NCCAVS CMPUG December Virtual Meeting
Dec 4 & 5, 2024

A Tribo-Electrochemical Approach for Performance Differentiation of CMP Slurry Inhibitors and PCMP Formulations

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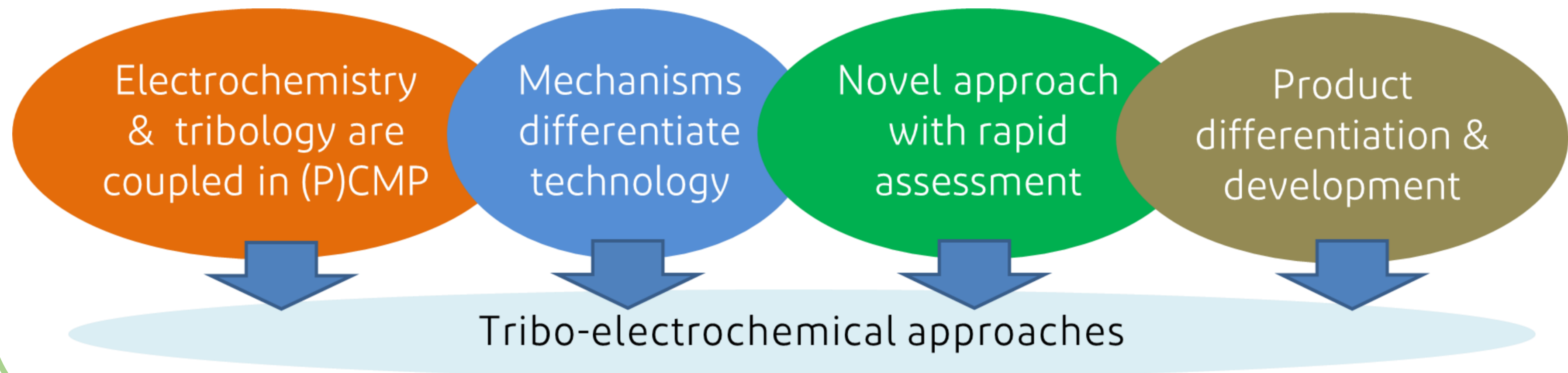
Session Four | December 5, 2024
1:30 p.m. (Eastern Time)

Tribo-Electrochemical Approaches for CMP Slurry & PCMP Cleans R&D

*Our tribo-electrochemical capabilities provide unique scientific opportunities for **performance prediction** and **technology differentiation** of CMP Slurry & PCMP Cleaning formulations*



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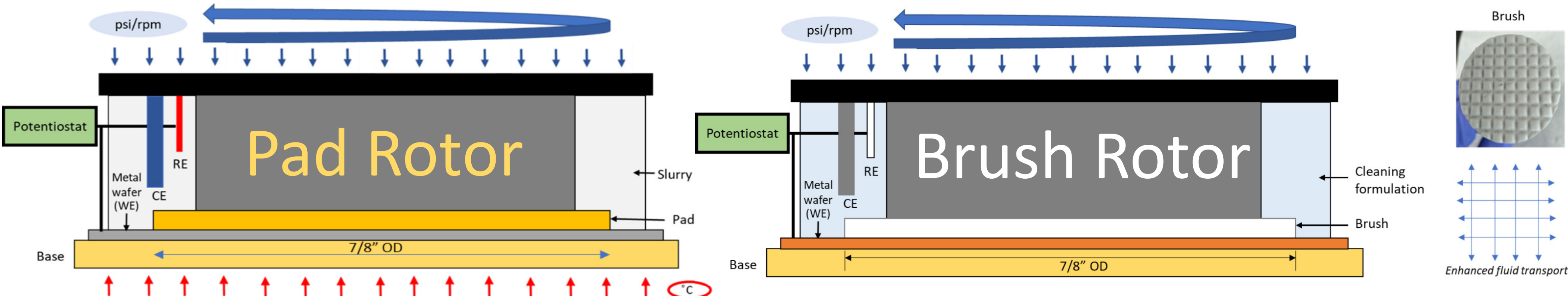
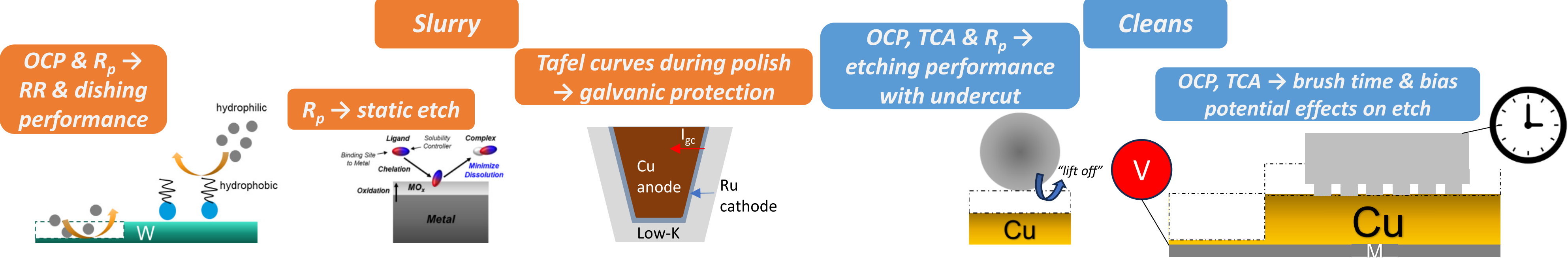
Apparatus has been designed for both Slurry & Cleans R&D

Methodology employs a benchtop polisher with a 3-electrode cell design circuit



Tribo-electrochemical properties are strongly linked with performance metrics



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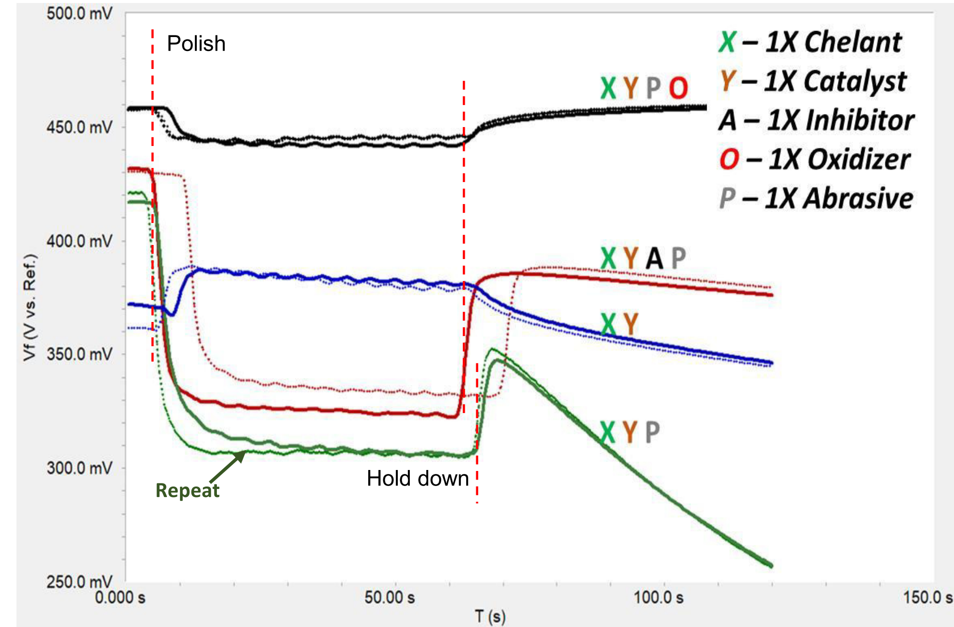
Baseline: high-selective Me slurry, IC1000 pad, 2.5psi, 500rpm, 18ml slurry volume, room temp.

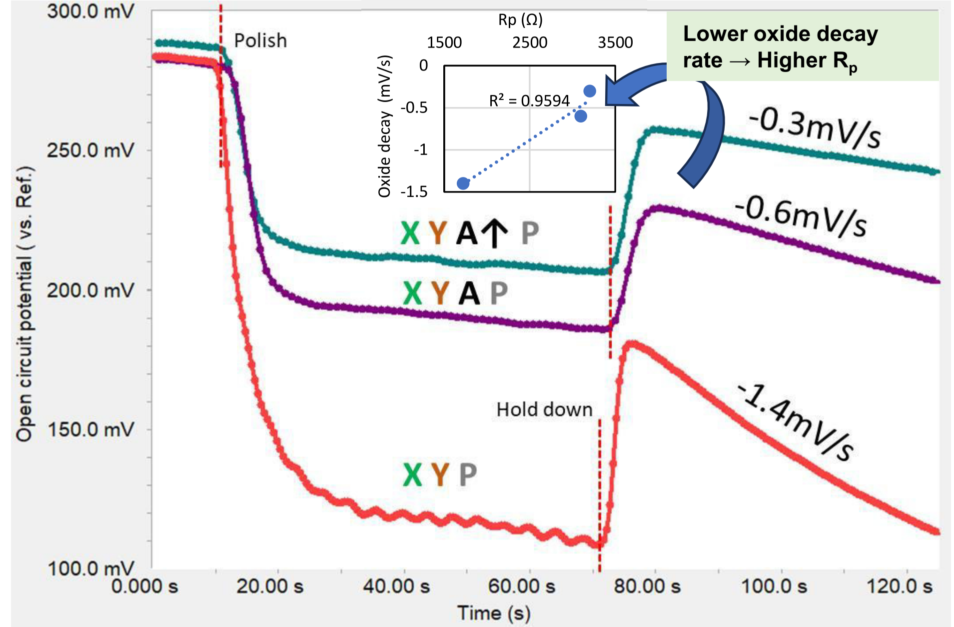
Slurry Applications: Rapid, mechanistic assessment to differentiate technology

Hypothesis: Can we design a benchtop apparatus that is sensitive to both wear and corrosion?

Open circuit potential transients offer rapid preliminary assessment



Further proof-of-concept studies confirm slurry inhibitor differentiation



✓ ***Proof-of-concept study on baseline slurry/pad/metal system provided analytical framework***

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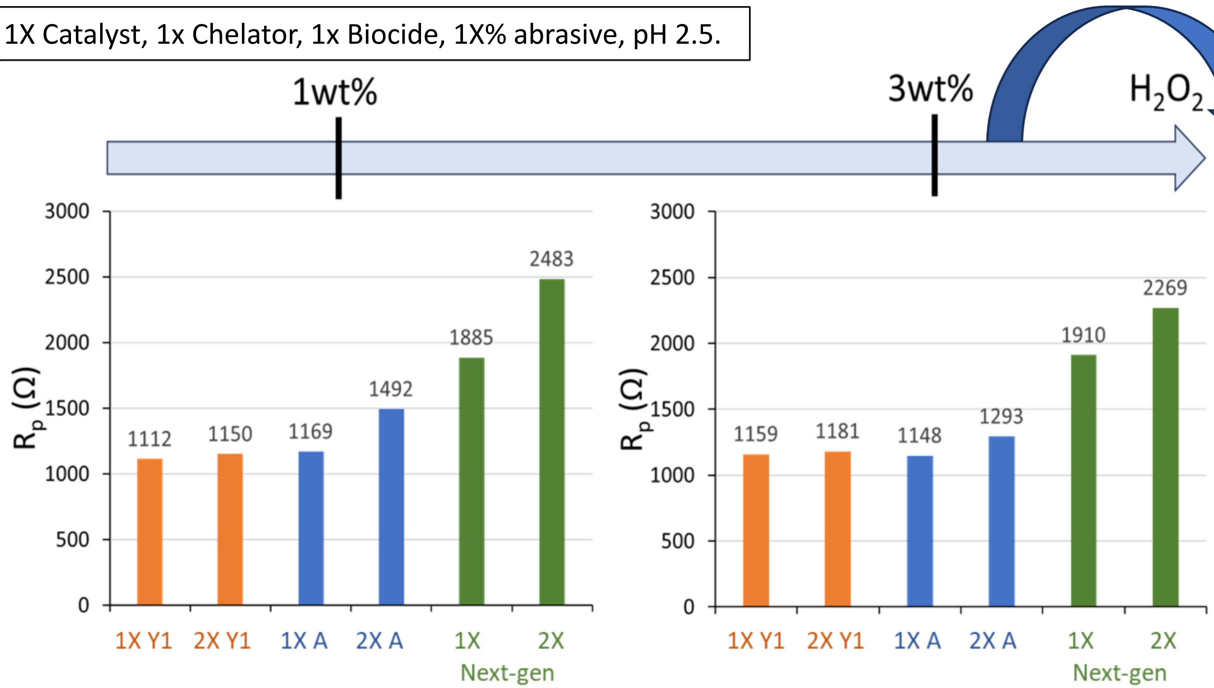
Baseline: high-selective Me slurry, IC1000 pad, 2.5psi, 300rpm, 18ml slurry volume, room temp.

Slurry Applications: Rapid, mechanistic assessment to differentiate technology

Higher tribo-electrochemical resistance R_p → Suppression of dishing/topography

1X Catalyst, 1x Chelator, 1x Biocide, 1X% abrasive, pH 2.5.



Next-gen: Macromolecular Protection for Topography

Utilize multiple binding sites with bulky structure (Macromolecule) to protect from mechanical attack for topography improvement

Y1

Next-gen

Me

Non-Me

Me

Topography improvement data

Slurry with Y1	Slurry with Next-gen inhibitor

Protocol:

- OCP allowed to stabilize 30s after polish, pad remains on wafer in slurry at set downforce
- +/-0.025V vs open circuit potential applied @ 1mV/s scan rate, giving total experiment time of 50s per test

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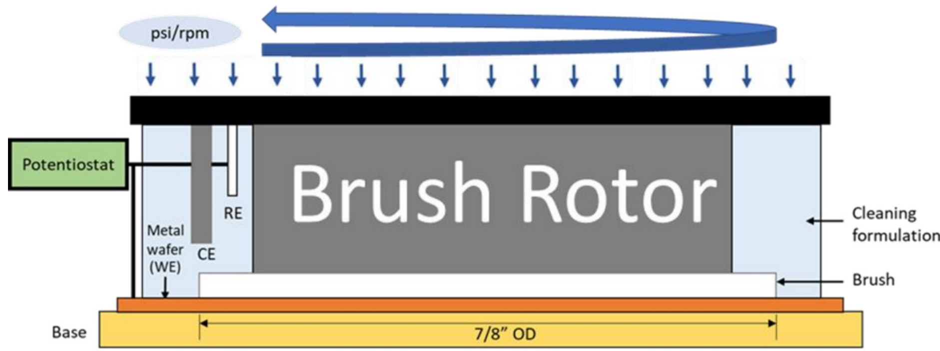
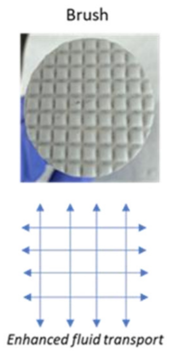
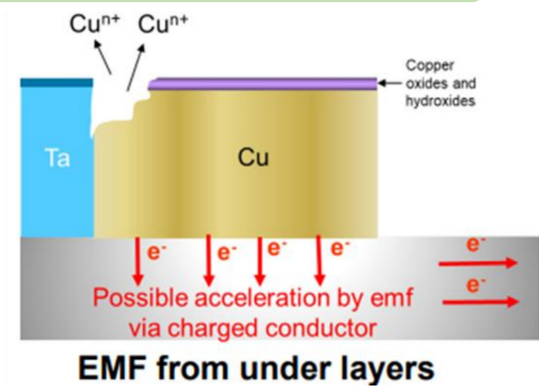
Baseline: Cu cleaning formulations, Surrogate brush, 0.5psi, 60rpm, 18ml volume

Cleans Applications: Leverage capabilities to solve customer challenges

Hypothesis: Oxidative potential from charged conductor beneath triggers Cu corrosion in PCMP cleaner

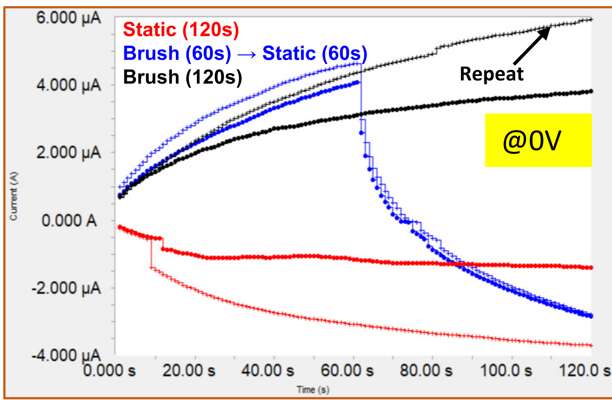




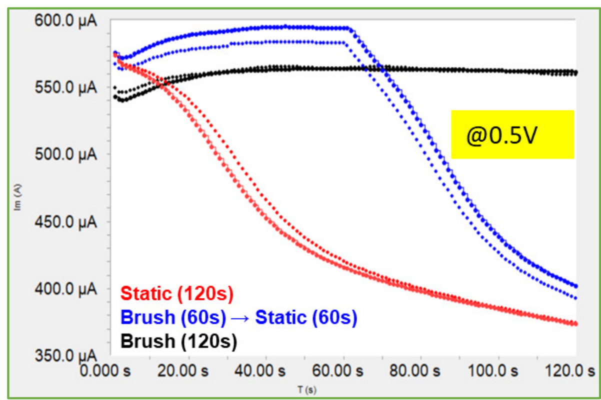


Tribo-Chronoamperometry (TCA) analyses demonstrated the effect of bias potential on corrosion and accurately predicted metal loss

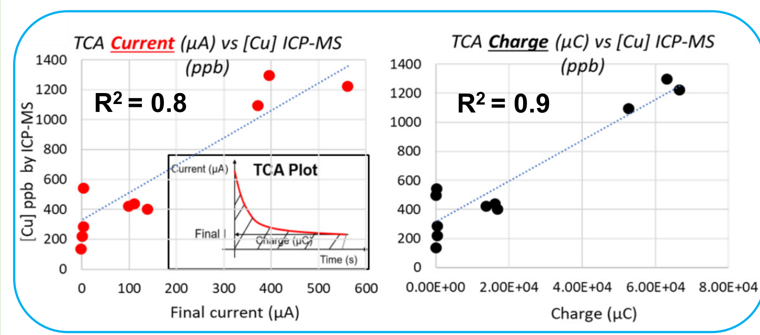
Brushing contributes to corrosion…



… as well as bias potential



✓ **TCA current and charge → [Cu] loss**



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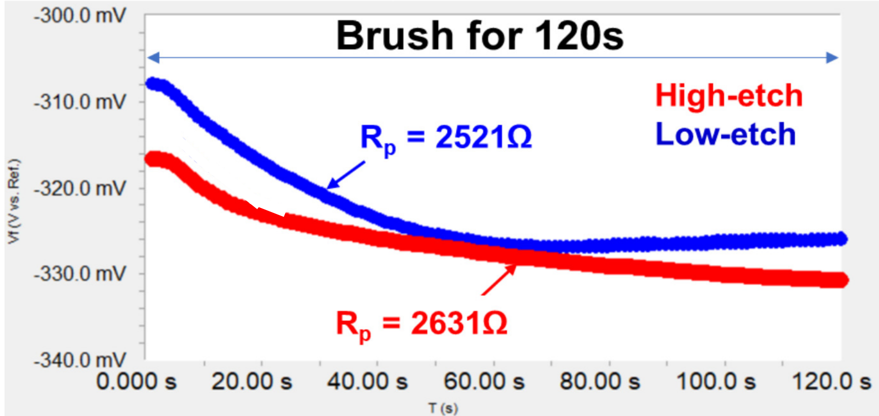
Baseline: Cu cleaning formulations, Surrogate brush, 0.5psi, 60rpm, 18ml volume

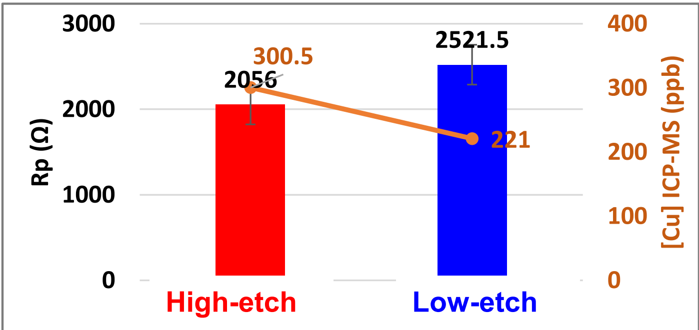
Cleans Applications: Leverage capabilities to solve customer challenges

Hypothesis: Etch performance of PCMP formulations can be predicted by potential and current transients

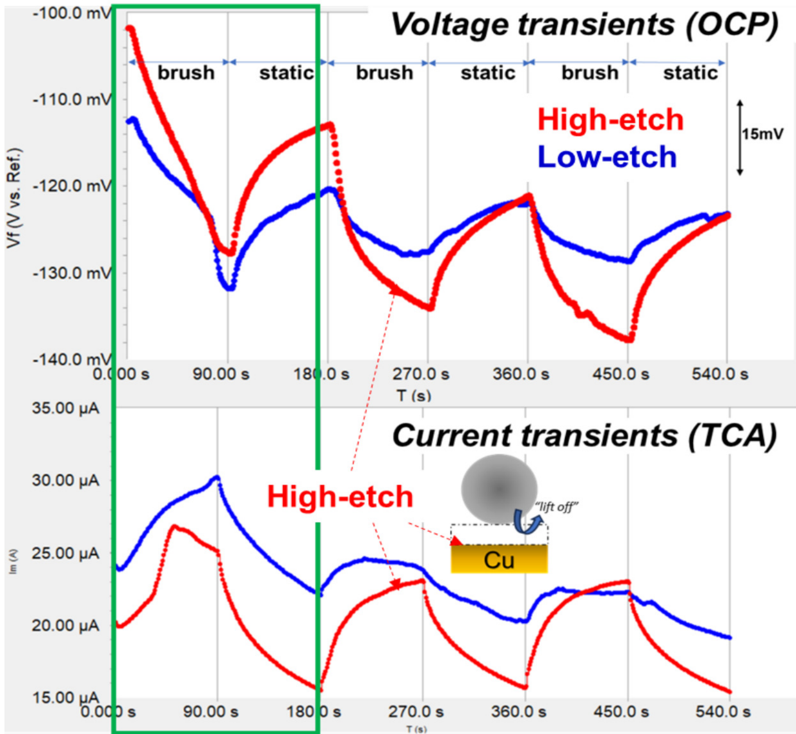
Initial approach could not distinguish etch rate performance…



Polarization resistance with improved method → [Cu] loss



…due to effect of time. Improved methods with transient analyses distinguished etch rate performance.



Customer feedback: ***"Critical to next-gen PCMP cleaners"***

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Summary

- Performance case studies have been used to demonstrate innovative tribo-electrochemical approaches for CMP Slurry & PCMP Cleaners

- For the CMP slurry case, OCP transients and R_p measurements under tribo-corrosion conditions differentiated corrosion inhibitor candidates and correlated with topography improvements.

- For the PCMP case, chrono-amperometry charge and current signals under brush and static conditions demonstrated bias potential and brushing effects on corrosion and were used to accurately predict metal loss. Potential and current transients revealed the time dependence of the PCMP cleaners' corrosion performance window

- Tribo-electrochemical approaches could serve to enrich the "marriage" between CMP slurry & PCMP cleans and help address key aspects of future formulation design challenges.

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