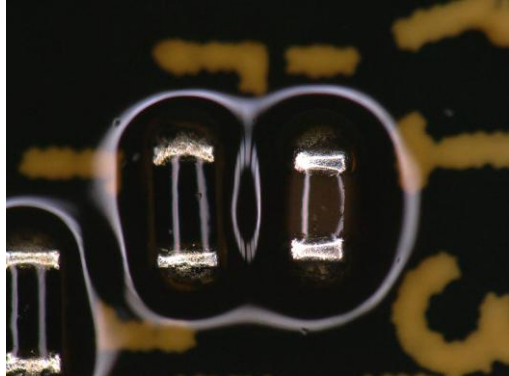
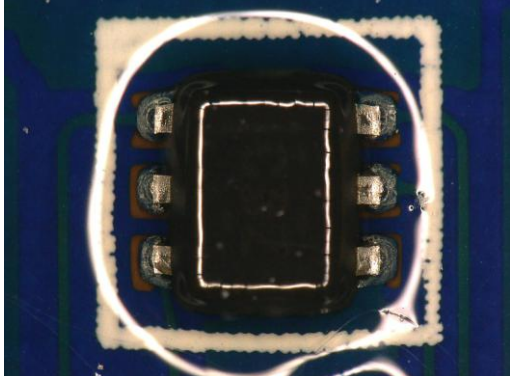
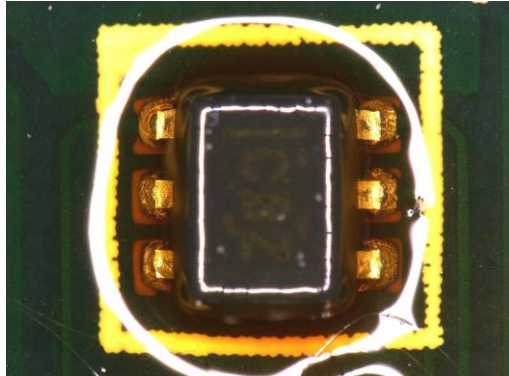
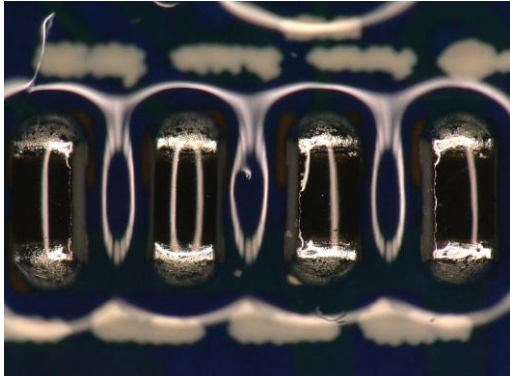
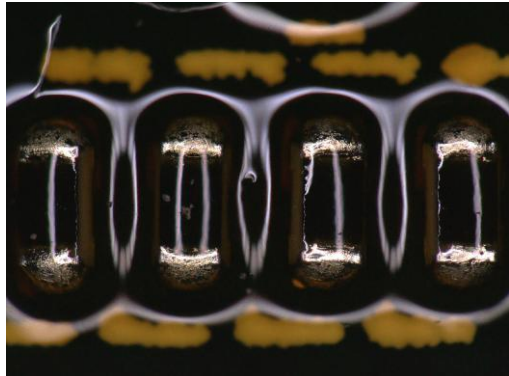
Attachment 1 :

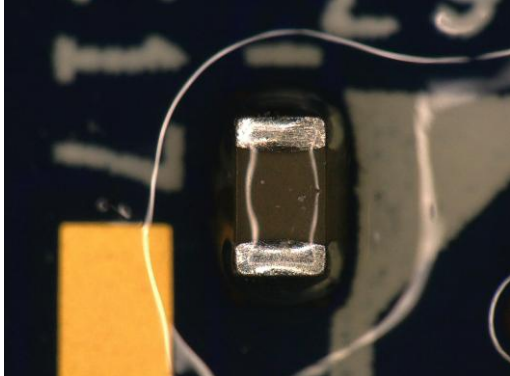
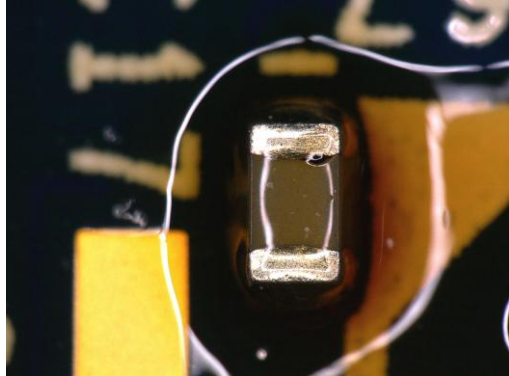
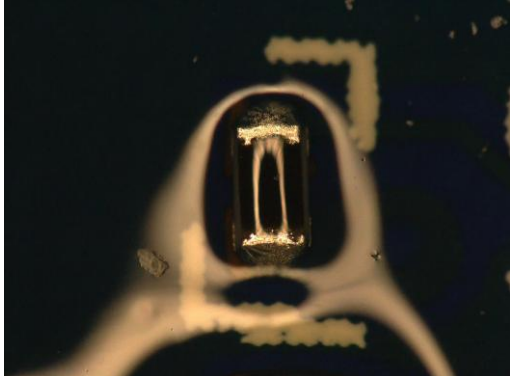
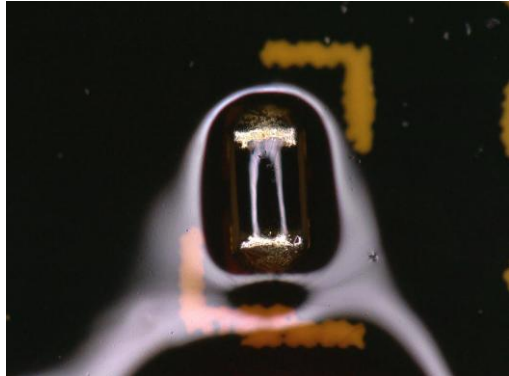
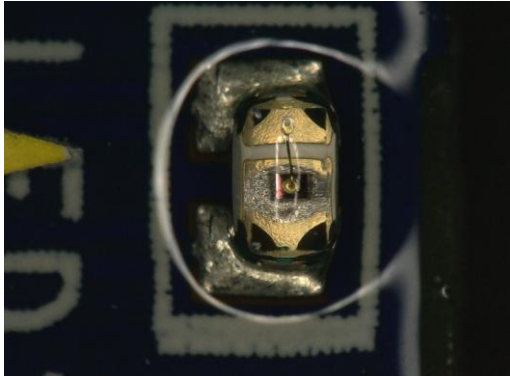
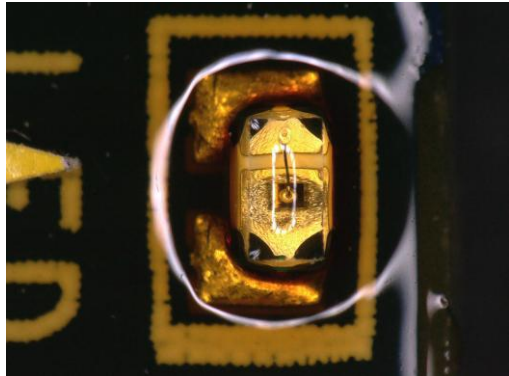
Please refer to the mapping and location of visual inspection as below:

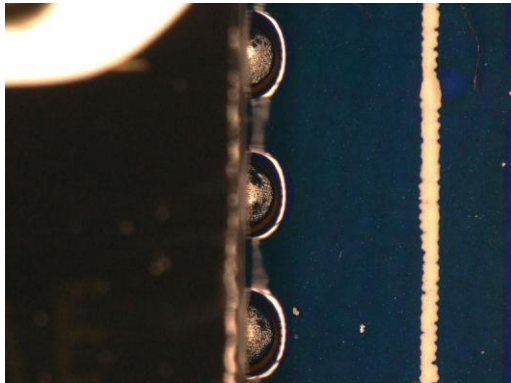
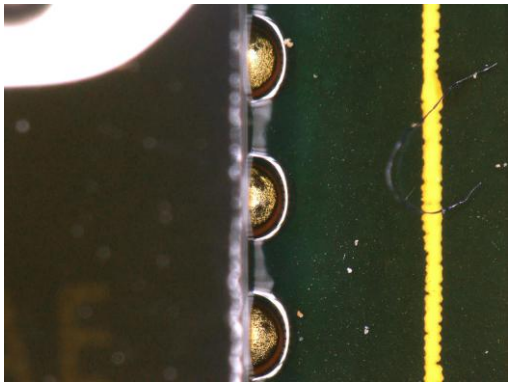


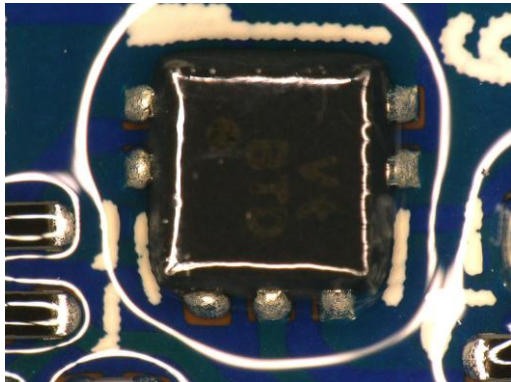
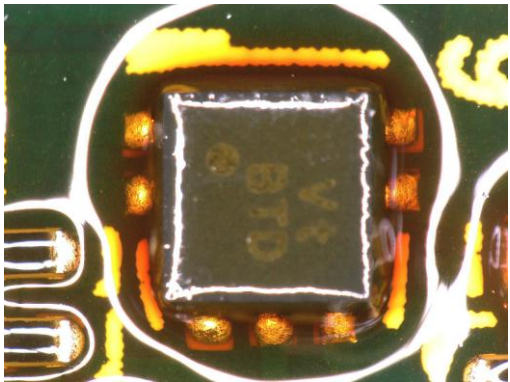
Please refer to the visual inspection in 50x-200x magnification by OM as below:

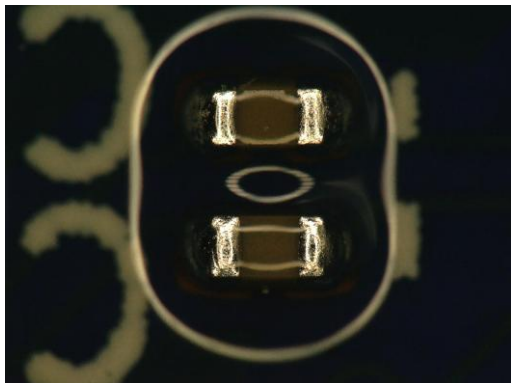
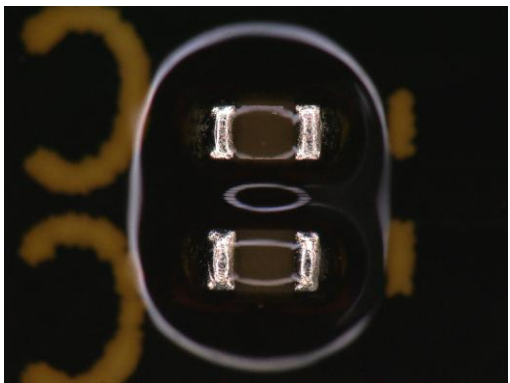
Location	Before Test (Day0)	After Test (Day8)
TV#01_01		
Results	No Corrosion	No Corrosion
TV#01_02		
Results	No Corrosion	No Corrosion
TV#01_03		
Results	No Corrosion	Leadframe Pitting/Pore Corrosion

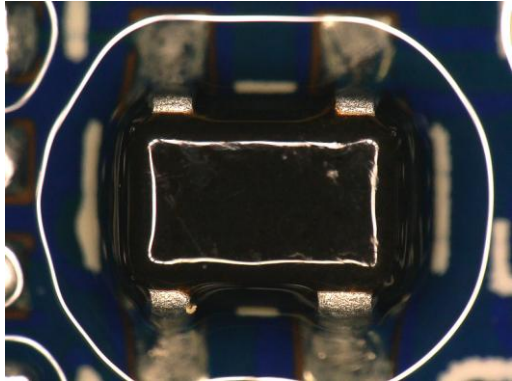
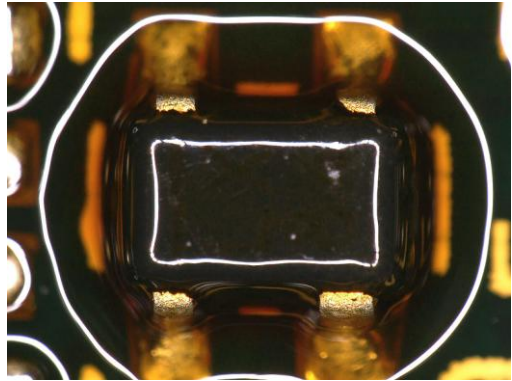
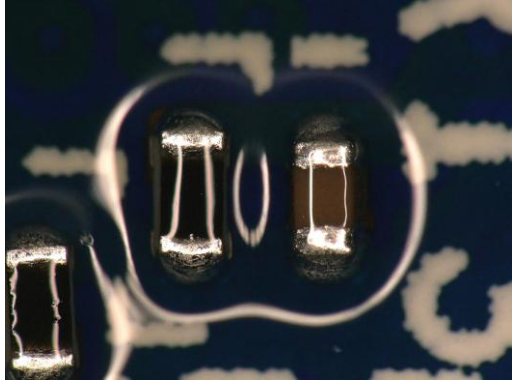
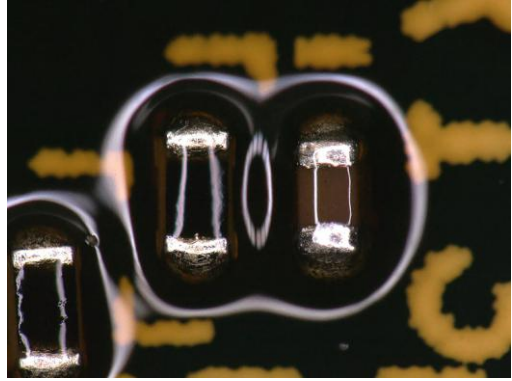
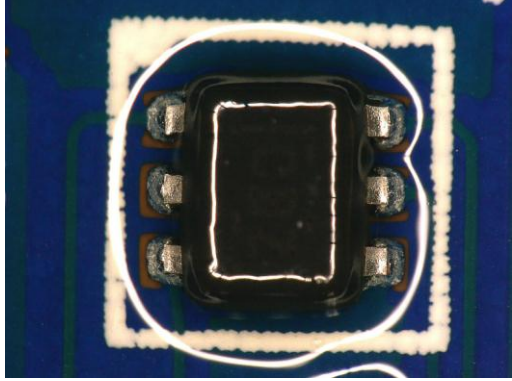
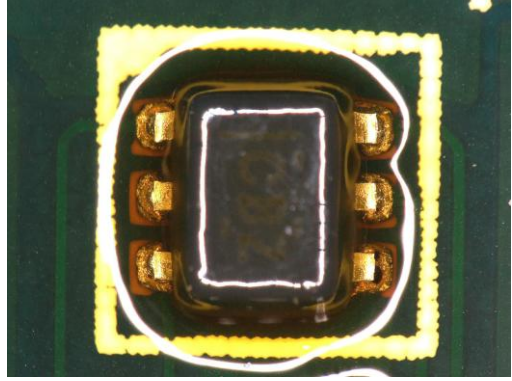
Location	Before Test (Day0)	After Test (Day8)
TV#01_04		
Results	No Corrosion	No Corrosion
TV#01_05		
Results	No Corrosion	No Corrosion
TV#01_06		
Results	No Corrosion	No Corrosion

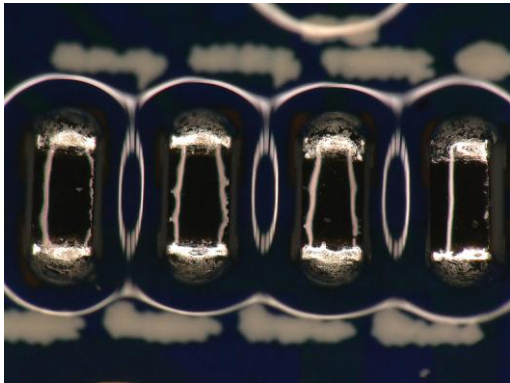
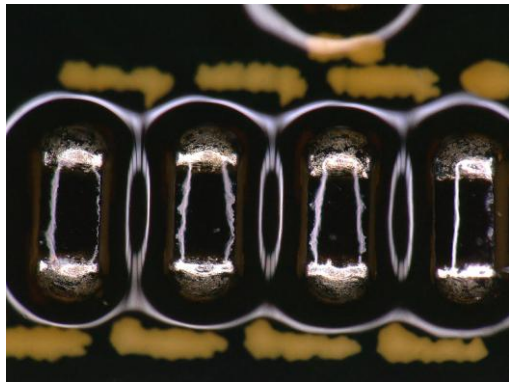
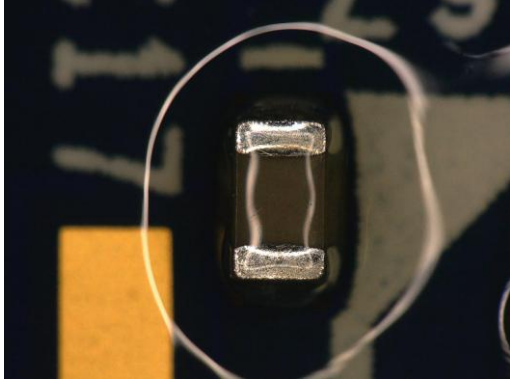
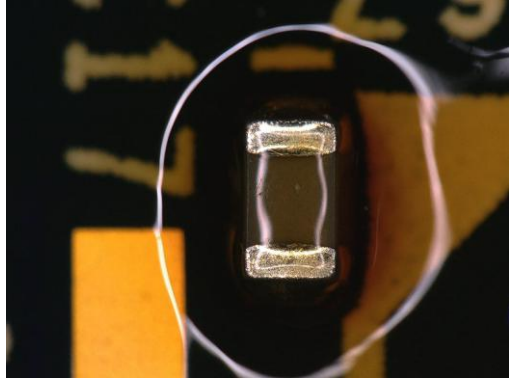
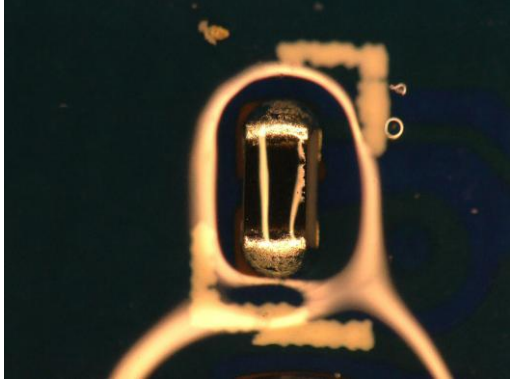
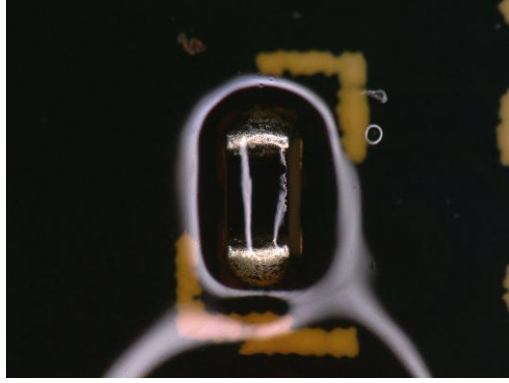
Location	Before Test (Day0)	After Test (Day8)
TV#01_07		
Results	No Corrosion	Pitting/Pore Corrosion
TV#01_08		
Results	No Corrosion	No Corrosion
TV#01_09		
Results	No Corrosion	No Corrosion

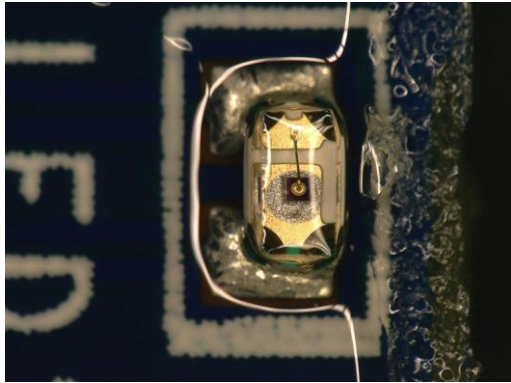
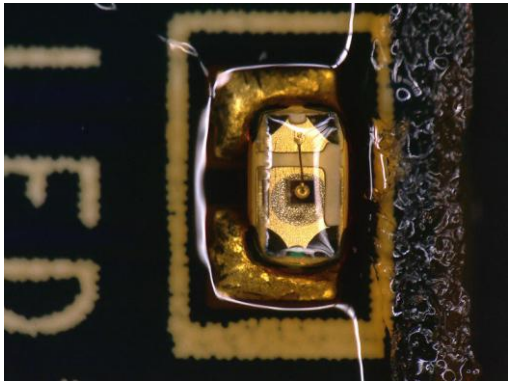
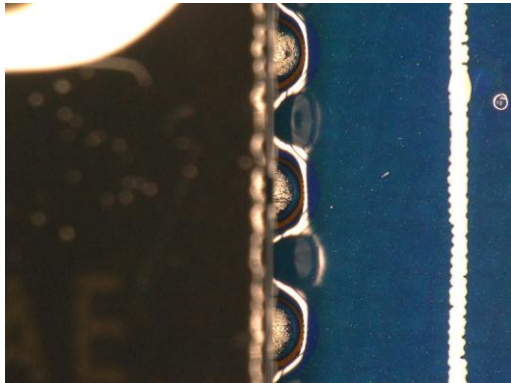
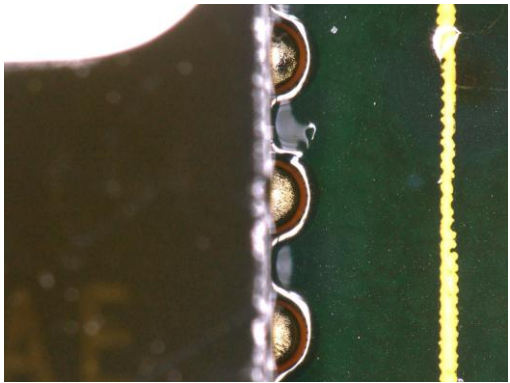
Location	Before Test (Day0)	After Test (Day8)
TV#01_10		
Results	No Corrosion	No Corrosion

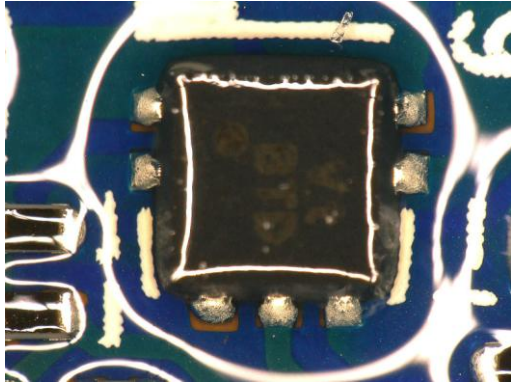
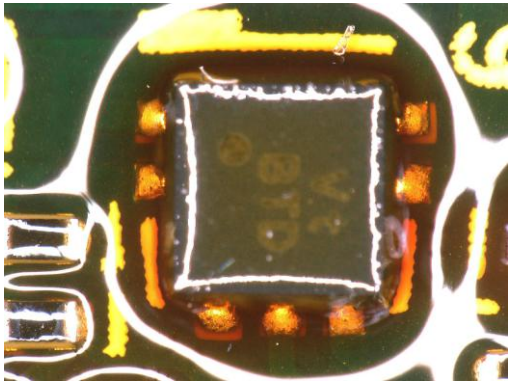
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TV#02_01		
Results	No Corrosion	No Corrosion

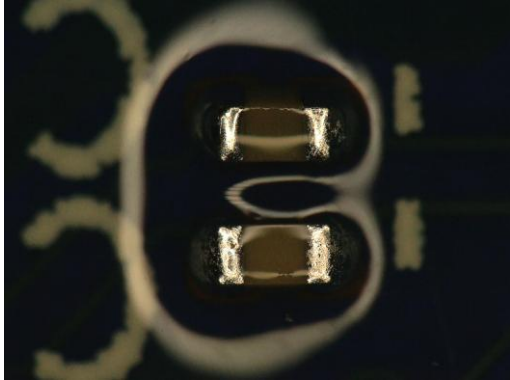
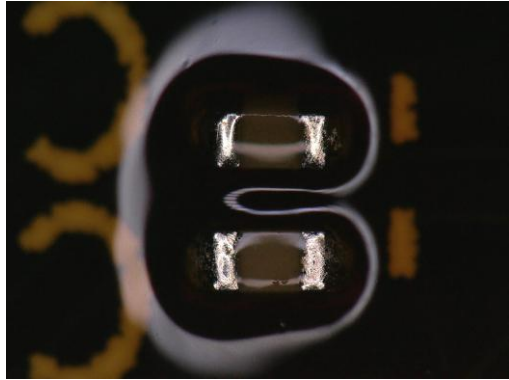
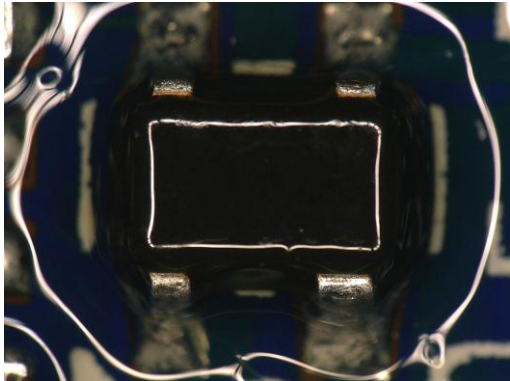
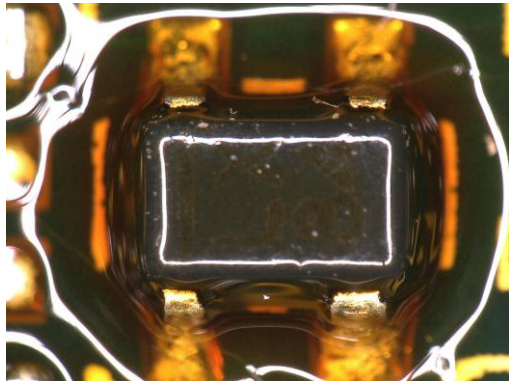
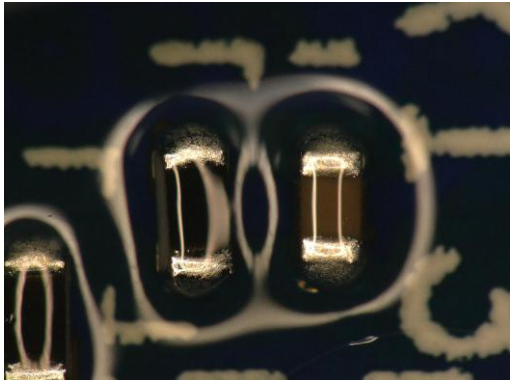

TV#02_02		
Results	No Corrosion	No Corrosion

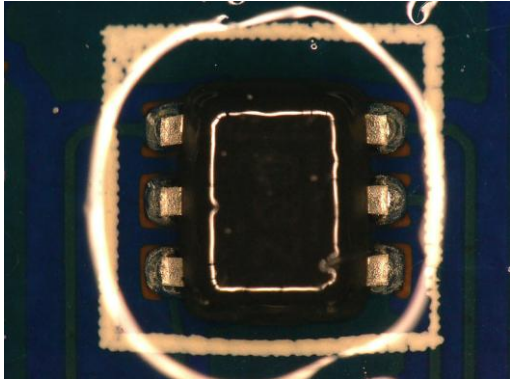
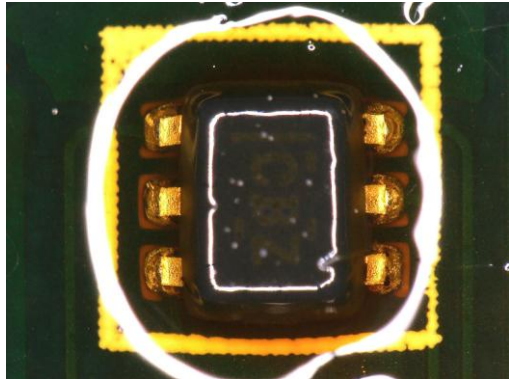
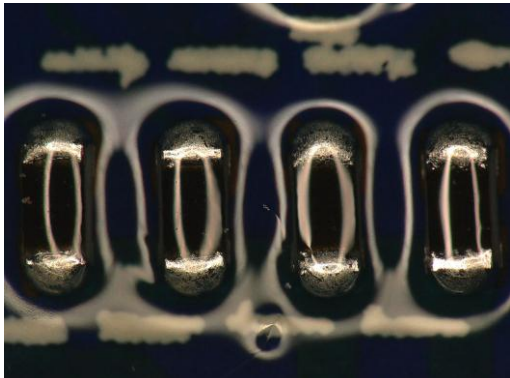
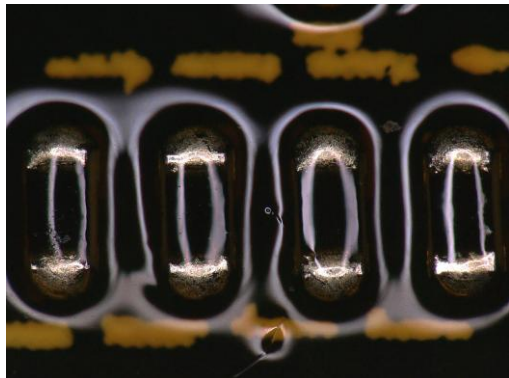
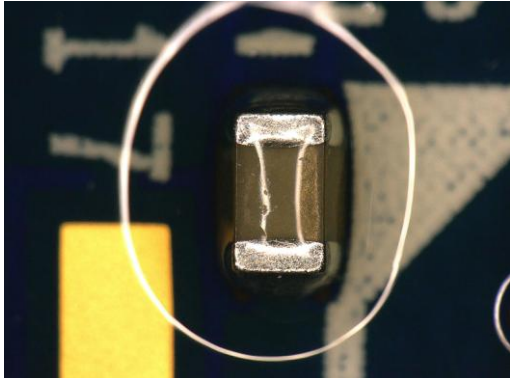
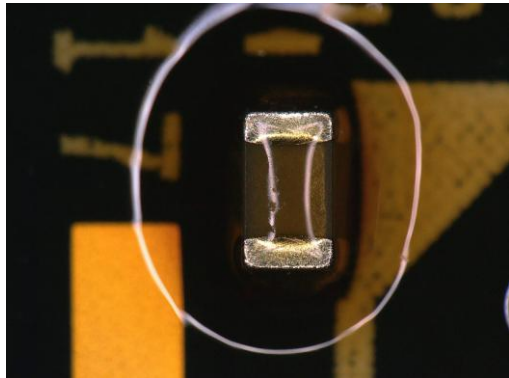
Location	Before Test (Day0)	After Test (Day8)
TV#02_03		
Results	No Corrosion	Leadframe Pitting/Pore Corrosion
TV#02_04		
Results	No Corrosion	No Corrosion
TV#02_05		
Results	No Corrosion	Leadframe Pitting/Pore Corrosion

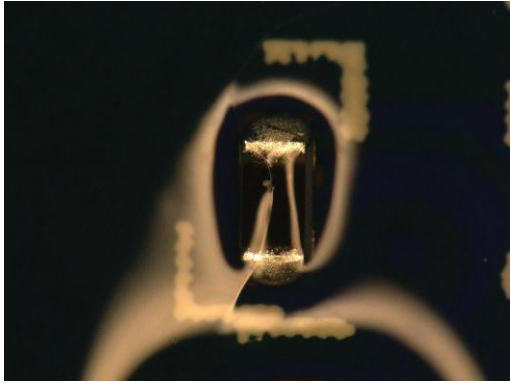
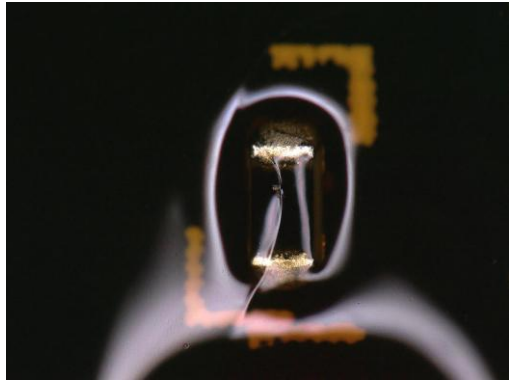
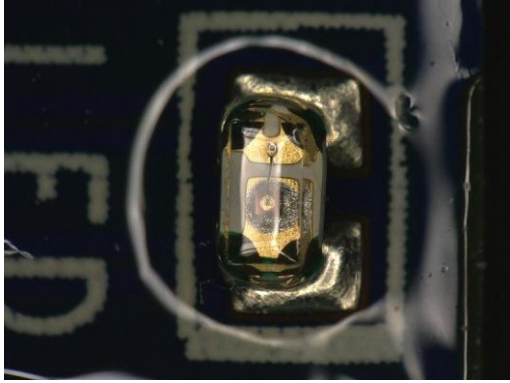
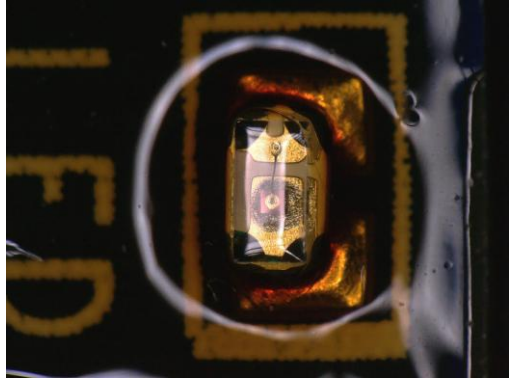
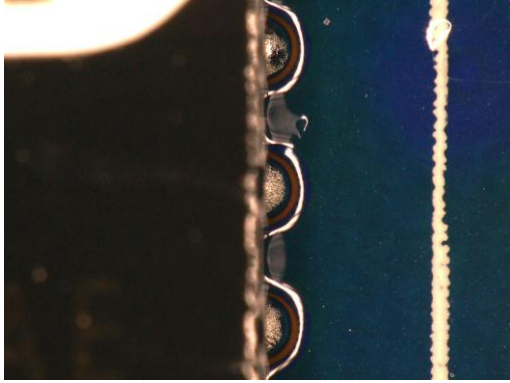
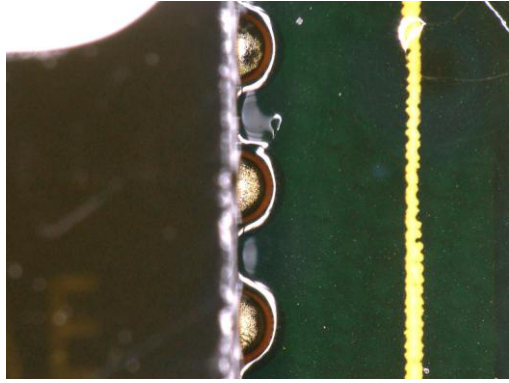
Location	Before Test (Day0)	After Test (Day8)
TV#02_06		
Results	No Corrosion	No Corrosion
TV#02_07		
Results	No Corrosion	No Corrosion
TV#02_08		
Results	No Corrosion	No Corrosion

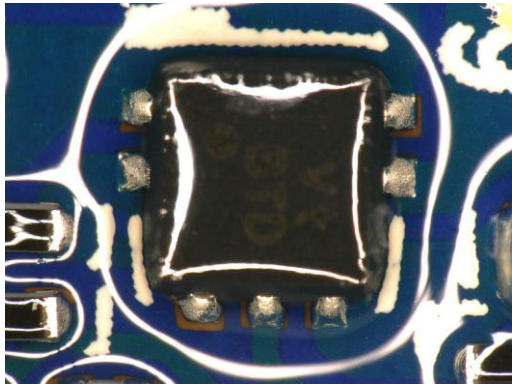
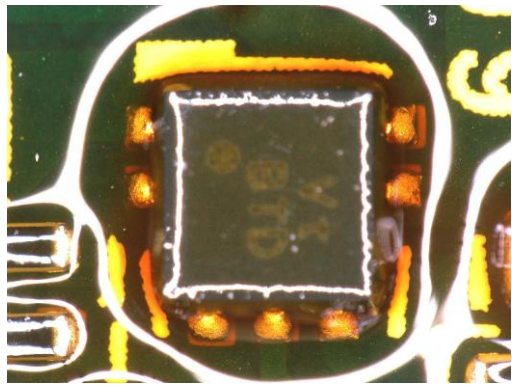
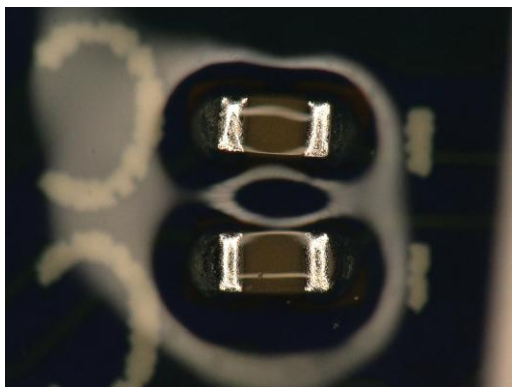
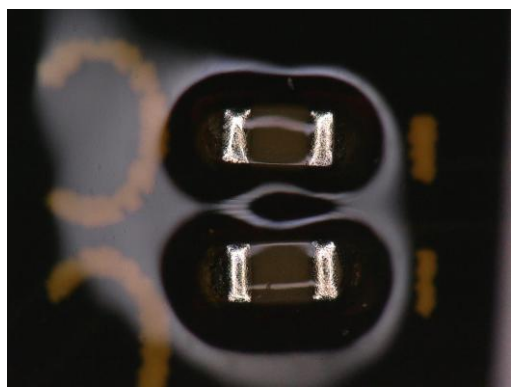
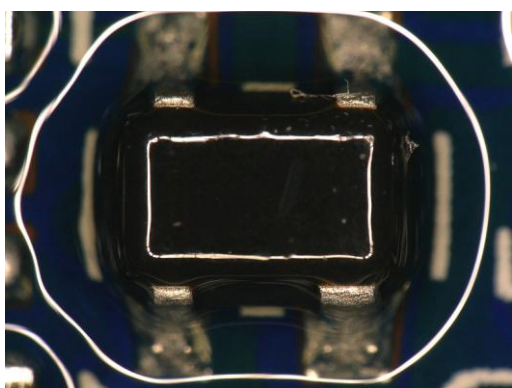
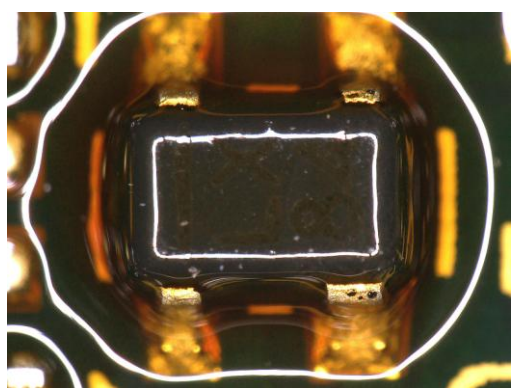
Location	Before Test (Day0)	After Test (Day8)
TV#02_09		
Results	No Corrosion	No Corrosion
TV#02_10		
Results	No Corrosion	No Corrosion

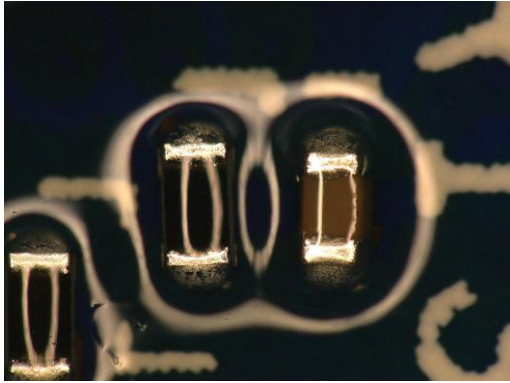
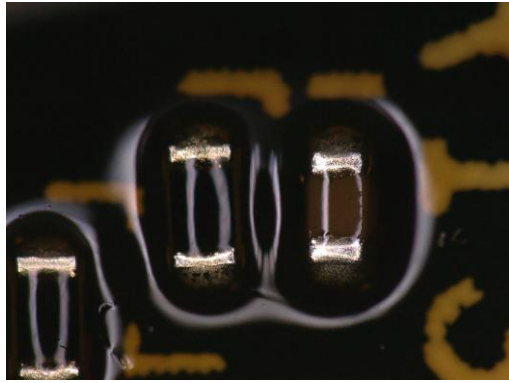
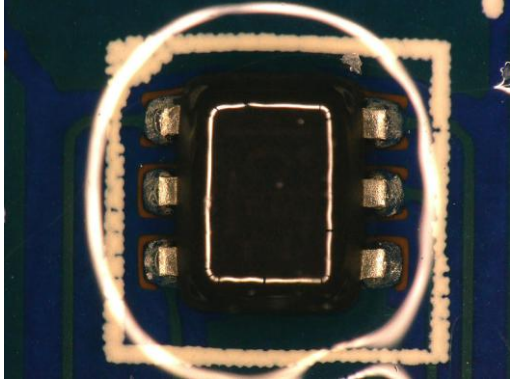
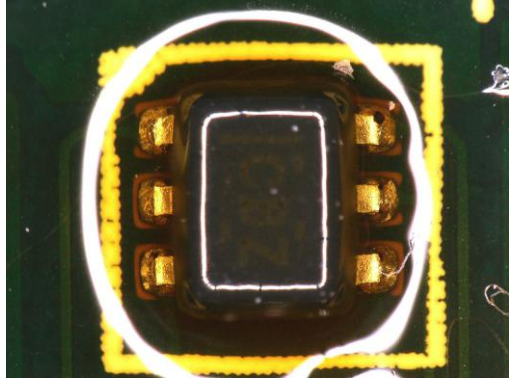
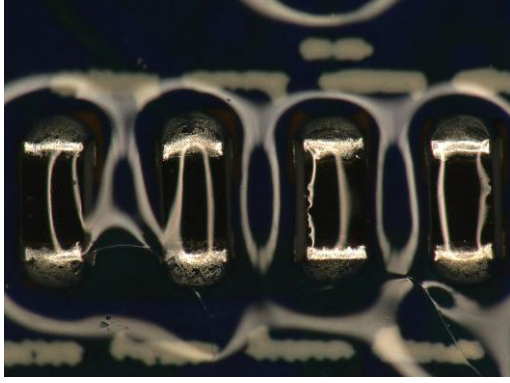
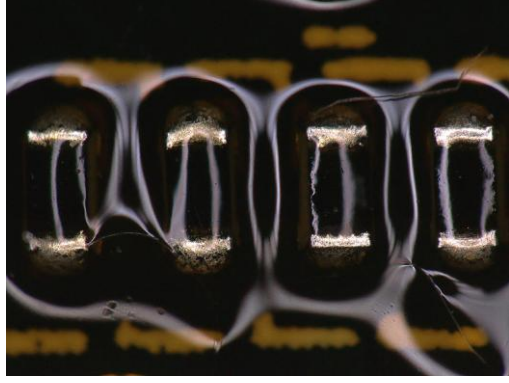
Location	Before Test (Day0)	After Test (Day8)
TV#03_01		
Results	No Corrosion	No Corrosion

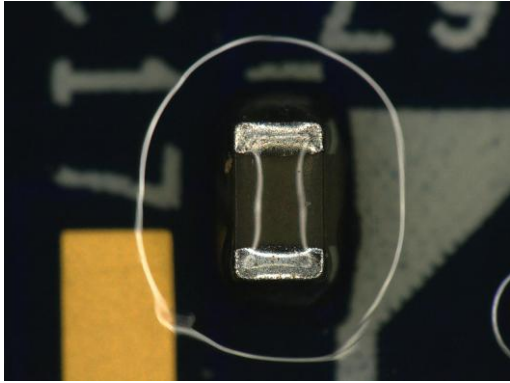
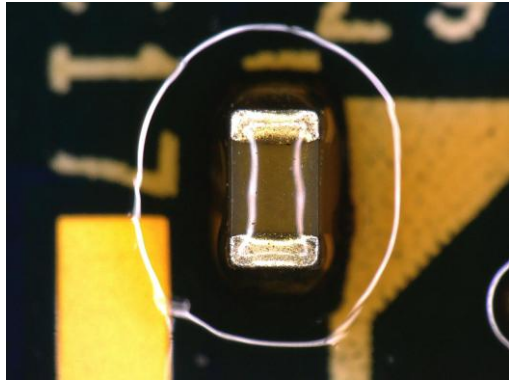
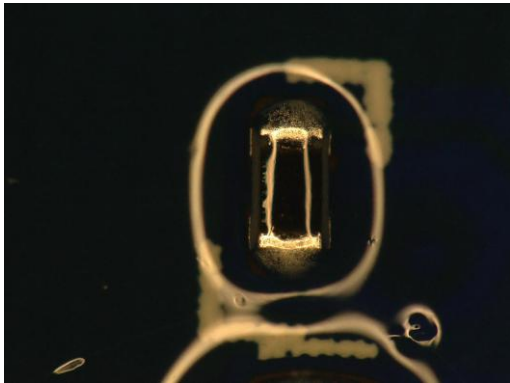
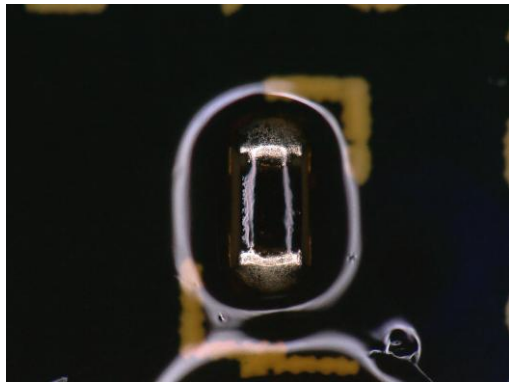
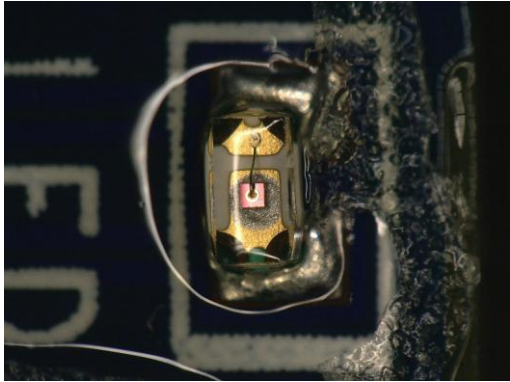
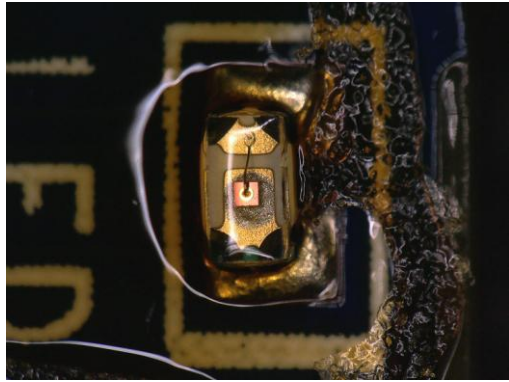
Location	Before Test (Day0)	After Test (Day8)
TV#03_02		
Results	No Corrosion	No Corrosion
TV#03_03		
Results	No Corrosion	Leadframe Pitting/Pore Corrosion
TV#03_04		
Results	No Corrosion	No Corrosion

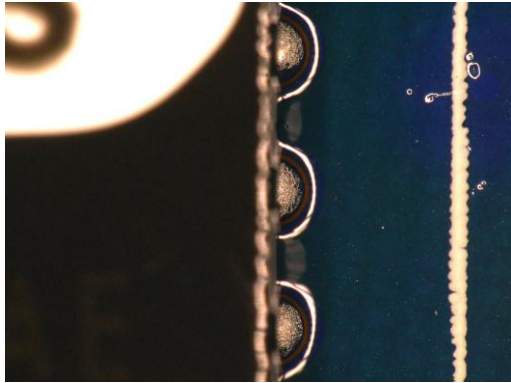
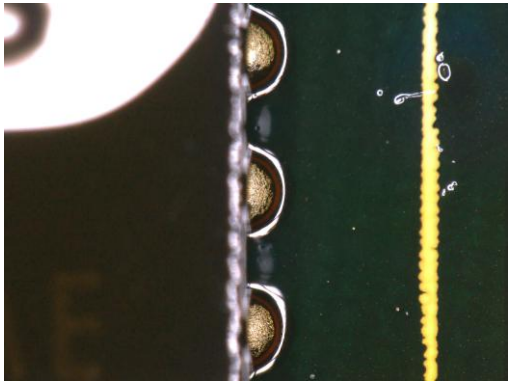
Location	Before Test (Day0)	After Test (Day8)
TV#03_05		
Results	No Corrosion	Leadframe Pitting/Pore Corrosion
TV#03_06		
Results	No Corrosion	No Corrosion
TV#03_07		
Results	No Corrosion	No Corrosion

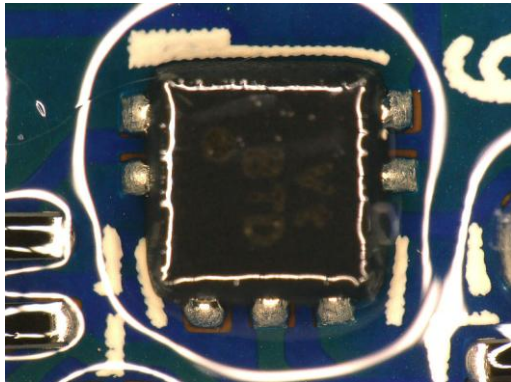
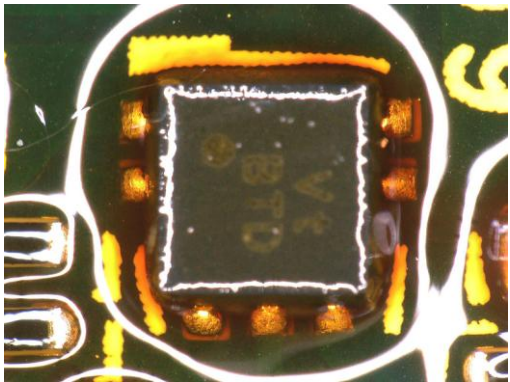
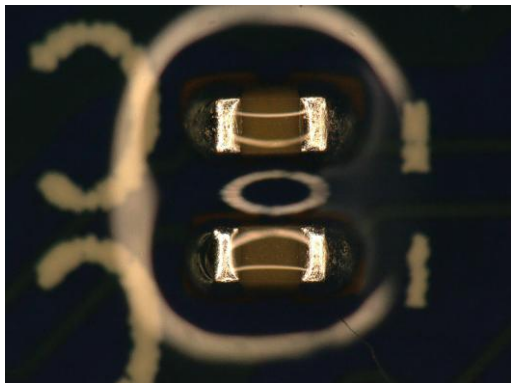
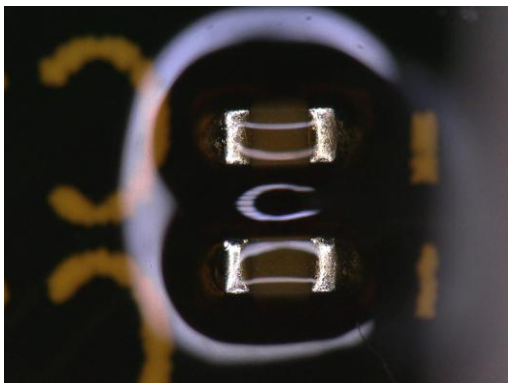
Location	Before Test (Day0)	After Test (Day8)
TV#03_08		
Results	No Corrosion	No Corrosion
TV#03_09		
Results	No Corrosion	No Corrosion
TV#03_10		
Results	No Corrosion	No Corrosion

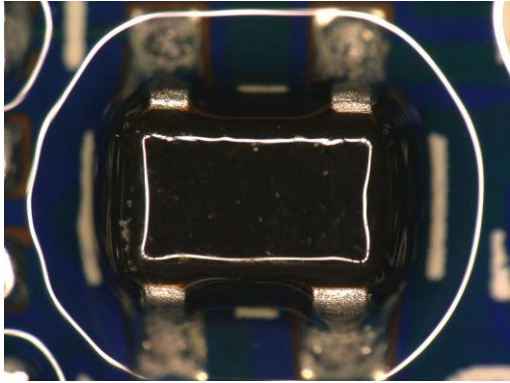
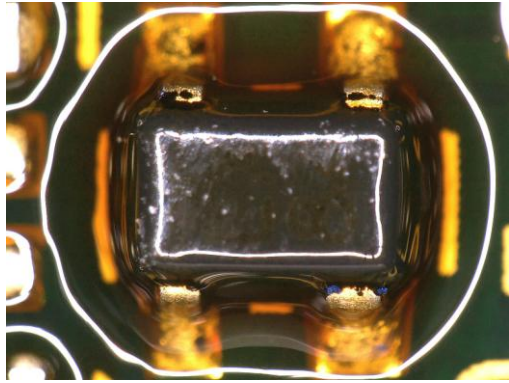
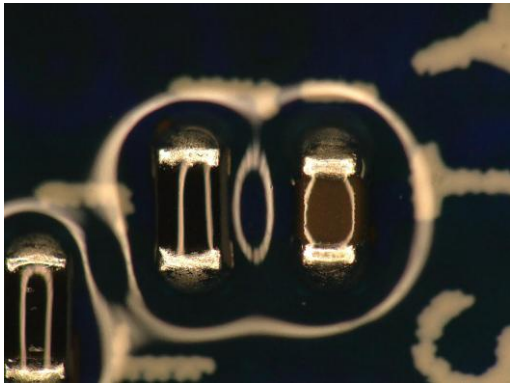
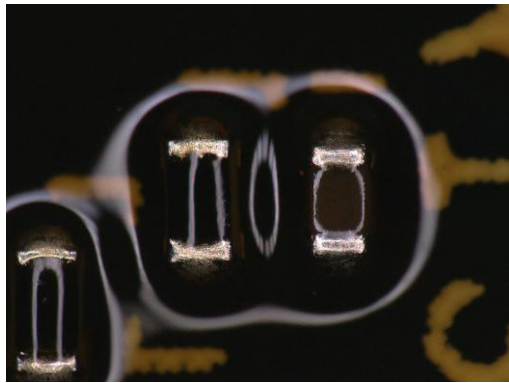
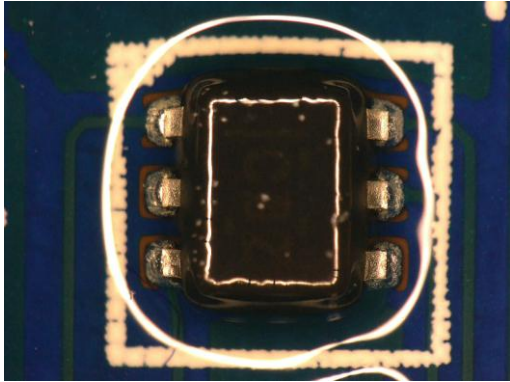
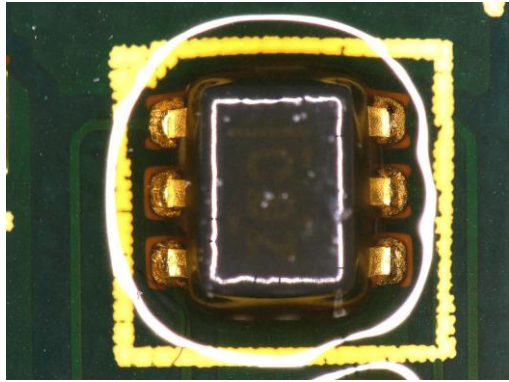
Location	Before Test (Day0)	After Test (Day8)
TV#04_01		
Results	No Corrosion	No Corrosion
TV#04_02		
Results	No Corrosion	No Corrosion
TV#04_03		
Results	No Corrosion	Leadframe Pitting/Pore Corrosion

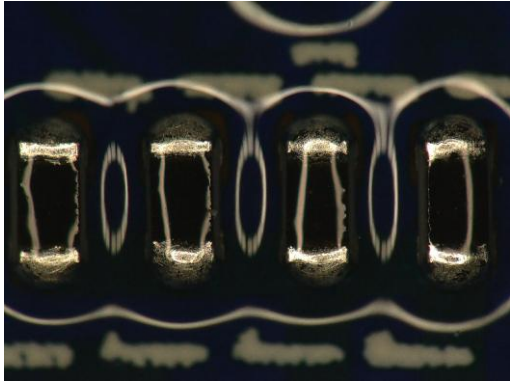
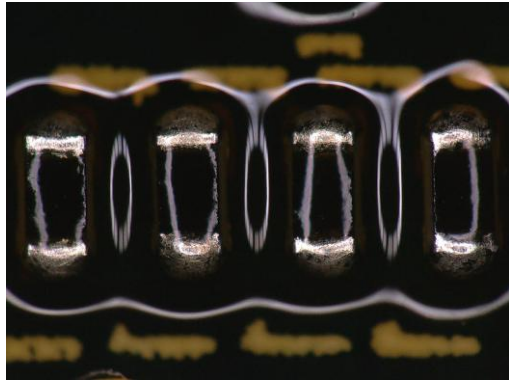
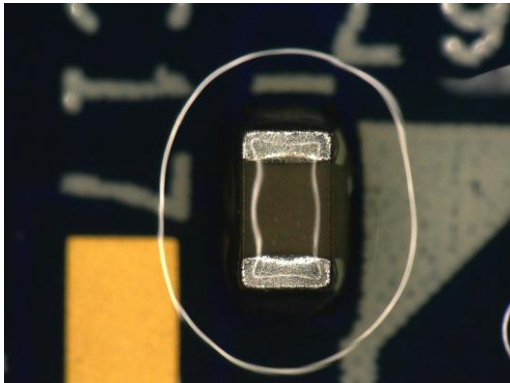
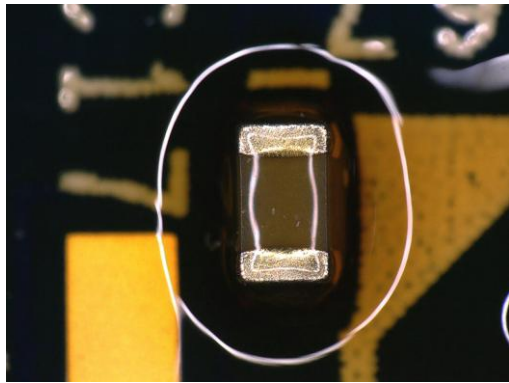
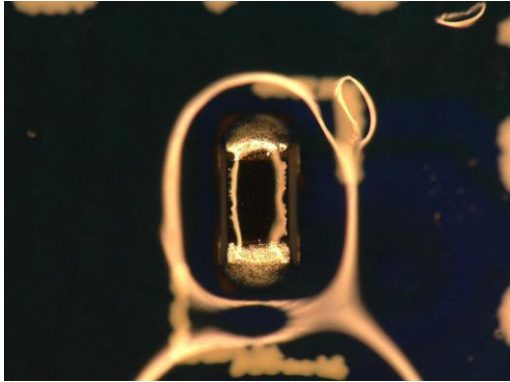
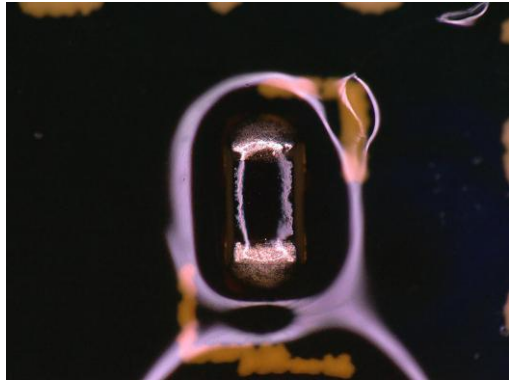
Location	Before Test (Day0)	After Test (Day8)
TV#04_04		
Results	No Corrosion	No Corrosion
TV#04_05		
Results	No Corrosion	Leadframe Pitting/Pore Corrosion
TV#04_06		
Results	No Corrosion	No Corrosion

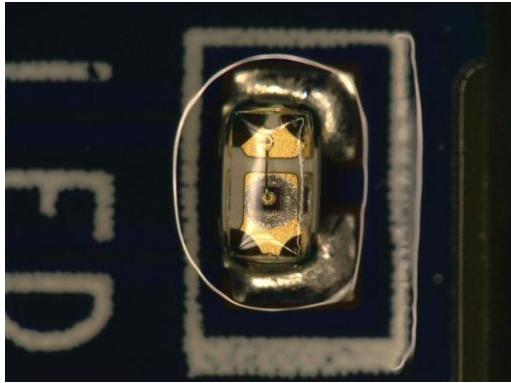
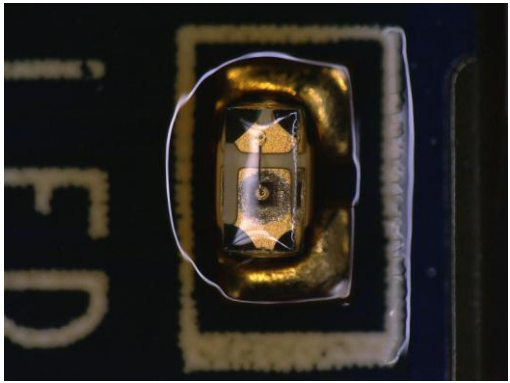
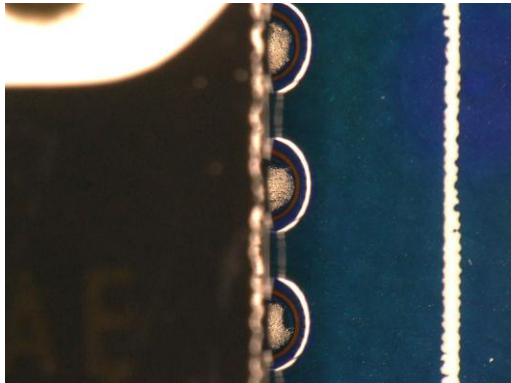
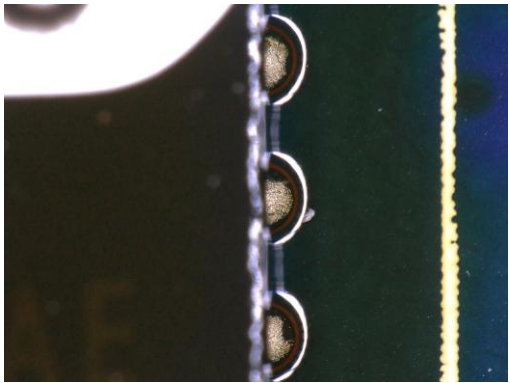
Location	Before Test (Day0)	After Test (Day8)
TV#04_07		
Results	No Corrosion	No Corrosion
TV#04_08		
Results	No Corrosion	No Corrosion
TV#04_09		
Results	No Corrosion	No Corrosion

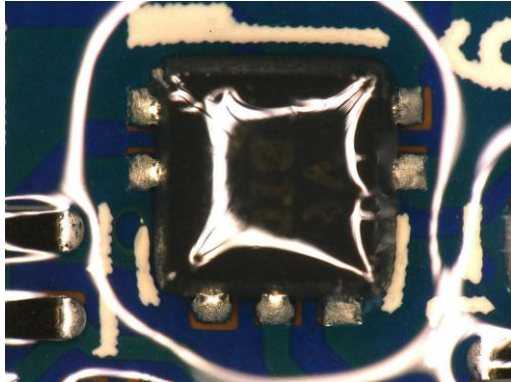
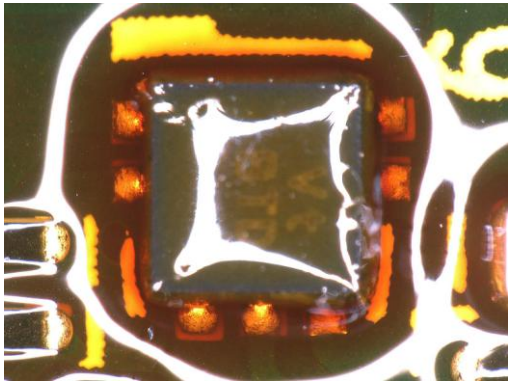
Location	Before Test (Day0)	After Test (Day8)
TV#04_10		
Results	No Corrosion	No Corrosion

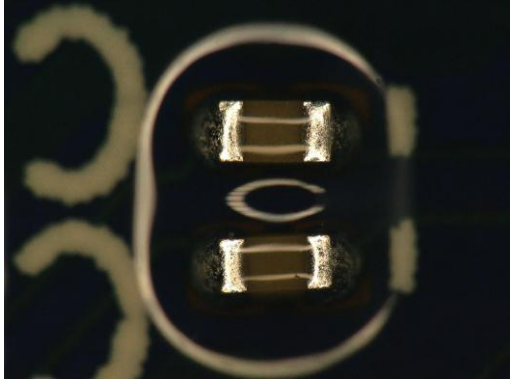
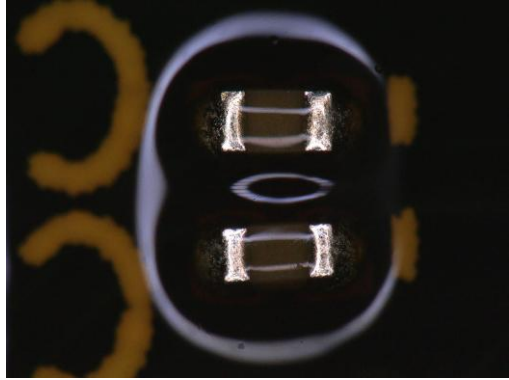
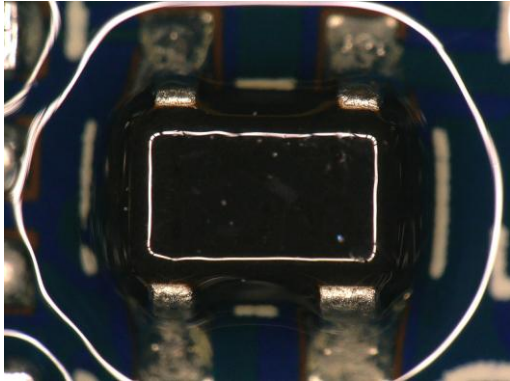
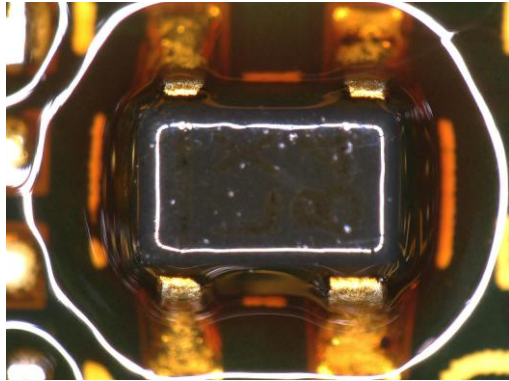
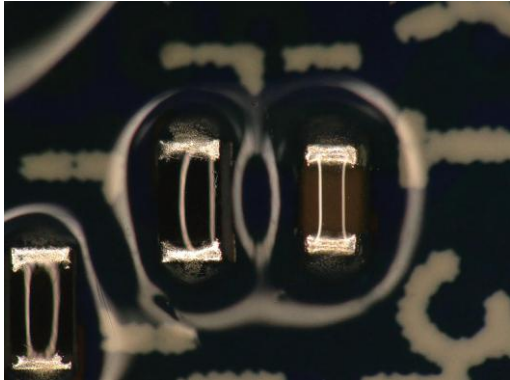
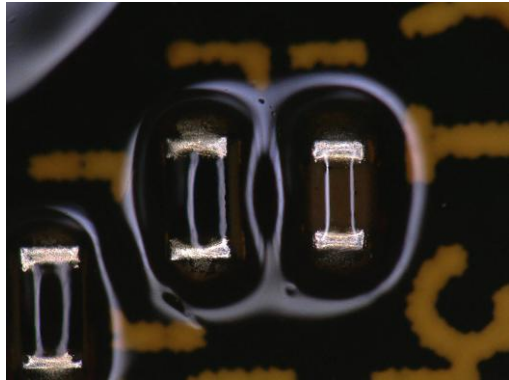
Location	Before Test (Day0)	After Test (Day8)
TV#05_01		
Results	No Corrosion	Leadframe Pitting/Pore Corrosion
TV#05_02		
Results	No Corrosion	No Corrosion

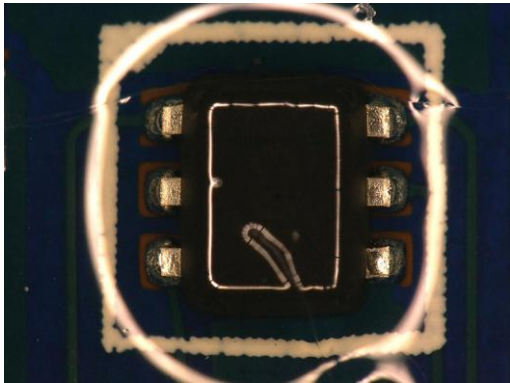
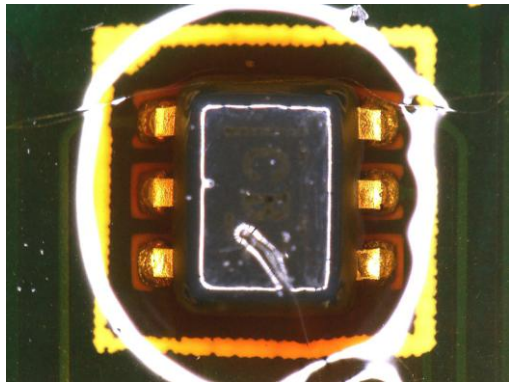
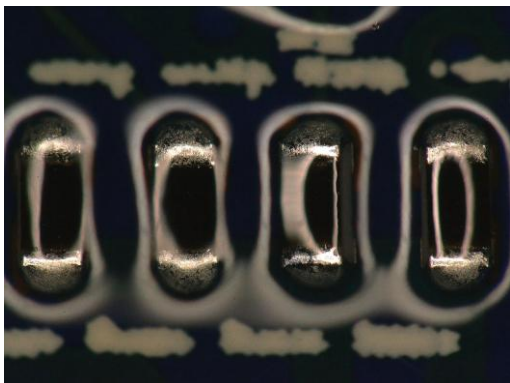
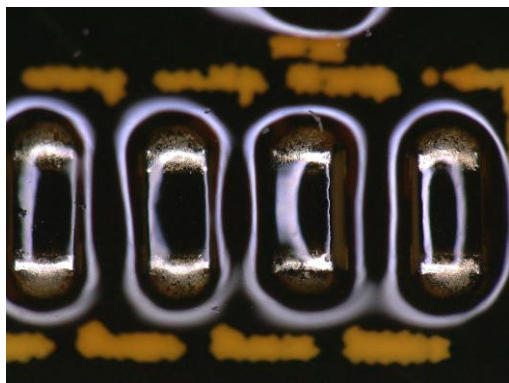
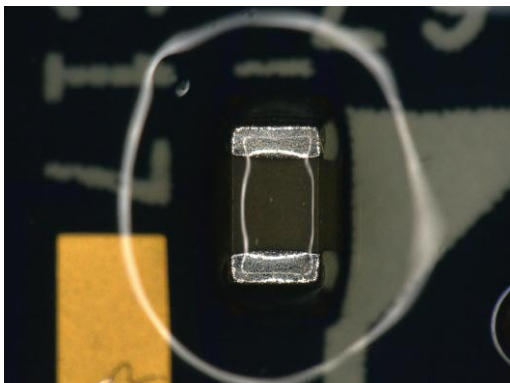
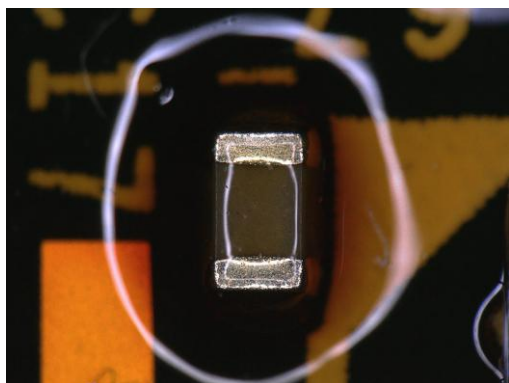
Location	Before Test (Day0)	After Test (Day8)
TV#05_03		
Results	No Corrosion	Leadframe Pitting/Pore Corrosion
TV#05_04		
Results	No Corrosion	No Corrosion
TV#05_05		
Results	No Corrosion	Leadframe Pitting/Pore Corrosion

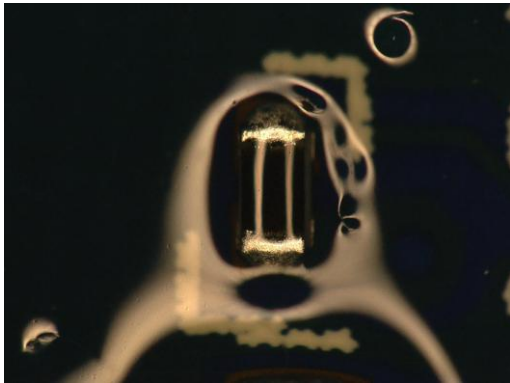
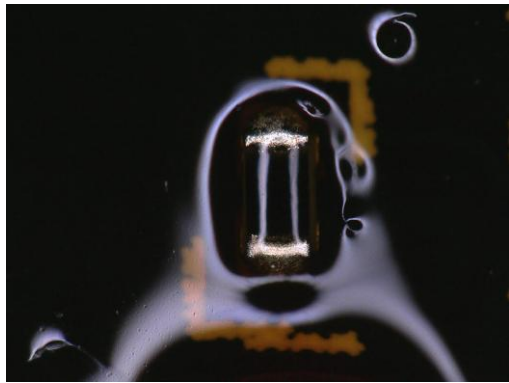
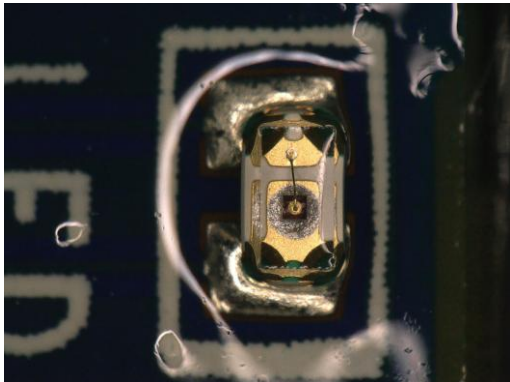
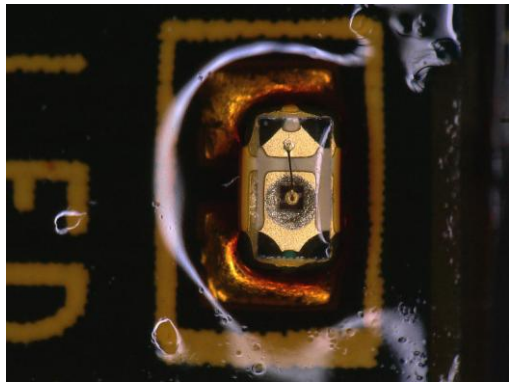
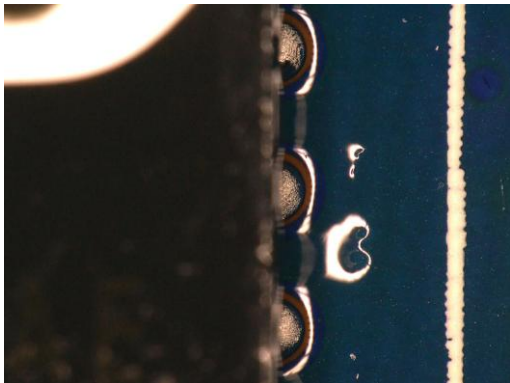
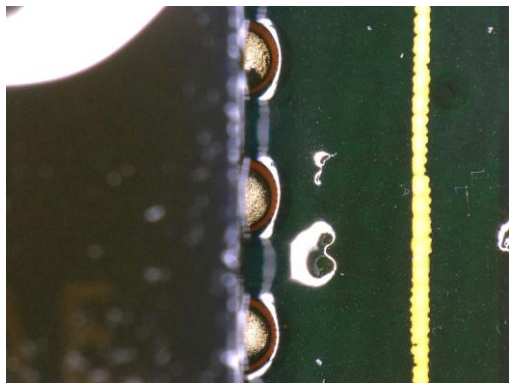
Location	Before Test (Day0)	After Test (Day8)
TV#05_06		
Results	No Corrosion	No Corrosion
TV#05_07		
Results	No Corrosion	No Corrosion
TV#05_08		
Results	No Corrosion	No Corrosion

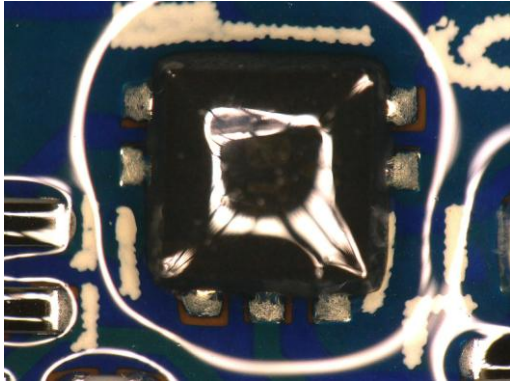
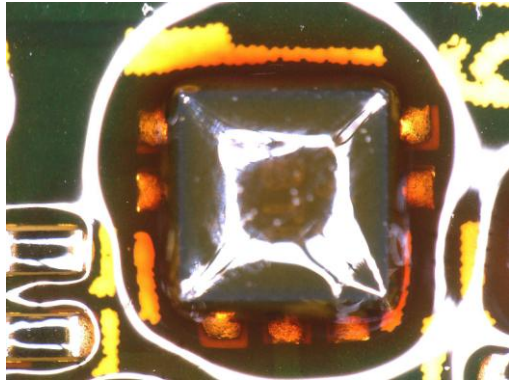
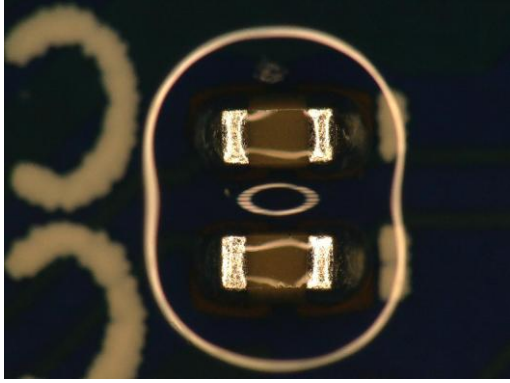
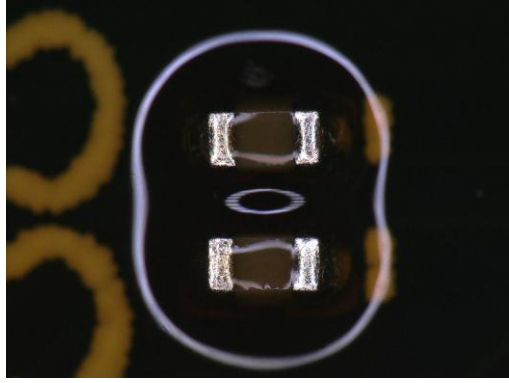
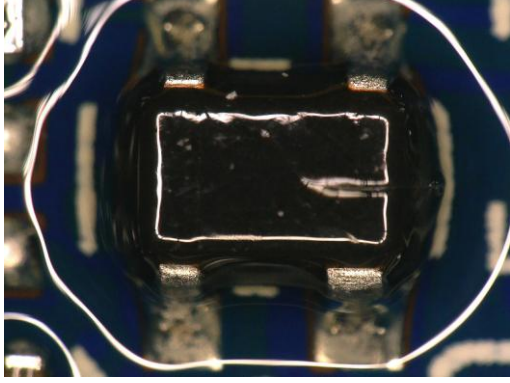
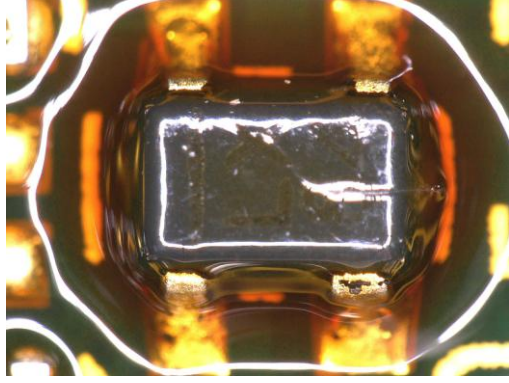
Location	Before Test (Day0)	After Test (Day8)
TV#05_09		
Results	No Corrosion	No Corrosion
TV#05_10		
Results	No Corrosion	No Corrosion

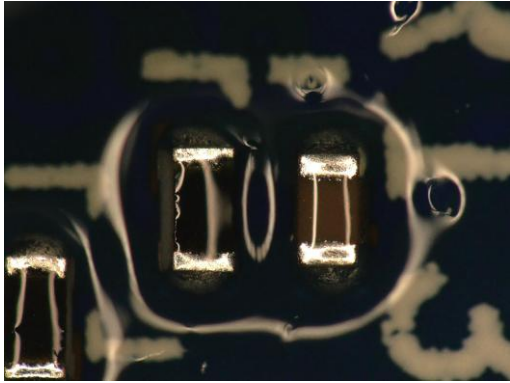
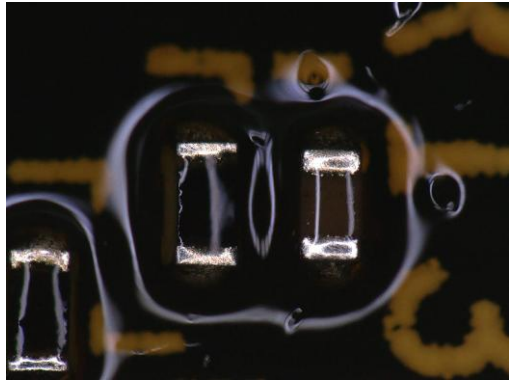
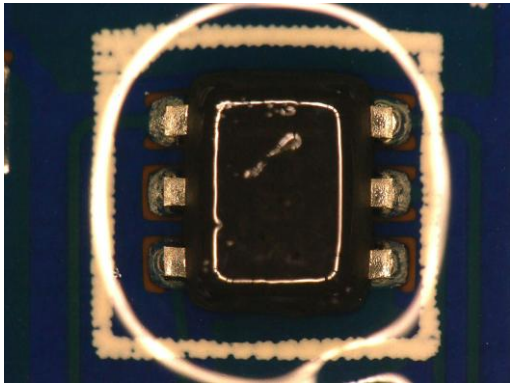
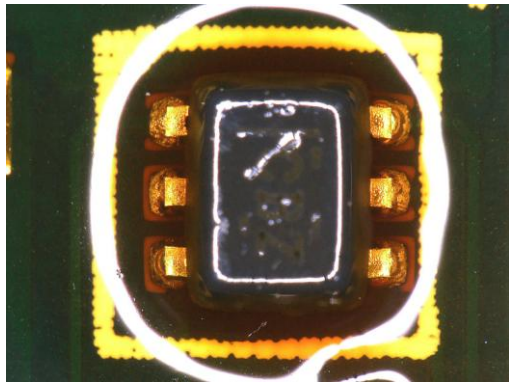
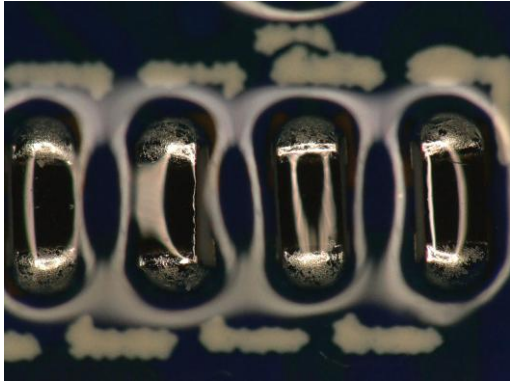
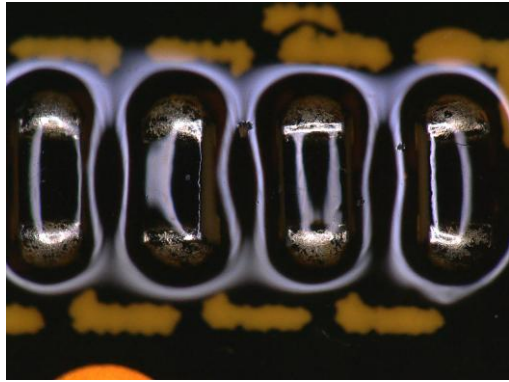
Location	Before Test (Day0)	After Test (Day8)
TV#06_01		
Results	No Corrosion	Leadframe Pitting/Pore Corrosion

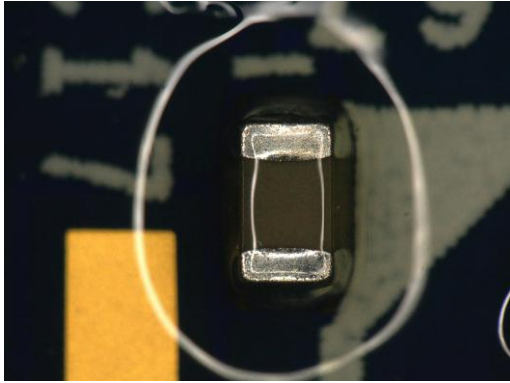
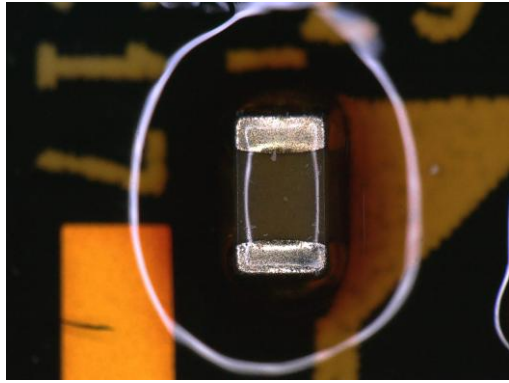
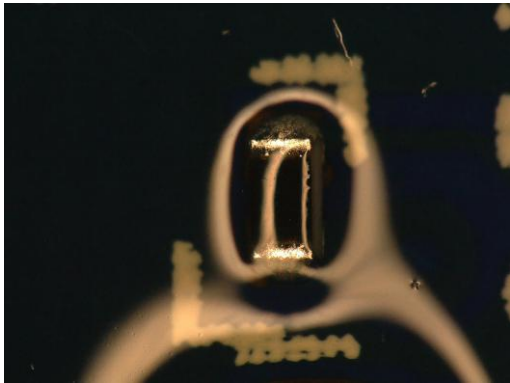
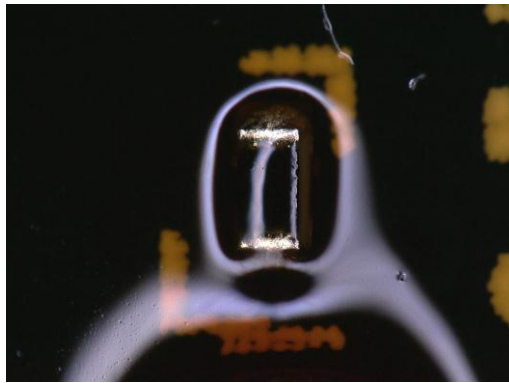
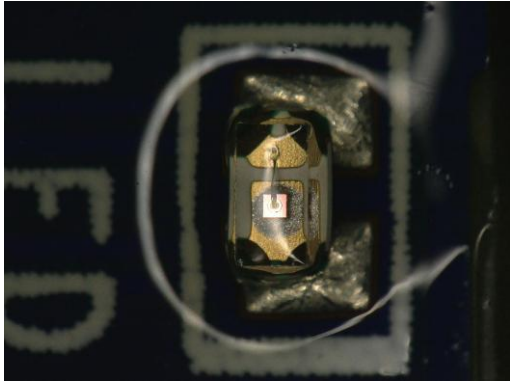
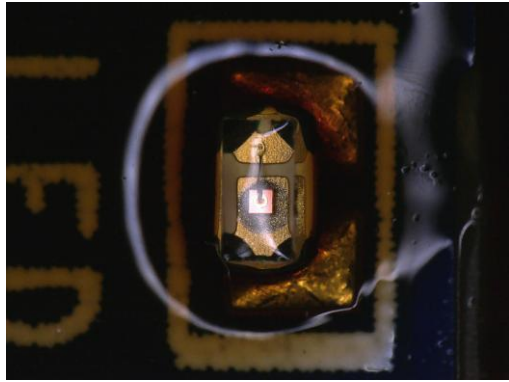
Location	Before Test (Day0)	After Test (Day8)
TV#06_02		
Results	No Corrosion	No Corrosion
TV#06_03		
Results	No Corrosion	Leadframe Pitting/Pore Corrosion
TV#06_04		
Results	No Corrosion	No Corrosion

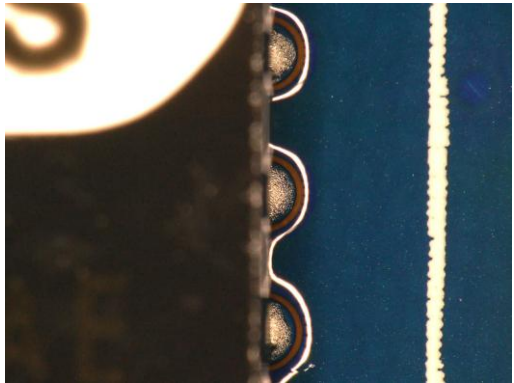
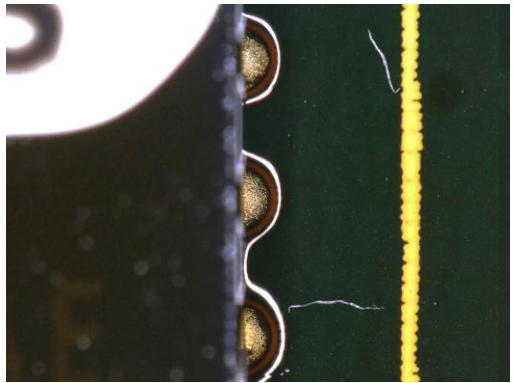
Location	Before Test (Day0)	After Test (Day8)
TV#06_05		
Results	No Corrosion	Leadframe Pitting/Pore Corrosion
TV#06_06		
Results	No Corrosion	No Corrosion
TV#06_07		
Results	No Corrosion	No Corrosion

Location	Before Test (Day0)	After Test (Day8)
TV#06_08		
Results	No Corrosion	No Corrosion
TV#06_09		
Results	No Corrosion	No Corrosion
TV#06_10		
Results	No Corrosion	No Corrosion

Location	Before Test (Day0)	After Test (Day8)
TV#07_01		
Results	No Corrosion	Leadframe Pitting/Pore Corrosion
TV#07_02		
Results	No Corrosion	No Corrosion
TV#07_03		
Results	No Corrosion	Leadframe Pitting/Pore Corrosion

Location	Before Test (Day0)	After Test (Day8)
TV#07_04		
Results	No Corrosion	No Corrosion
TV#07_05		
Results	No Corrosion	Leadframe Pitting/Pore Corrosion
TV#07_06		
Results	No Corrosion	No Corrosion

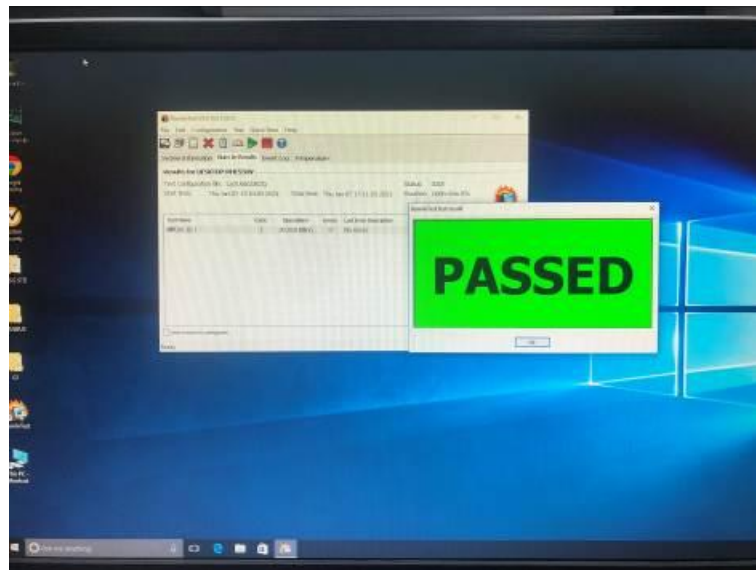
Location	Before Test (Day0)	After Test (Day8)
TV#07_07		
Results	No Corrosion	No Corrosion
TV#07_08		
Results	No Corrosion	No Corrosion
TV#07_09		
Results	No Corrosion	No Corrosion

Location	Before Test (Day0)	After Test (Day8)
TV#07_10		
Results	No Corrosion	No Corrosion

Attachment 2 :

Please refer to the results of functional test after FoS test as below:

TV # ID	Model	P/N NO.	S/N NO.	Functional Test
#01	PX220-M280	B92.225KHD.002NA	122048500914	Passed
#02			122048500915	Passed
#03			122048500916	Passed
#04			122048500917	Passed
#05			122048500918	Passed
#06			122048500919	Passed
#07			122048500920	Passed



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