IEEE SW Test Workshop
Semiconductor Wafer Test Workshop

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MicroProbe Vx-RF Probe Card Technology

Outline

- Vx-RF Technology Overview
  - Problem Statement and Requirements
  - Approach
  - Characterization Data
- Wafer-Test Results
  - Bump-probe interaction
  - Cleaning
  - Qualification Methodology and Results
- Summary and Conclusions

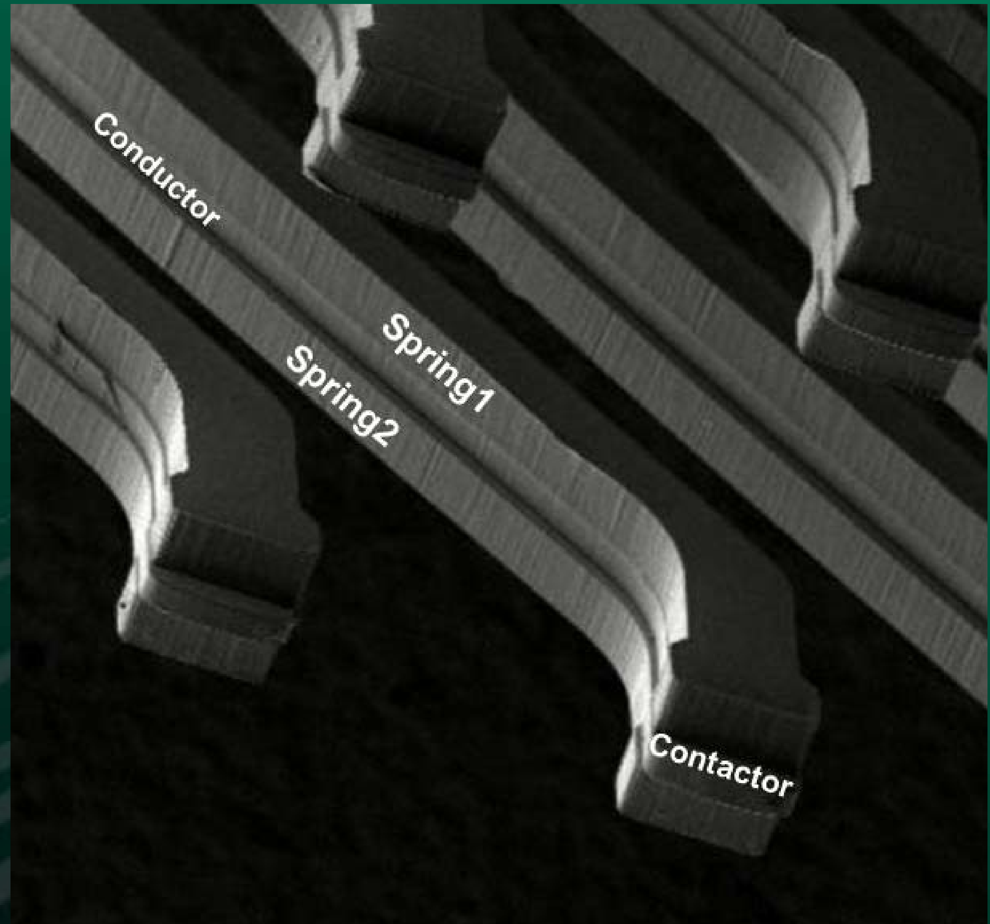
Problem Statement

- Infineon Technologies required a RF probe-card technology to provide:
  - Probing of Pb-free bumps and Al pads with same technology
  - Minimal pad/bump damage for KGD apps
  - Pitch scalability to 80um; corresponding planarity and alignment
  - Moderate pin count (< 500)
  - Moderate RF bandwidth (<6GHz)
  - Reliable and robust
- Collaboration with MicroProbe produced a production-worthy probe-card that meets all requirements

MicroProbe's MEMs-enabled Probe Architecture

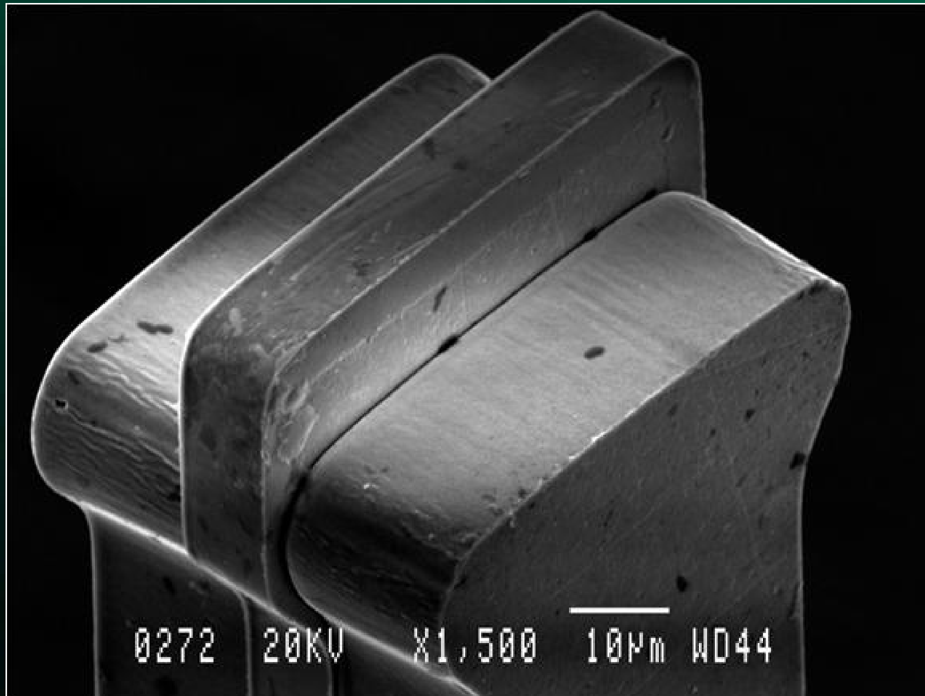
Composite structure allows optimization of both mechanical and electrical properties

- Technical approach
  - Multiple materials
  - Photolithographically defined
- Material/geometry flexibility to provide optimal mechanical *and* electrical performance



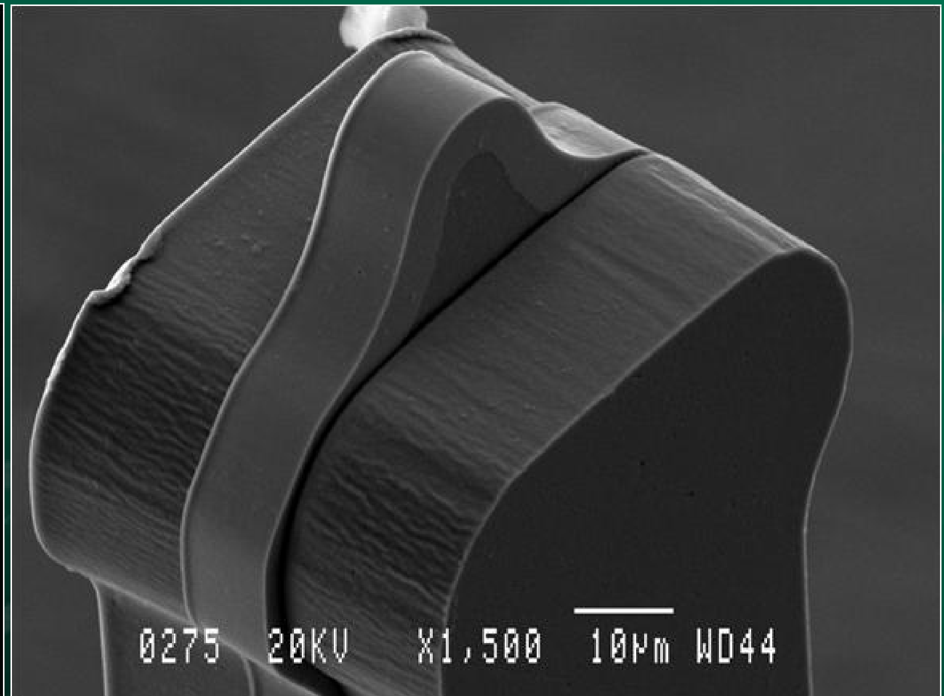
Probes selectively etched to highlight structure

Probes Optimized For Individual Applications



Flat probe

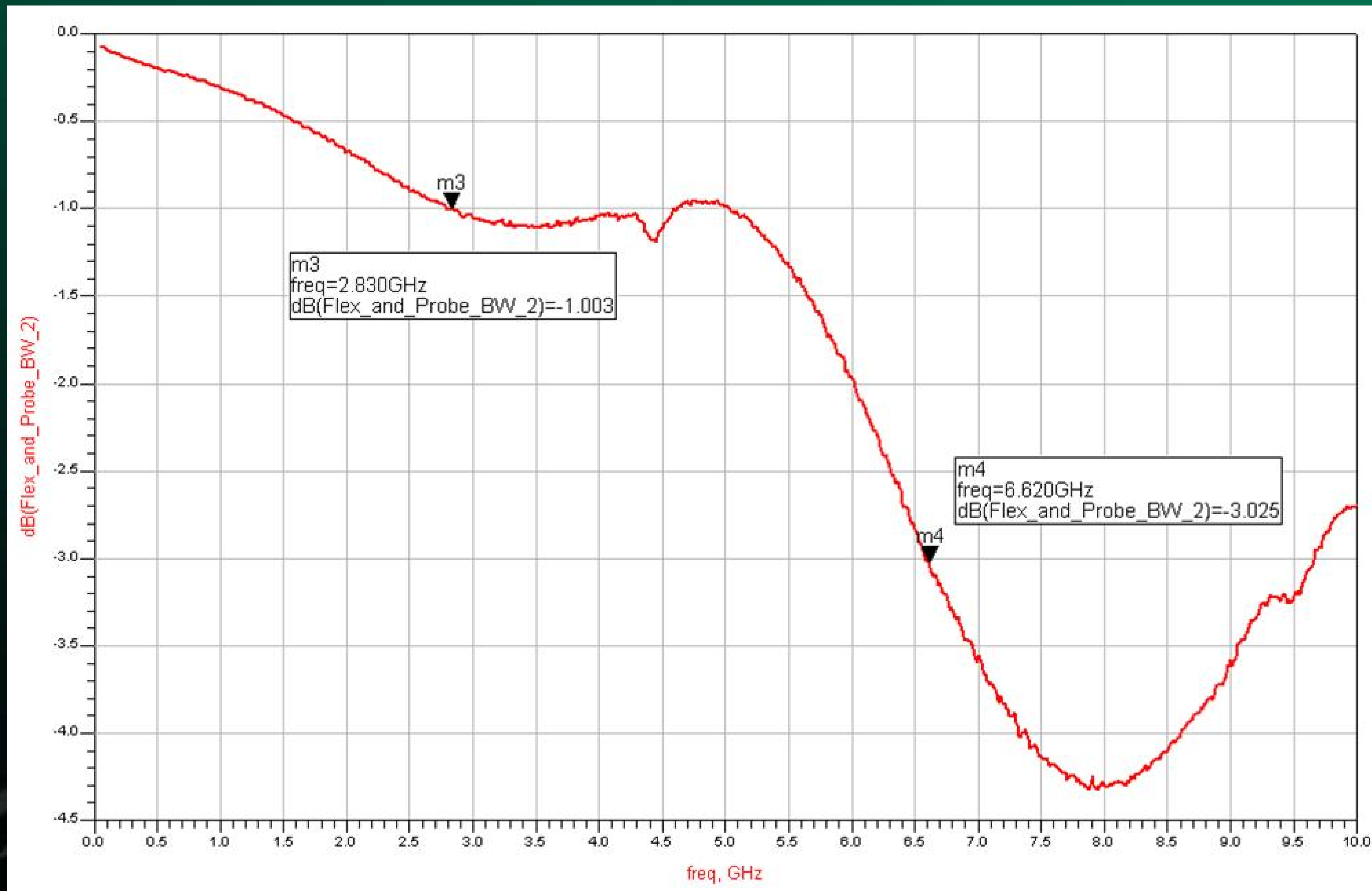
Cu Pillars, bumps, large pads



Pointed probe

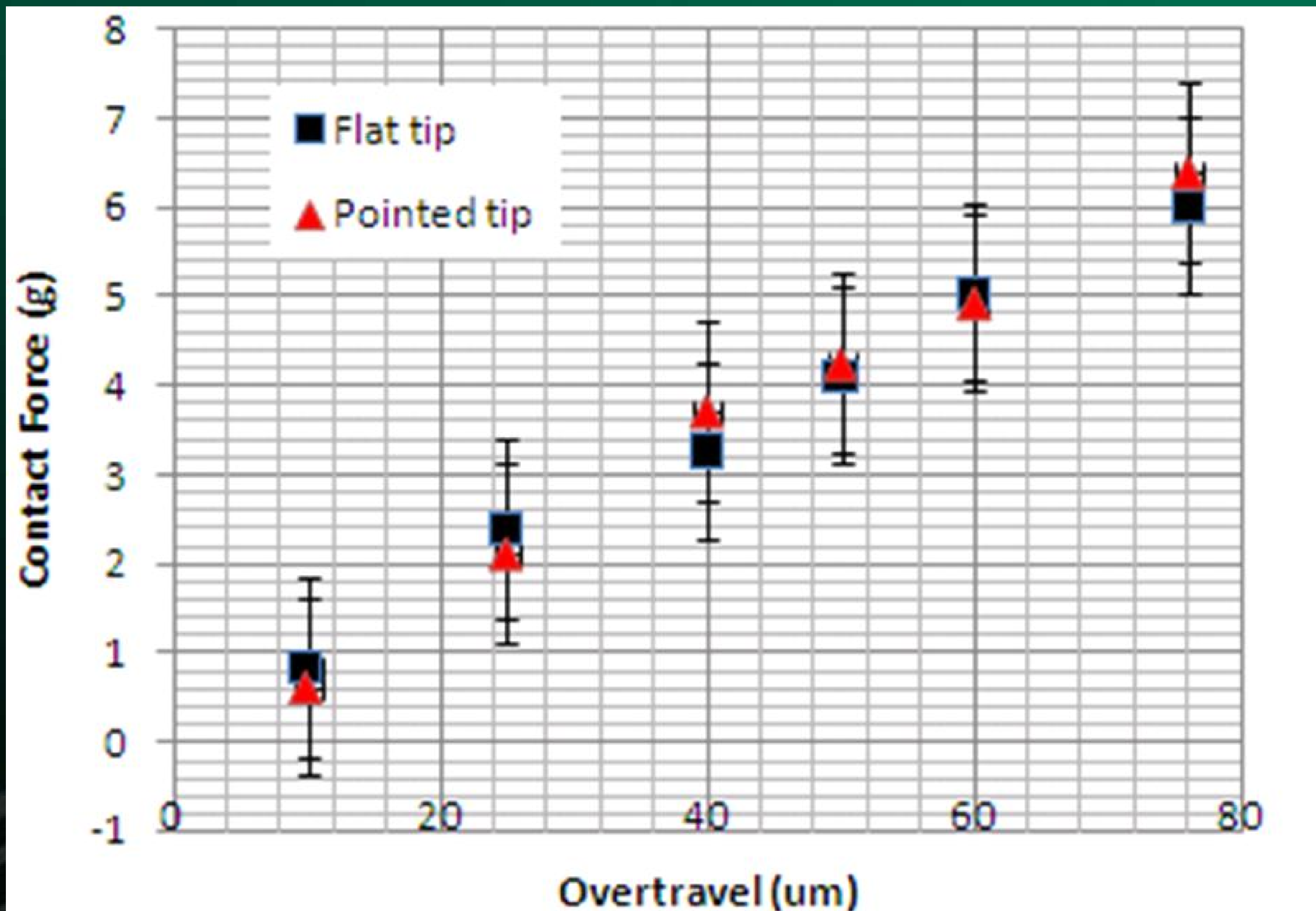
Small Pads

Vx-RF-80 Probe Head Bandwidth



-3dB @ 6.6GHz Frequency Response

Vx-RF-80 Contact Force



Wide overtravel range with low contact force

SMARTi-UE Product Outline

- SMARTi ® family - single chip CMOS transceivers Infineon is the leading supplier of standard GSM/GPRS, EDGE, and 3G/UMTS transceiver solutions.

- Applications:
  - Worldwide 3GPP UMTS / EDGE (W-EDGE) mobile handsets
  - HSDPA / HSUPA (H-EDGE) mobile data devices
  - Multi-Band UMTS
  - Quad-Band EDGE

- Test Requirements:
- Probe-after-Bump, 200µm min. pitch , full array, room temperature
- 5.0 GHz@-3.0dB, LTX Fusion-CX
- Ca. 80 pins , 1-DUT

Infineon's Probe Card Qualification Process

- Significant PC-qualification milestones
  - **PC6.1**: Probe card acceptance and verification
    - incoming check, mechanical check, heating behavior, first TD, manual stepping
  - **PC7**: Probe card engineering release
    - online cleaning, correlation (AMSA, see next page)
  - **PC8**: Early production release
    - early yield stability and repeatability for 5 wafers (300 dice min)
  - **PC9**: Production release
    - yield stability for 10 lots
  - **PC10**: Manufacturing release
    - yield stability for 3 months or 50 lots, 2 probe cards minimum

Advanced Measurement System Analysis

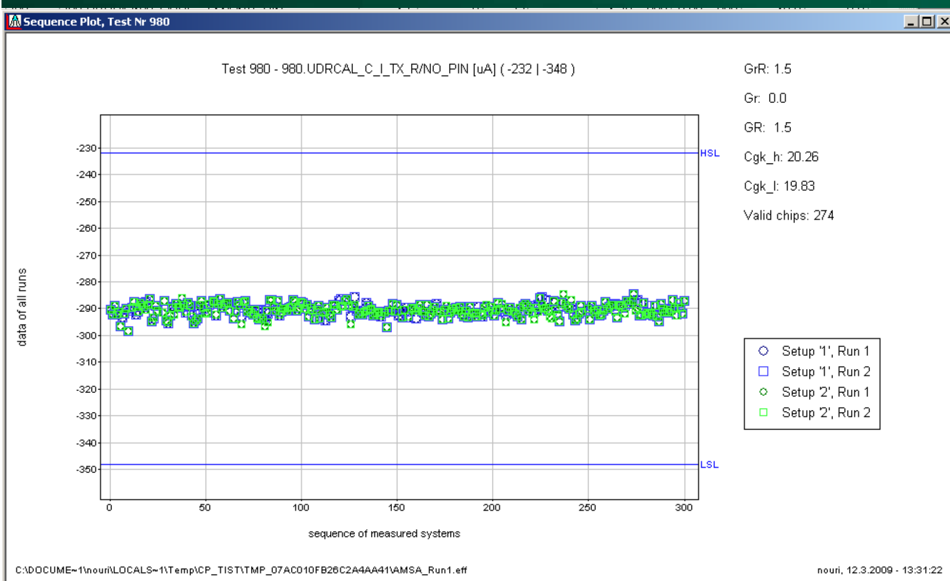
„*AMSA* is a fast and efficient tool based on Gage r&R methodology to analyze and assess test performance, identifying test instabilities (Gr&R and Bin Flips) and focusing on the impact on yield of the measurement process (C_{gk}) vs manufacturing process (C_{pk})"

- When to use AMSA:

  A regular Gr&R, whenever …

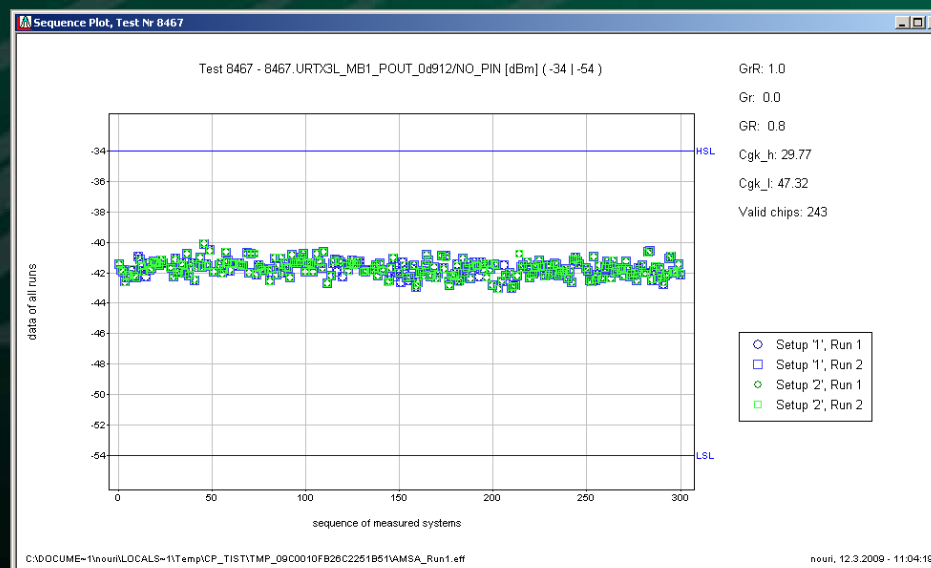
  - the product is transferred into production (test package transfer)
  - **a novel test equipment (e.g. probe cards) is introduced**
  - a transfer from existing to new test site location

Smarti UE
Critical Tests vs. 300 samples

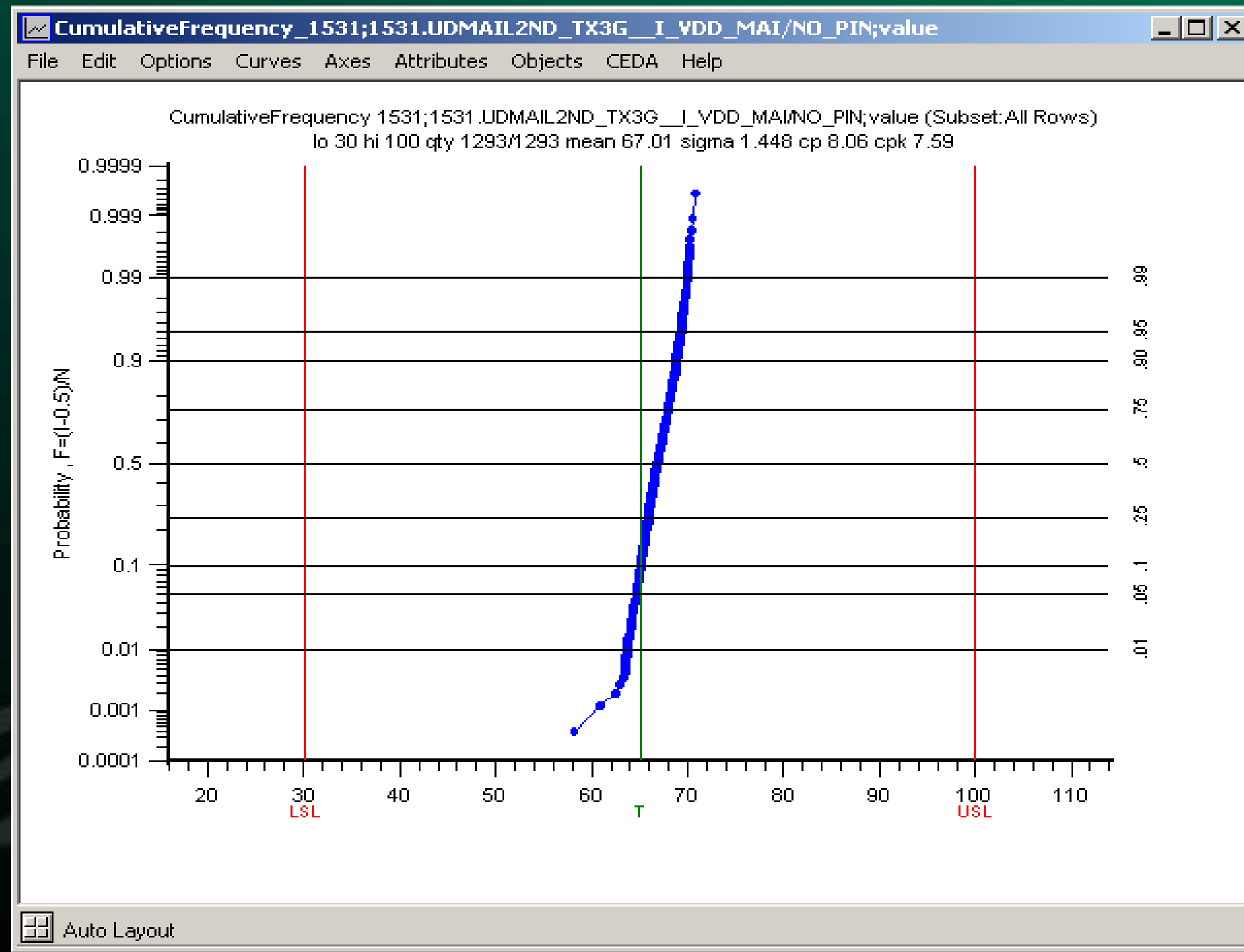


Cres Sensitivity

Tx – Pout



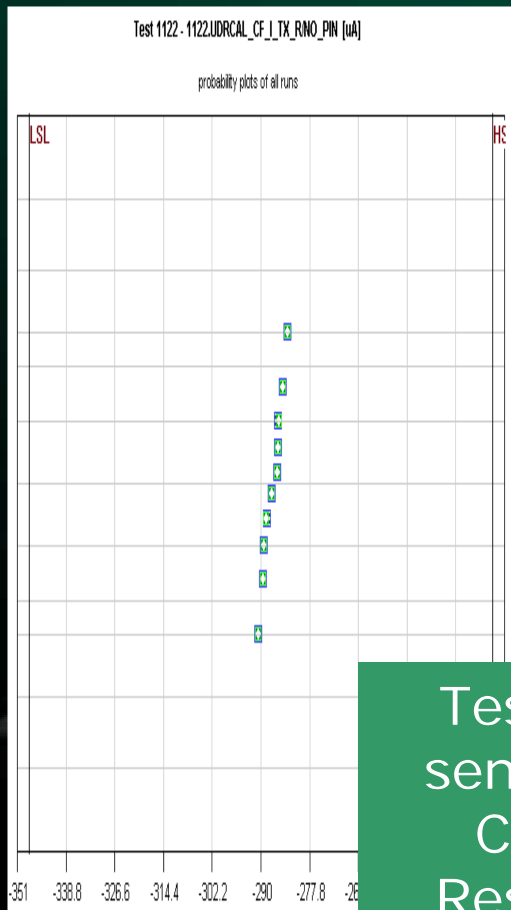
Smarti UE
Full Wafer, Tx_current

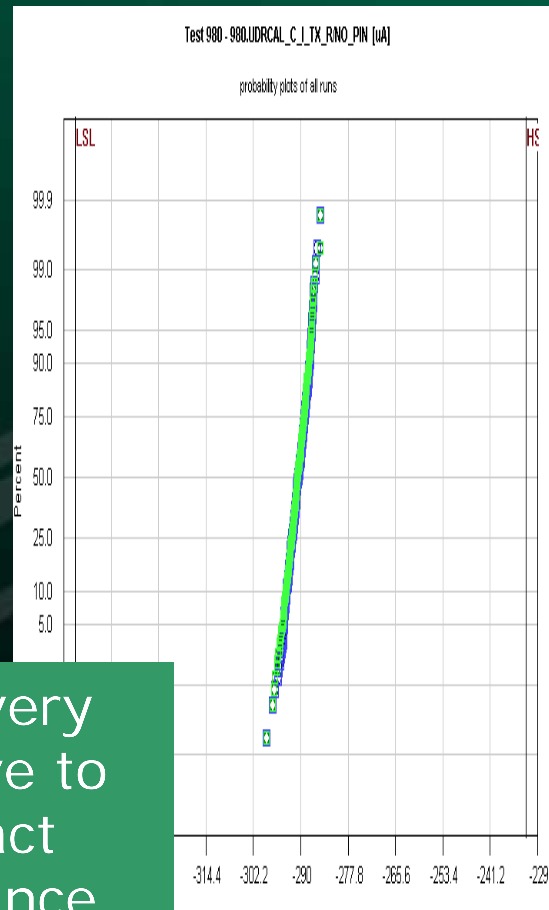


Smarti UE Comparison (I_TX)

Package Test

Vx-RF-80





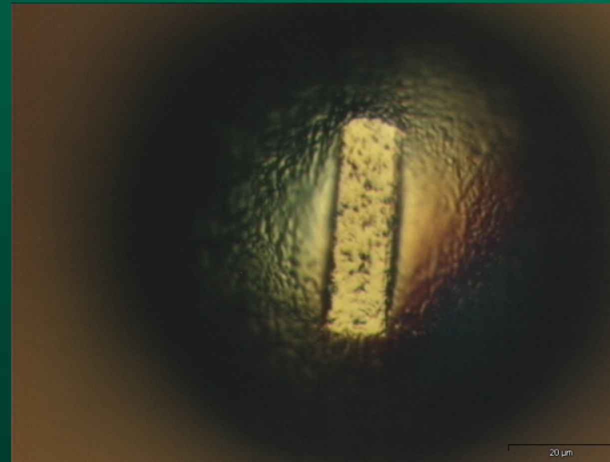
Tests very sensitive to Contact Resistance

Same performance for wafer and package test

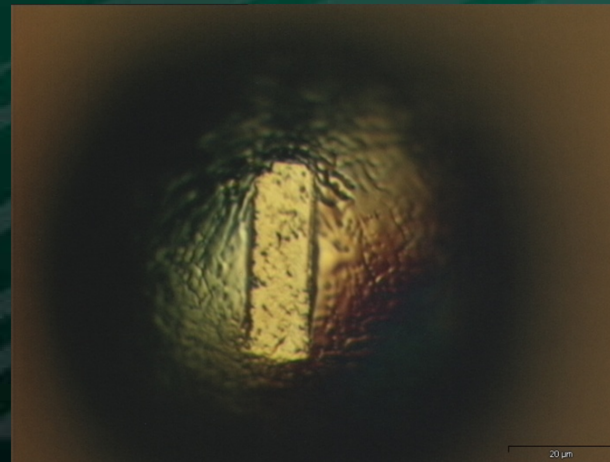
AMSA Qualification Results

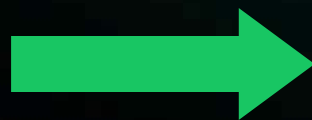
- Excellent performance
  - –RF-characteristics up to 6GHz
  - –High repeatability (GrR > 98%)
  - –Stable contact quality
  - –Low contact resistance

Minimal Bump Damage



65µm OD
No xy-offset
5x multiple-TD

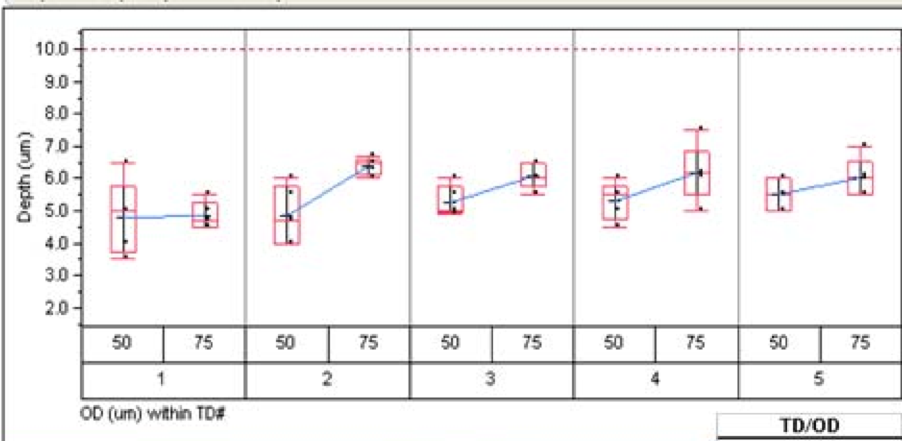




Bump imprint depth < 10µm

Qualification Results
Bump Imprint Depth

Scrub Depth on Bump



Depth

TD/OD	Mean	Std Dev	Min	Max	Range
TD#[1] OD (um)[50]	4.8	1.151086	3.5	6.5	3
TD#[1] OD (um)[75]	4.84	0.4219	4.5	5.5	1
TD#[2] OD (um)[50]	4.84	0.896103	4	6	2
TD#[2] OD (um)[75]	6.4	0.264575	6	6.7	0.7
TD#[3] OD (um)[50]	5.28	0.465833	4.9	6	1.1
TD#[3] OD (um)[75]	6.1	0.41833	5.5	6.5	1
TD#[4] OD (um)[50]	5.3	0.570088	4.5	6	1.5
TD#[4] OD (um)[75]	6.18	0.889944	5	7.5	2.5
TD#[5] OD (um)[50]	5.5	0.5	5	6	1
TD#[5] OD (um)[75]	6.02	0.614003	5.5	7	1.5

- For touchdown 4 and OD 50um, the depth is about 5.3um

Meets Infineon's bump damage requirements

Cleaning

- Media: ITS 1um AlO2 lapping Film
- Frequency every 1/250 - 1/750 TD
- Deflection during Cleaning = 20um
- Cleaning TD's = 10

Summary

- Vx-RF-80 uses MicroProbe's MEMs technology to provide a robust probe card for RF at-speed wafer sort
- Infineon Qualification Results:
  - Electrical performance: pass
  - Repeatability: pass
  - Bump damage: pass
- Next steps: Transfer to volume production