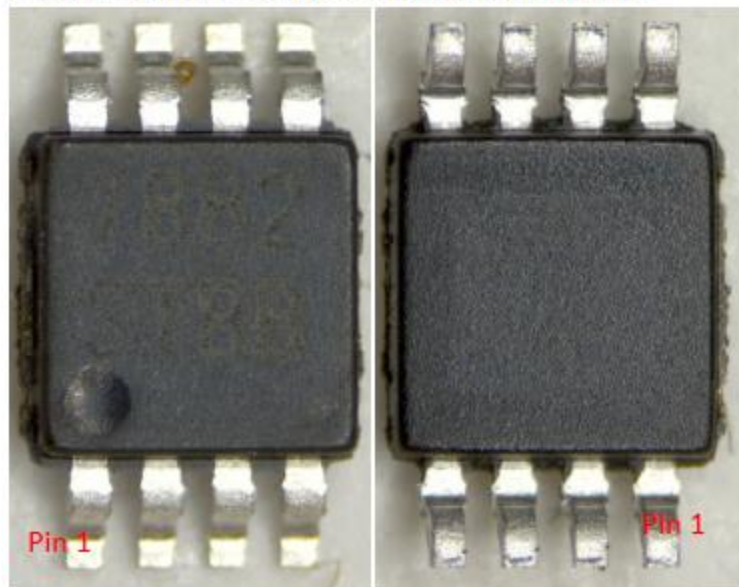


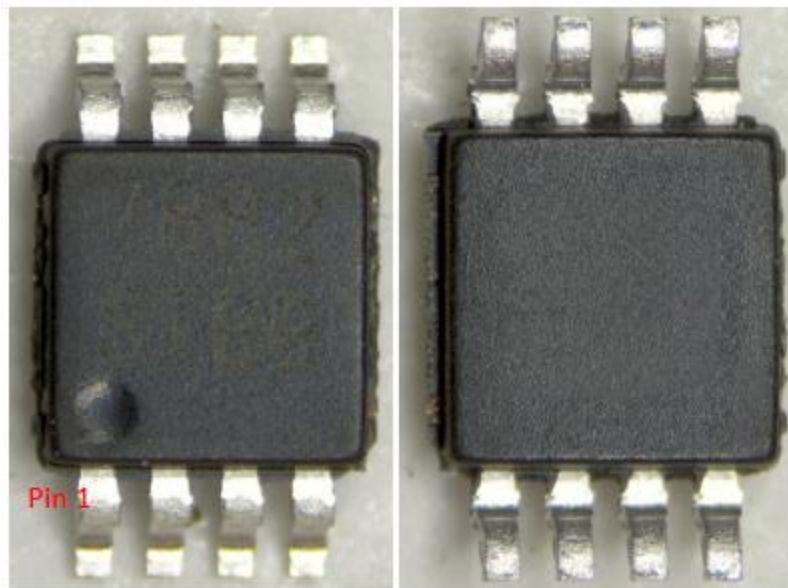
Problem Description

- Fresh units decap observed cratering (ILD crack) issue on all bonding pads.
- Visual inspection, X-ray, CSAM don't observe any anomaly on units
- IV test pass, no anomaly was observed.
- Fully decap on unit#1 found bonding layer crack at all pads.
- FIB cross section on unit#2 didn't observe damage at inner bonding layers.

External package inspection found no anomaly on return units,



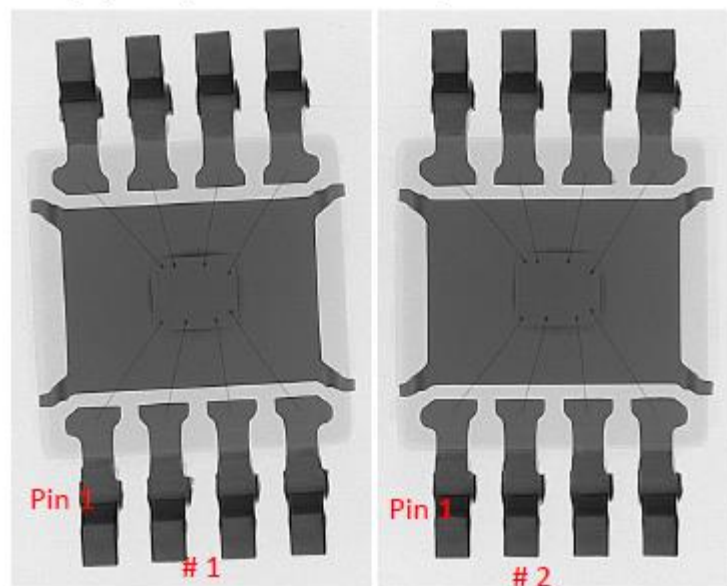
a. Top and bottom view of unit #1,



b. Top and bottom view of unit #2,

X-Ray Analysis:

Radiographic inspection found no anomaly on return units.



Acoustic microscopy found no delamination on return units die surface.

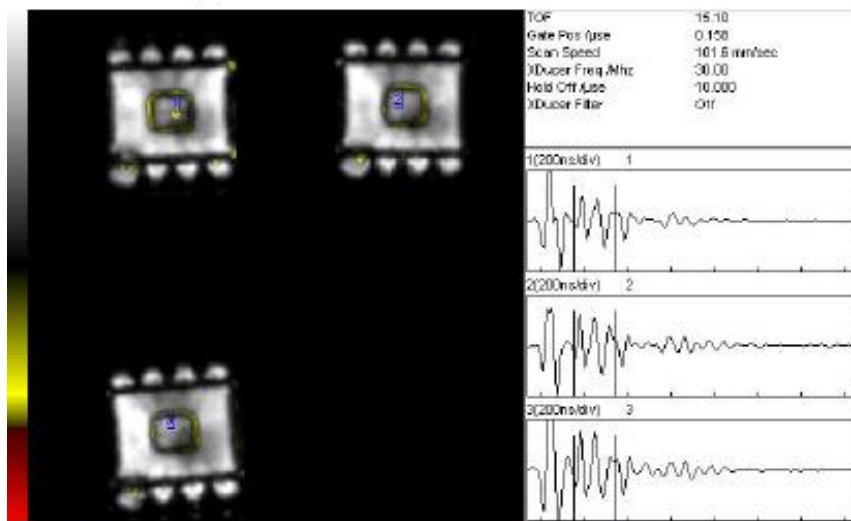
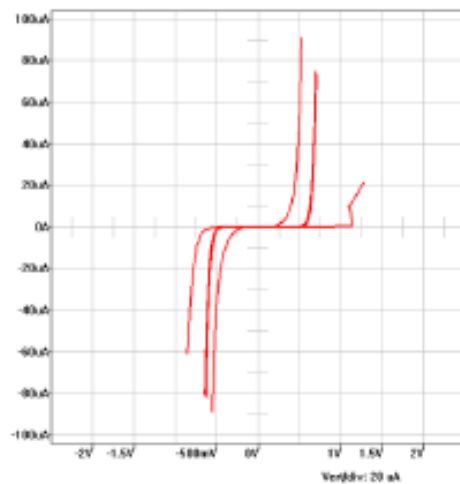
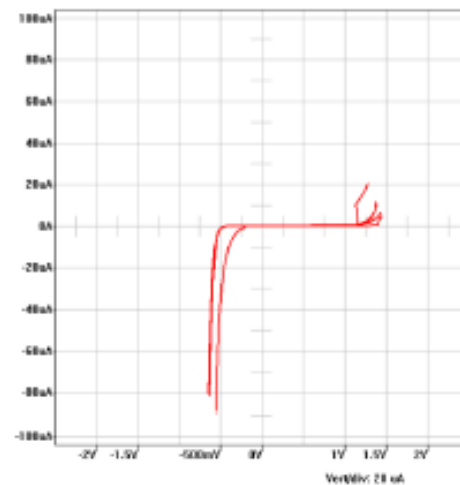


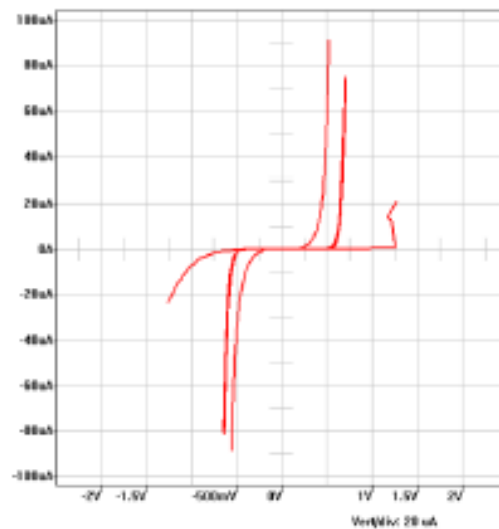
Fig. 3: No anomaly was observed on return units die surface.



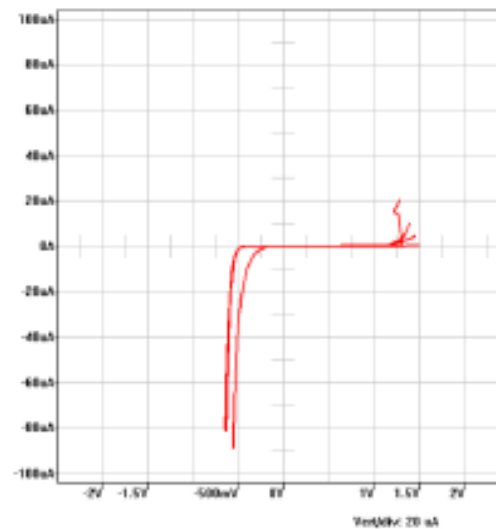
a. Pins to pins I/V of unit #1,



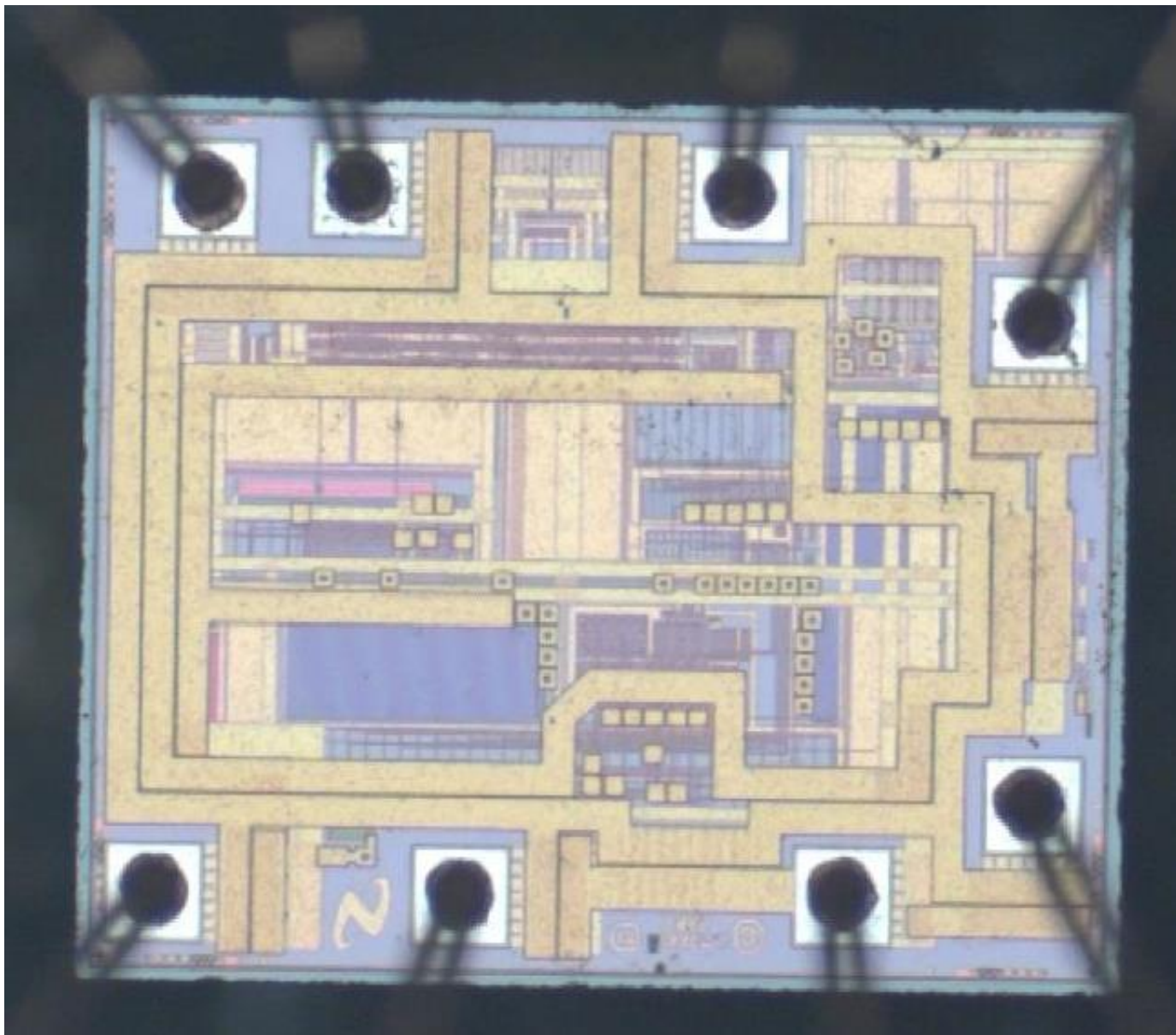
b. Pins to GND I/V of unit #1.



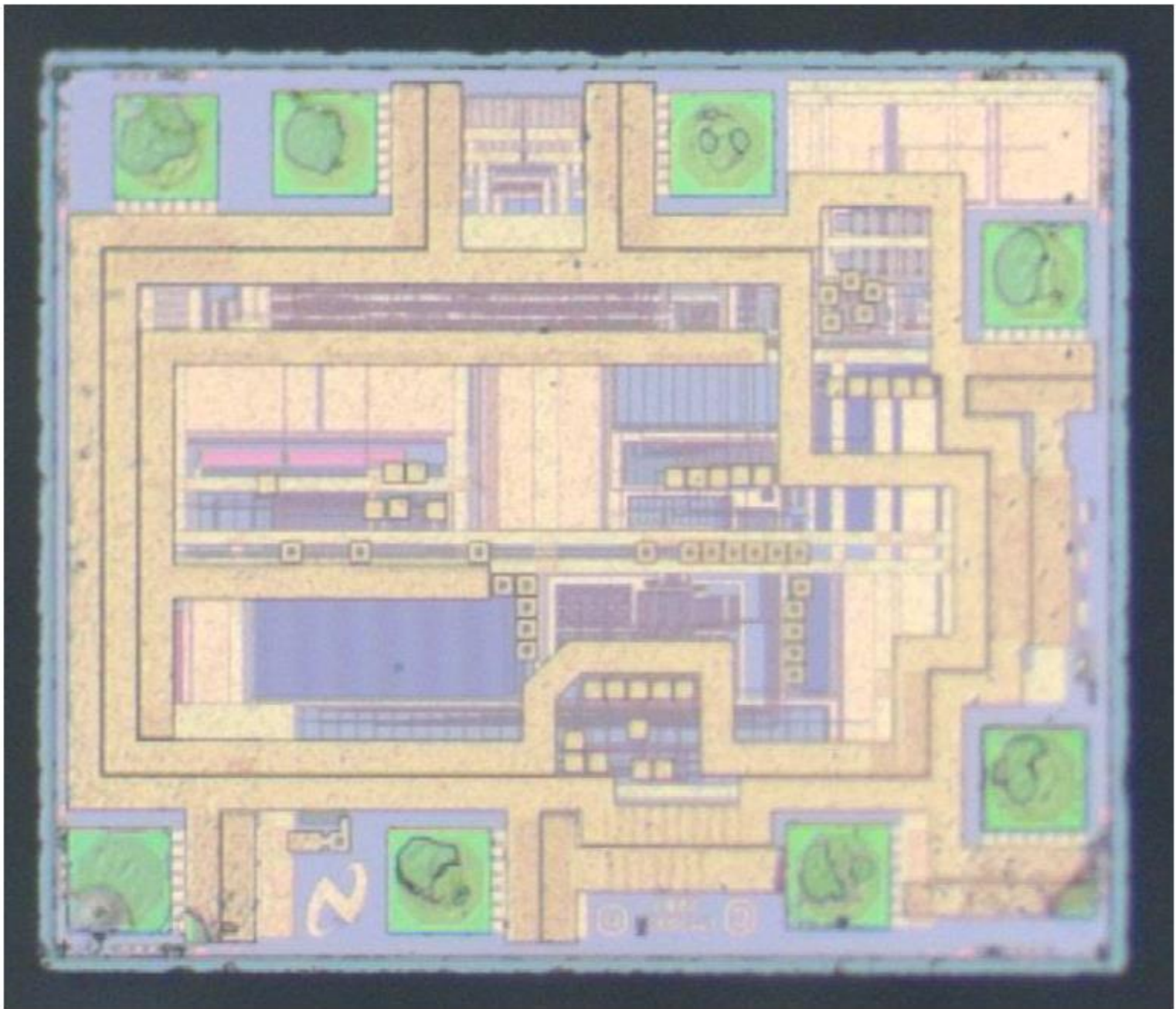
c. Pins to pins I/V of unit #2,



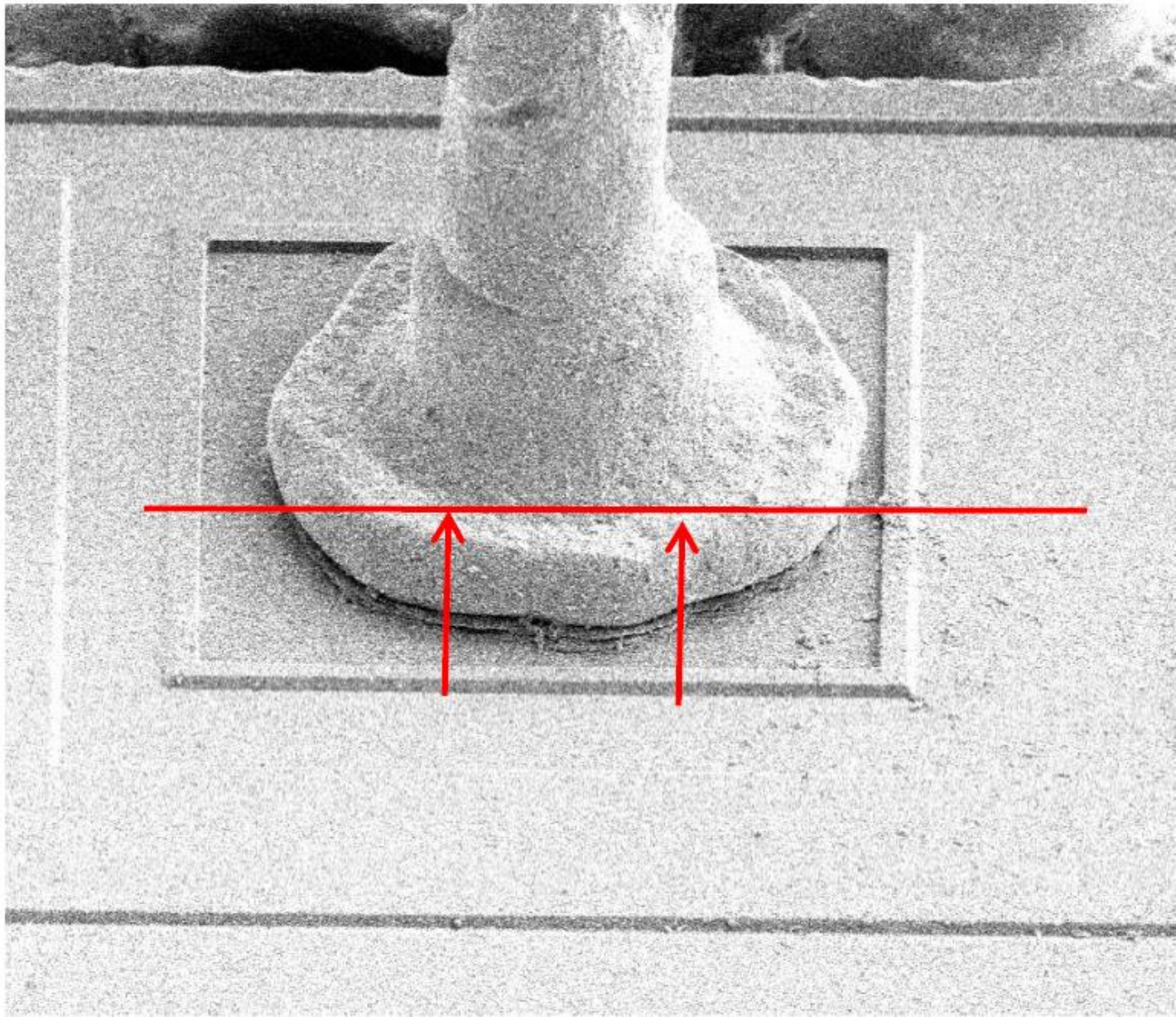
d. Pins to GND I/V of unit #2.



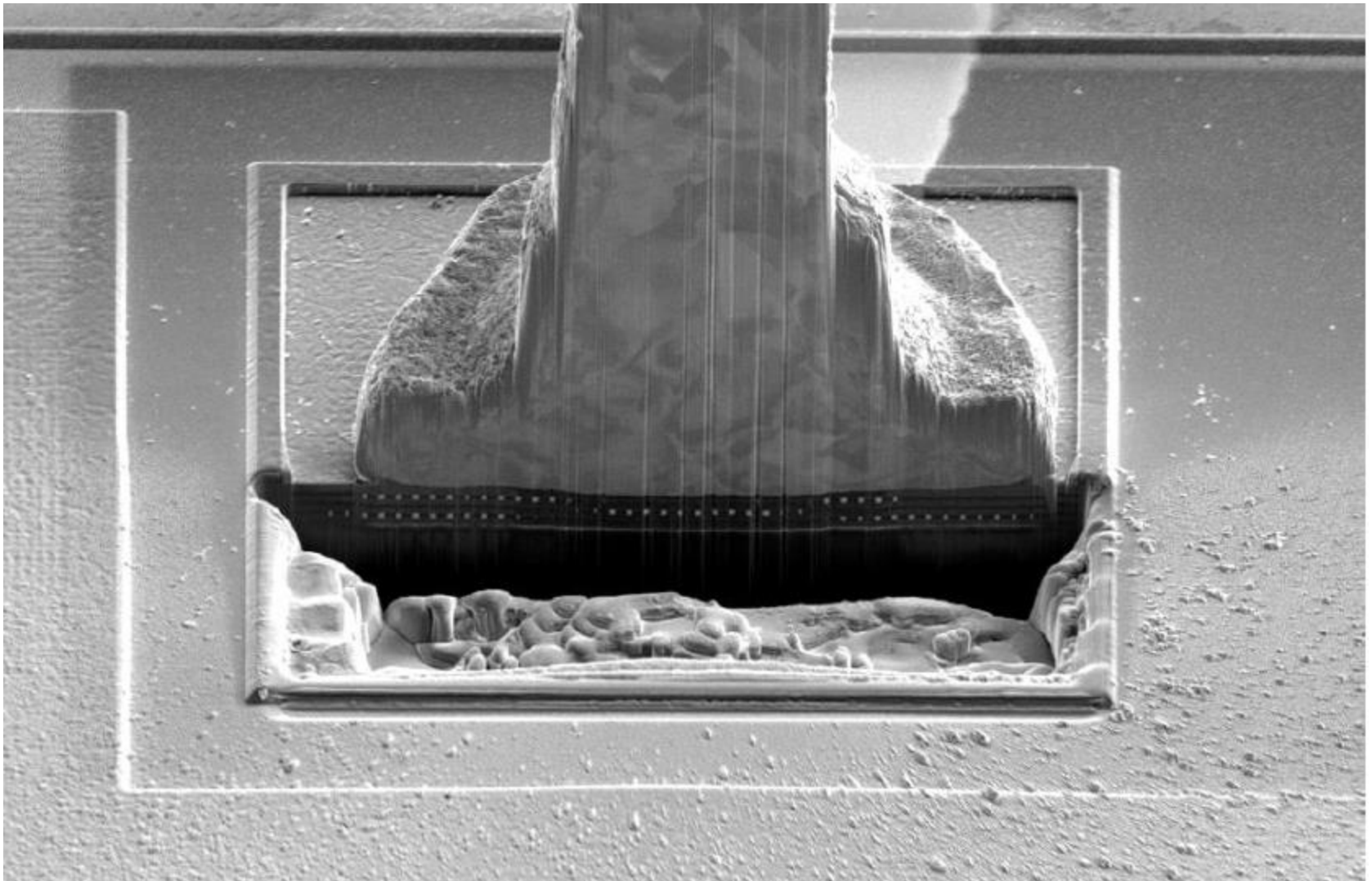
Return unit#1 was decapped and visual inspection didn't observe anomaly



Bonding wire of unit#1 was removed and observed bonding layer crack at all pads.



Return unit #2 was submitted to do FIB cross-section,
no anomaly was observed under the bond pad.

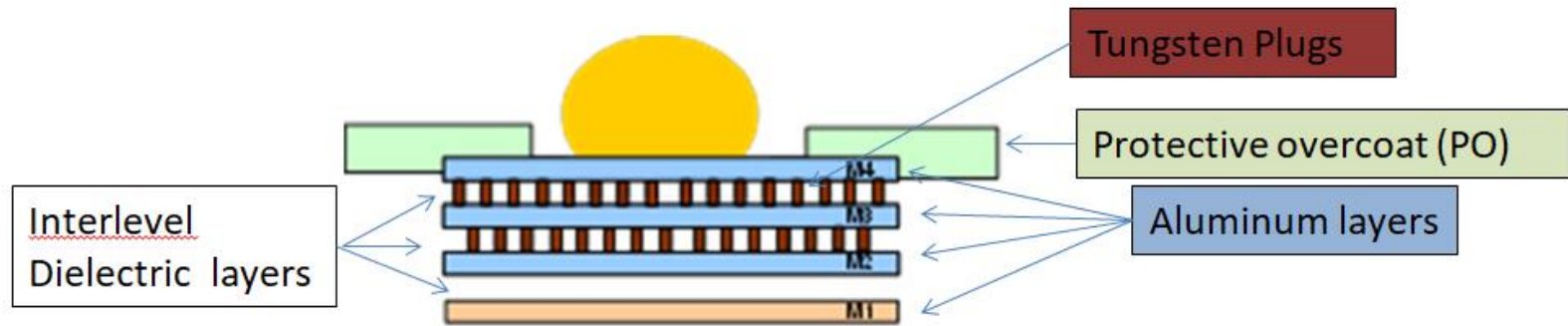


Unit#2: Overview of the cross-section



Zoom in the cross-section of unit #2. Inner bonding layers are not damaged.

Mechanical Explanation on bonding layer crack



1. TI examined this bond pad structure many years ago and noted that it was susceptible to cracks in the top metal layer and the dielectric beneath the ball bond but it did not fail electrically because the metal layers beneath the bond pads are not “active”. The diagram above illustrates the bond pad layout.
2. this is a 4 level metal product and the bond pad (Metal 4) is connected to Metal 3 by vias beneath the pad. Similarly, Metal 2 and Metal 1 are connected by vias. The zoom in cross section in slide 8, the four layers of metal and three separate via layers are visible. The above drawing does not show the Via1 structures between Metal 1 and Metal 2 but they are there on the product. **The vias are a very low resistance ohmic contact between the metal layers.** So minor crack above metal 4 won't impact electrical performance.
3. And, the pad is electrically immune to this defect, because **signal and power leads are not allowed to run under the pad. In addition, the silicon under the pad does not have any components.**
4. The crack between the ball and aluminum pad are common to this technology as TIEM controls the bond process tightly to minimize damage to the pad structure without causing non-stick on pad (NSOP) fails during bonding.

TI Qualification Report

Stress	Reference	Min Lot Qty	Sample Size / Lot	Condition	Duration	Result
TC	JESD22-A104	3	25	Temperature Cycle -65/150C	500 Cycles	PASS
AC/UHAST	JESD22-A102/JESD22-A118	3	25	Autoclave 121C or Unbiased HAST 130C / 85% RH	96 Hours	PASS
HTSL	JESD22-A103	3	25	High Temp Storage Bake 150C	1000 Hours	PASS
THB/HAST	JESD22-A101/JESD22-A110	3	25	THB 85C/85%RH or HAST 130C/110C /85%RH	1000 Hours or 96 Hours	PASS
CDM	JESD22-C101	1	3	ESD - CDM	Classification	See datasheet
HBM	JS-001	1	3	ESD - HBM	Classification	See datasheet
HTOL	JESD22-A108	3	77	Life Test, 125C	1000 Hours	PASS
LU	JESD78	1	3	Latch-up	Per JESD78	PASS
MSL	JEDEC J-STD-020E			Per JEDEC J-STD-020E	Classification	See datasheet

Reliability Risk Assessment

- TI Reliability tests all passed.
- TI have shipped 6M+ units, so far no verified electrical/function failure related to bond pad crack.
- **In conclusion, the minor crack at bond pad top metal is acceptable, no impact to device electrical performance and reliability risk.**