POSTER #

Eliminating Cleaning-Induced Failures: Achieving Zero-Debris Probe Tips in Low and High Temperature Wafer Testing

Victoria TRAN (Senior Director, R&D, Gel-Pak - USA)
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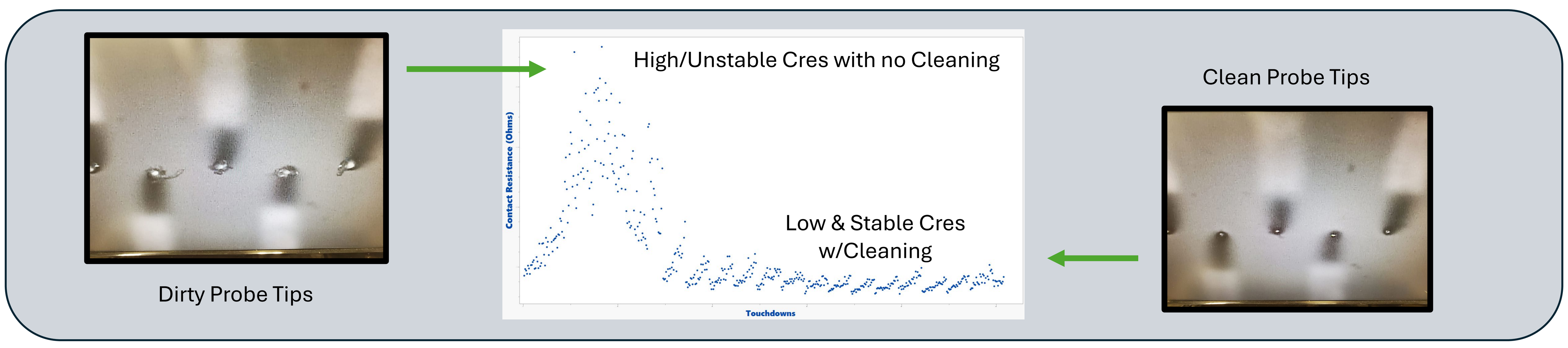
INTRODUCTION & PROBLEM STATEMENT

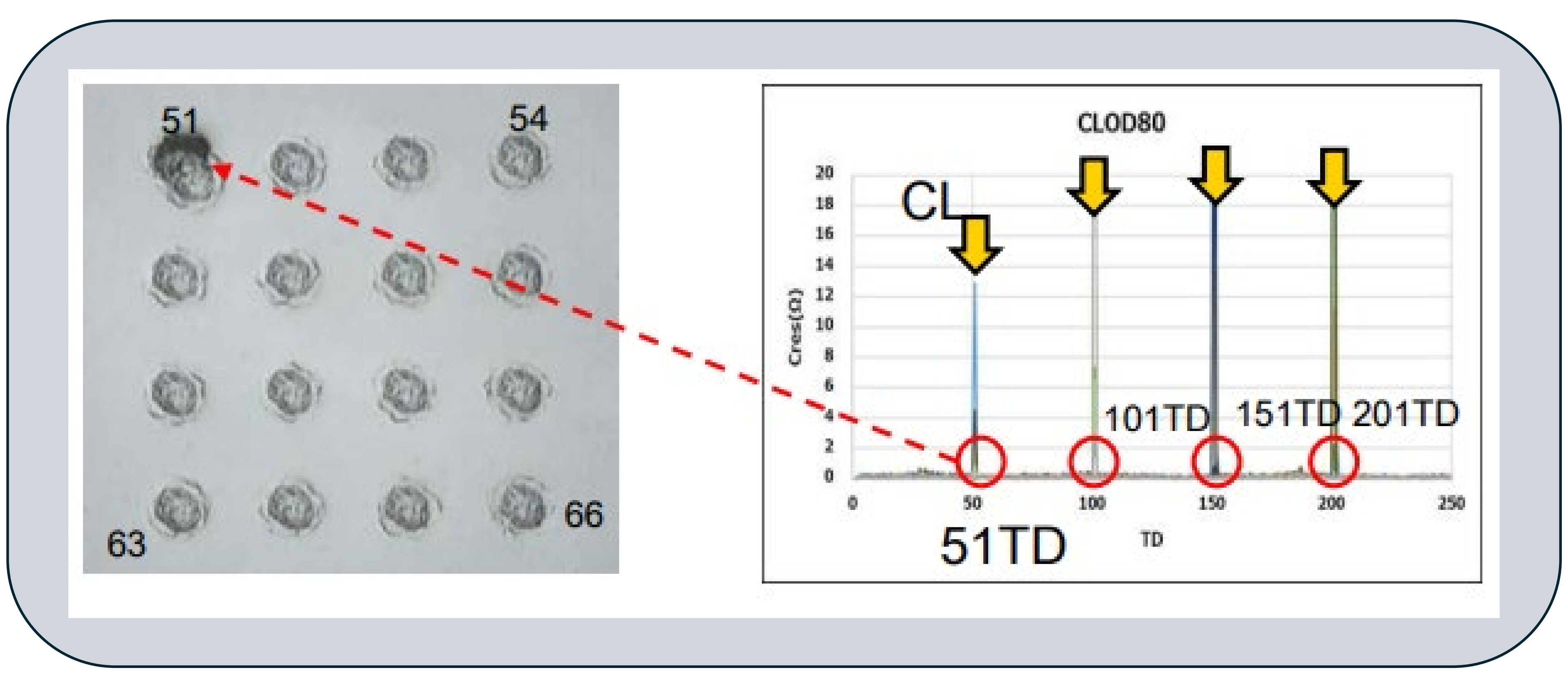
The Critical Role of Cleaning

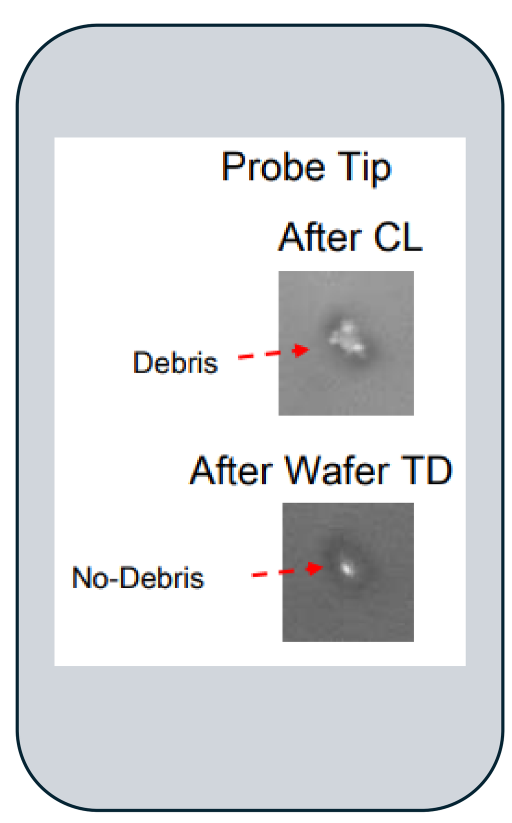
- Probe card cleaning is essential for **Contact Resistance (CRes)** stability, measurement accuracy, and long-term reliability.
- Accumulation of metallic oxides and particulate debris at the probe-pad interface leads to unstable electrical contact and yield loss.

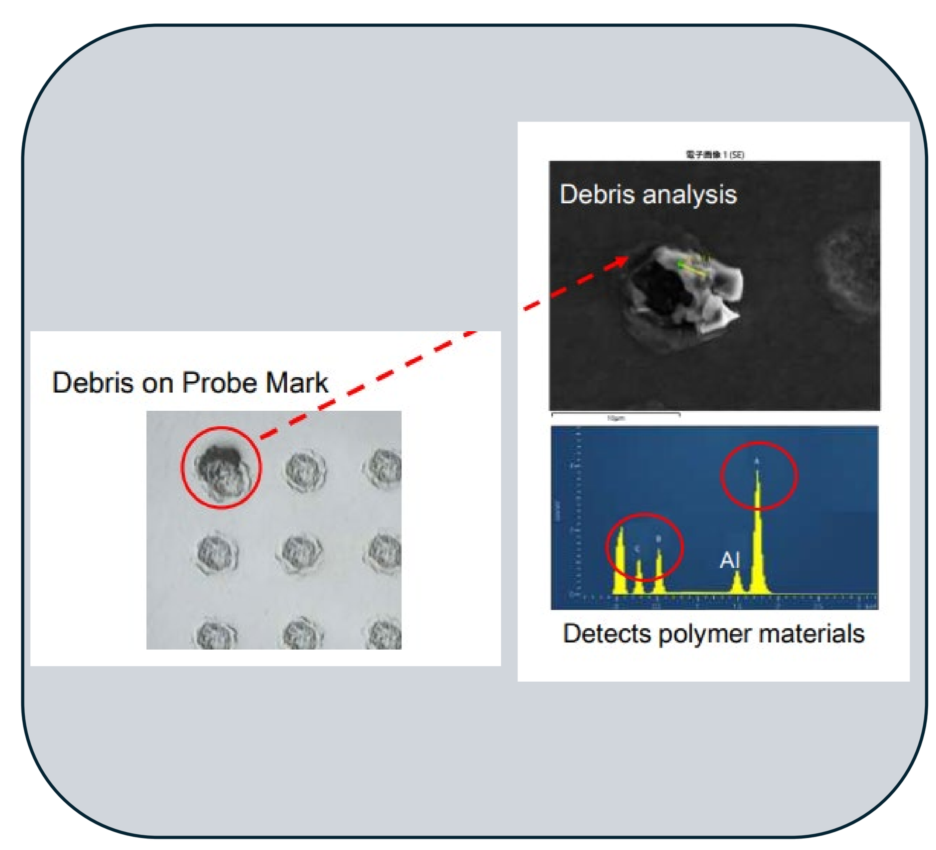


The Failure Mechanism: First-Touchdown Resistance

- A critical failure was identified where **MEMS vertical probe tips** experienced high CRes immediately at the first die touchdown after cleaning.
- Investigation revealed that contamination—specifically **abrasive-filled polymer residues**—was transferring from the cleaning sheet from Supplier A to the probe tip and subsequently to the test die.

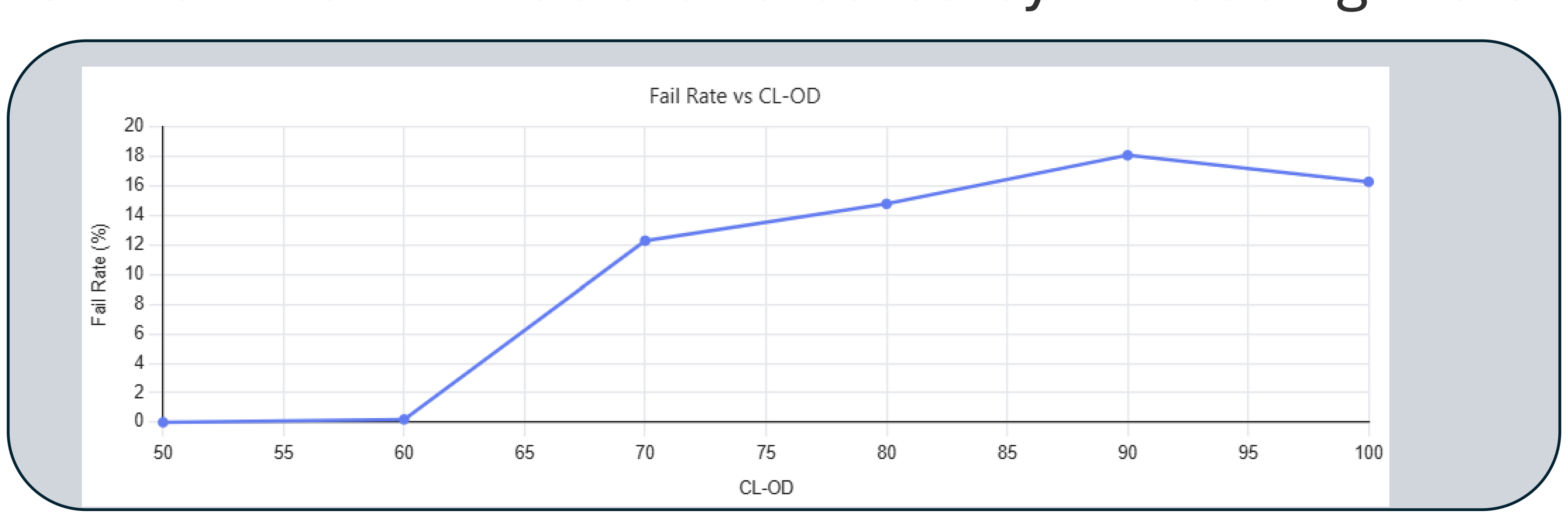


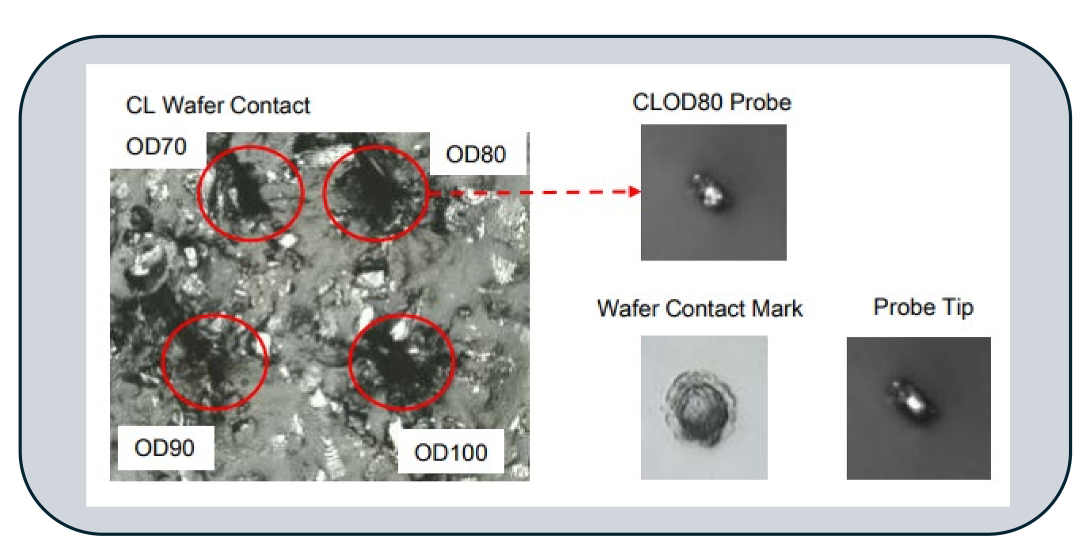




Environmental Factors

- This failure was found to be most severe at temperatures at **low temperatures (-5°C) and high temperatures (175 ° C)**.
- Contamination was exacerbated by increasing the **Cleaning Overdrive**.





Problem Statement

- Engineer a material that has no debris at high overdrives and at both low and high temperature range usage

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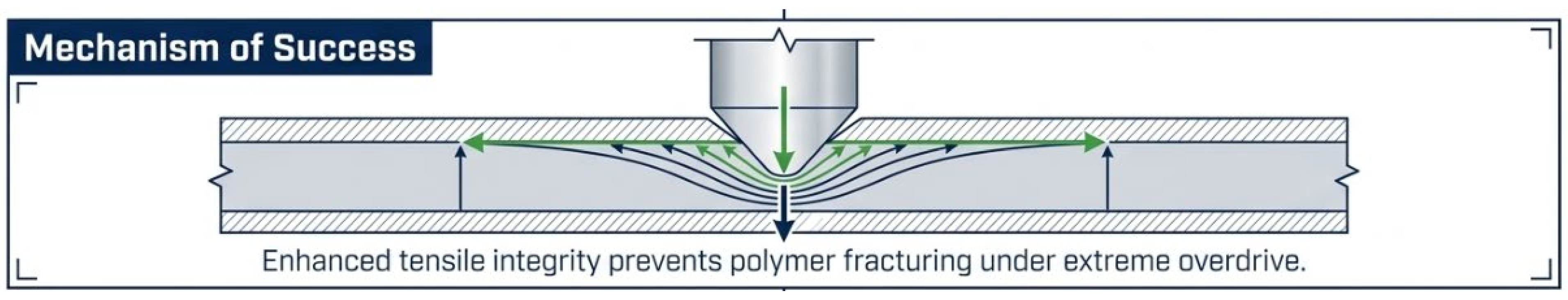
MATERIAL DEVELOPMENT & METHODOLOGY

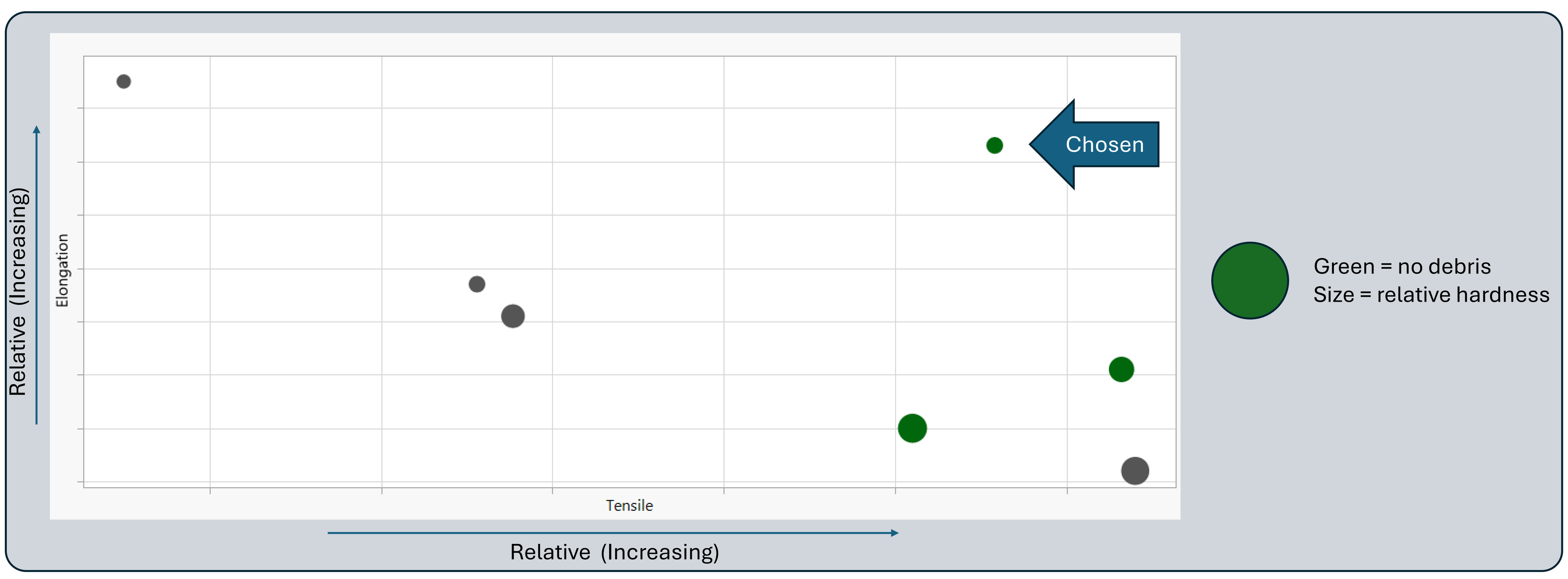
Objective: Developing Zero Debris Material

- The goal was to engineer an alternative cleaning material with **increased elastomer integrity** to eliminate debris generation across a wide temperature range (-5°C to 175°C).
- Research focused on how **abrasive particle size distribution and concentration**—not just material hardness—impact cleaning material integrity.



Material Property Comparison

- Several formulations were created to understand the what drives of hardness, tensile strength, elongation and particle size and their role in debris generation.



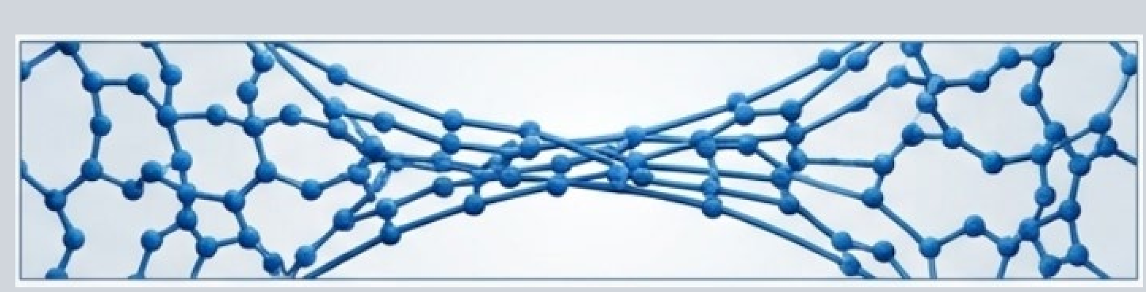
- **Hardness:** A function of the elastomer hardness, particle size and loading, and elastomer hardness. Hardness alone does not appear to impact debris.
- **Tensile strength:** Increasing tensile strength prevents debris generation. Although increasing hardness may increase tensile strength, ductility may be impacted negatively.
- **Particle size** – addition of abrasive particles weakens elastomer network. Larger particles weaken more. Although hardness may appear to increase hardness, the material becomes weaker.

Debunking the Hardness Assumption

Legacy Assumption

Previous models assumed higher hardness prevented debris.

New Paradigm



Analysis reveals that Tensile Strength and elongation of the overall elastomer are the primary variables for preventing material breakdown during high overdrive

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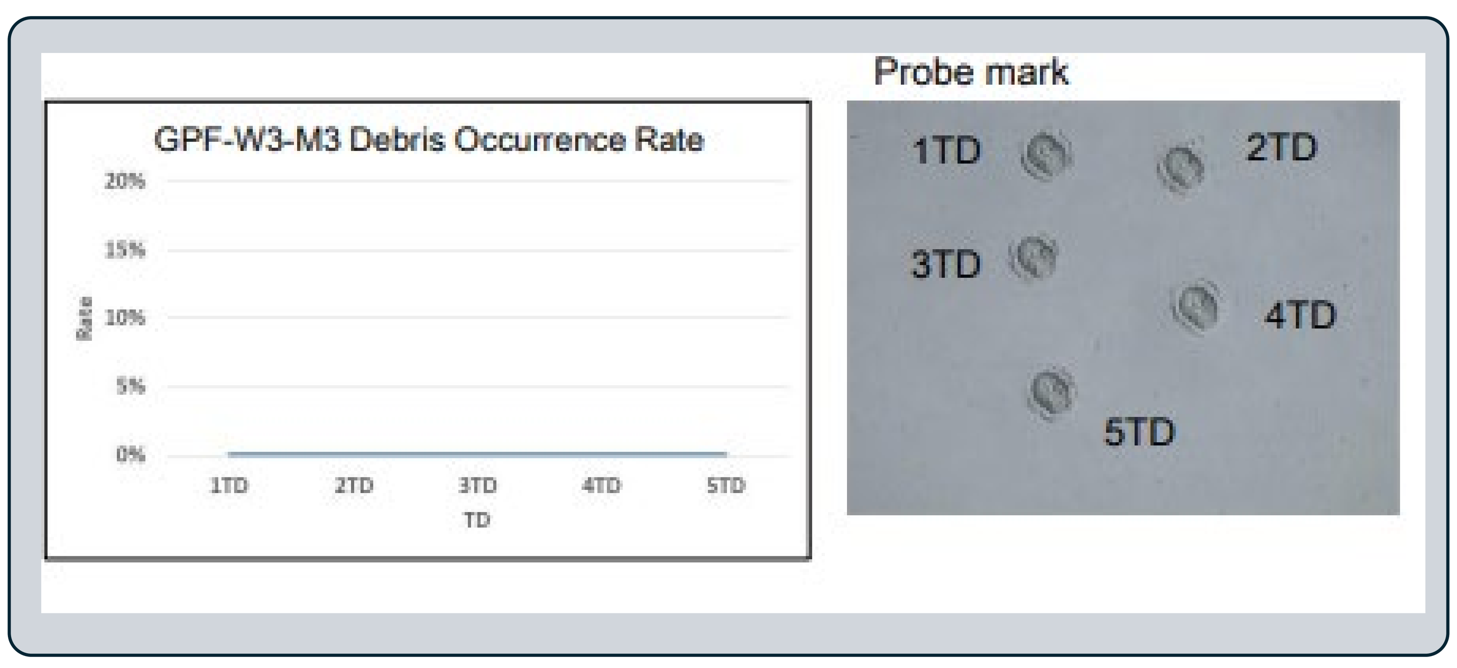
RESULTS & CONCLUSIONS

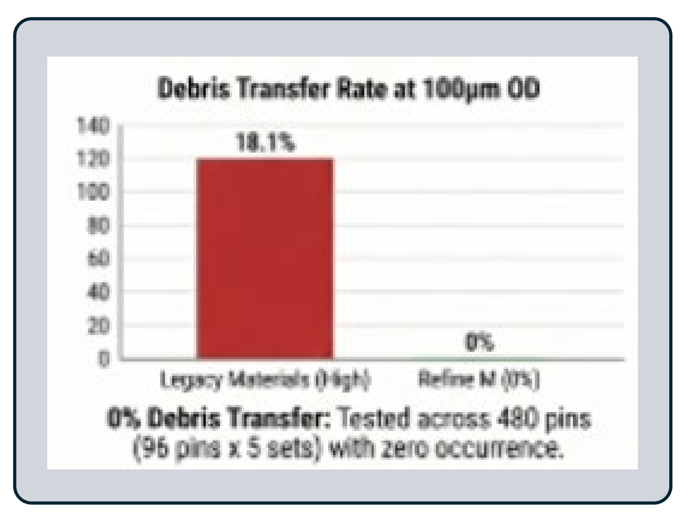
Zero Debris Transfer

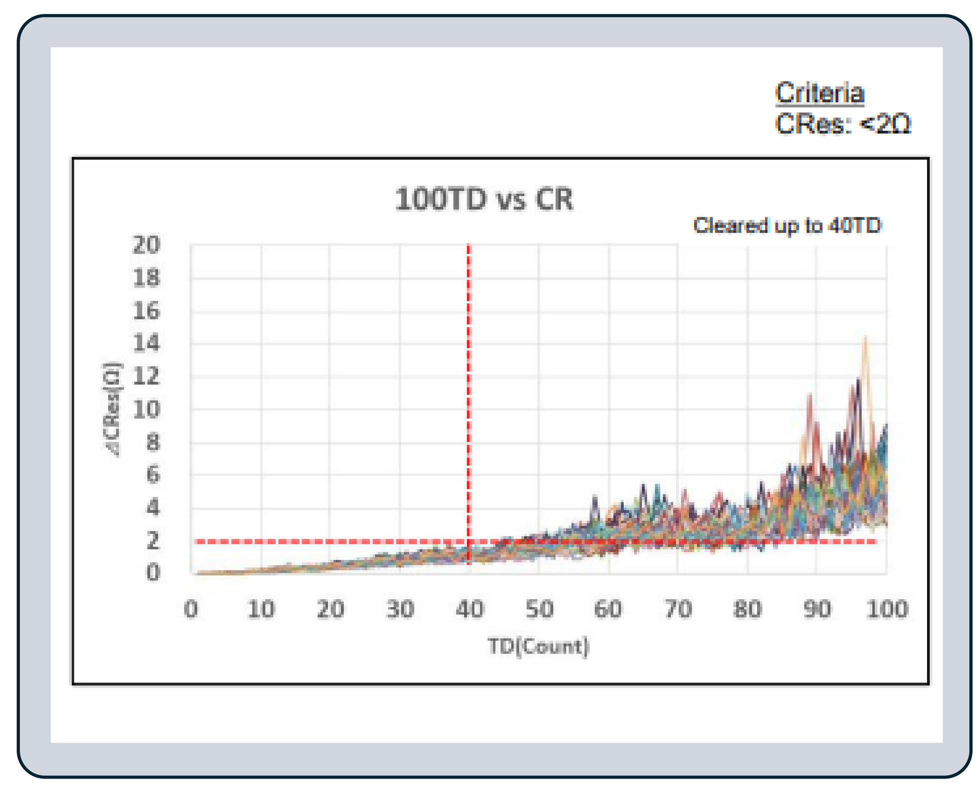
- Verification testing at 30°C confirmed **zero sheet debris transfer** even at the **Maximum OD setting (100μm)**.
- This represents a significant improvement over the 2.5% to 9.8% fail rates observed with previous formulations at high OD.

Electrical Performance (CRes Stability)

- During a **100TD vs. CRes** test at **175°C**, electrical performance remained stable for up to **40 touchdowns**.
- The CRes values successfully stayed below the **2Ω failure threshold** through the 40TD mark.



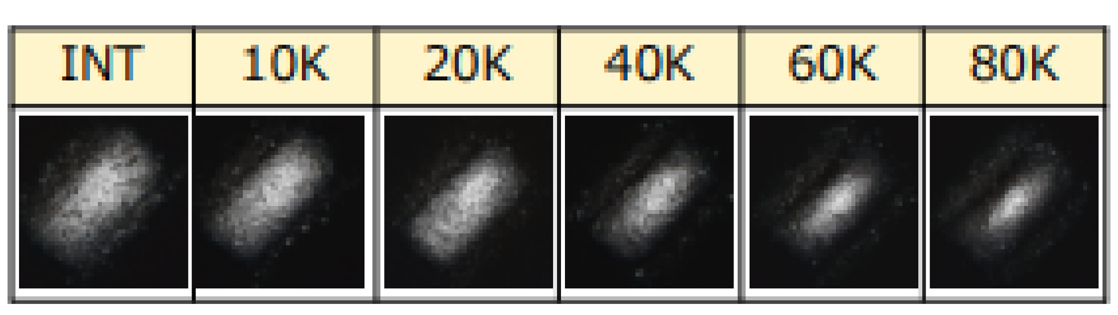


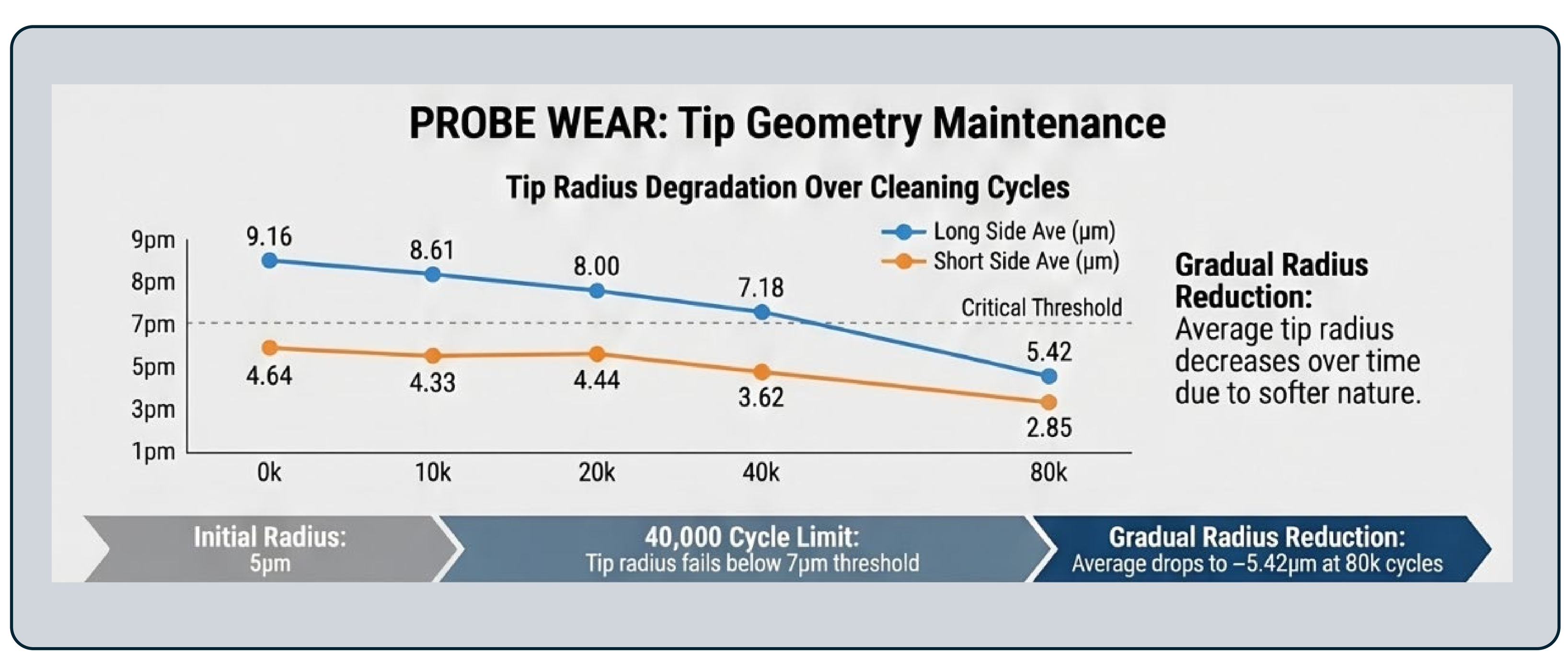


Mechanical Integrity: Tip Radius Maintenance

- Testing showed that the probe tip radius gradually decreases with continuous cleaning cycles.
- Starting from an initial radius of **9μm**, the radius shifted below the **7μm lower limit** after **40,000 cleaning cycles**.
- **Recommendation:** For long-term stable operation and tip radius maintenance, a **combination cleaning method** (utilizing hard clean alongside elastomer cleaning steps) to maintain tip size.

	Cleaning Count(k)	0	10	20	40	60	80
Long Side	MAX	9.97	9.51	8.54	7.76	6.63	5.94
	MIN	8.27	7.67	7.24	6.30	5.28	4.79
	AVE	9.16	8.61	8.00	7.18	6.10	5.42
Short Side	MAX	4.96	4.66	4.64	3.83	3.39	3.13
	MIN	4.30	3.92	4.21	3.26	2.76	2.55
	AVE	4.64	4.33	4.44	3.62	3.11	2.85





Summary

- **Gel-Pak's Gel-Probe** elastomer cleaning material successfully eliminates cleaning-induced debris transfer at both high and low temperatures.
- The material maintains stable CRes under aggressive cleaning overdrives.