3M Electronics

3M Products for Semiconductor Finishing

Developing a robust conditioning system in 300mm CuCMP

NCCAVS CMP, PAG, TF Joint User Group Meeting
Dec 8, 2010

John Zabasajja, *Michael Pevny, Tammy Engfer and Doug Pysher
3M Company Electronic Market Materials Division, St. Paul, MN

Introduction

- Current devices utilize multiple layers of copper metallization with complicated integration schemes have resulted in a barrage of various CMP pad constructions being deployed to meet the fab's manufacturing requirements.
- Next generation Cu slurries are targeting lower concentrations and smaller abrasive particle sizes compared to traditional copper slurries.
- To match the pad and slurry evolution, different types of conditioners with varying levels of aggressiveness and surface finishes are being produced to optimize pad conditioning and resultant wafer performance.

Introduction

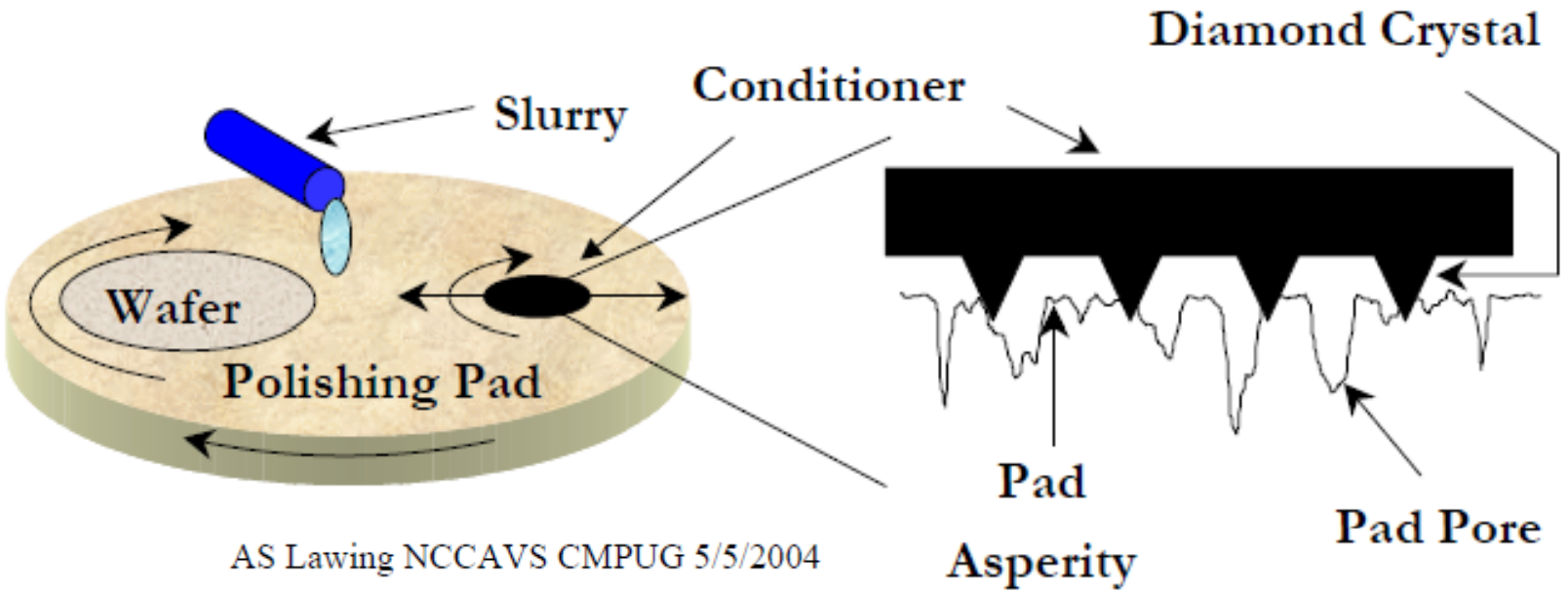
- For bulk copper removal, pads with a large degree of hardness have been traditionally used and for the Cu polish steps. This is changing with the deployment of alternate pad designs.
- Historically, in CuCMP, aggressive conditioning disks are needed to texturize the pad and maintain consistent surface morphology.
- For improved defectivity, next generations pads with lower hardness and various porosities are being designed and deployed.
- Less aggressive disks designed to maintain the original pad asperities, minimize pad wear, minimize erosion and reduce defectivity are being introduced to match next generation pads and slurries as an optimized system.

Background

Key variables identified for optimal conditioner disk selection during this test were:

1) Type of slurry used

2) Pad design



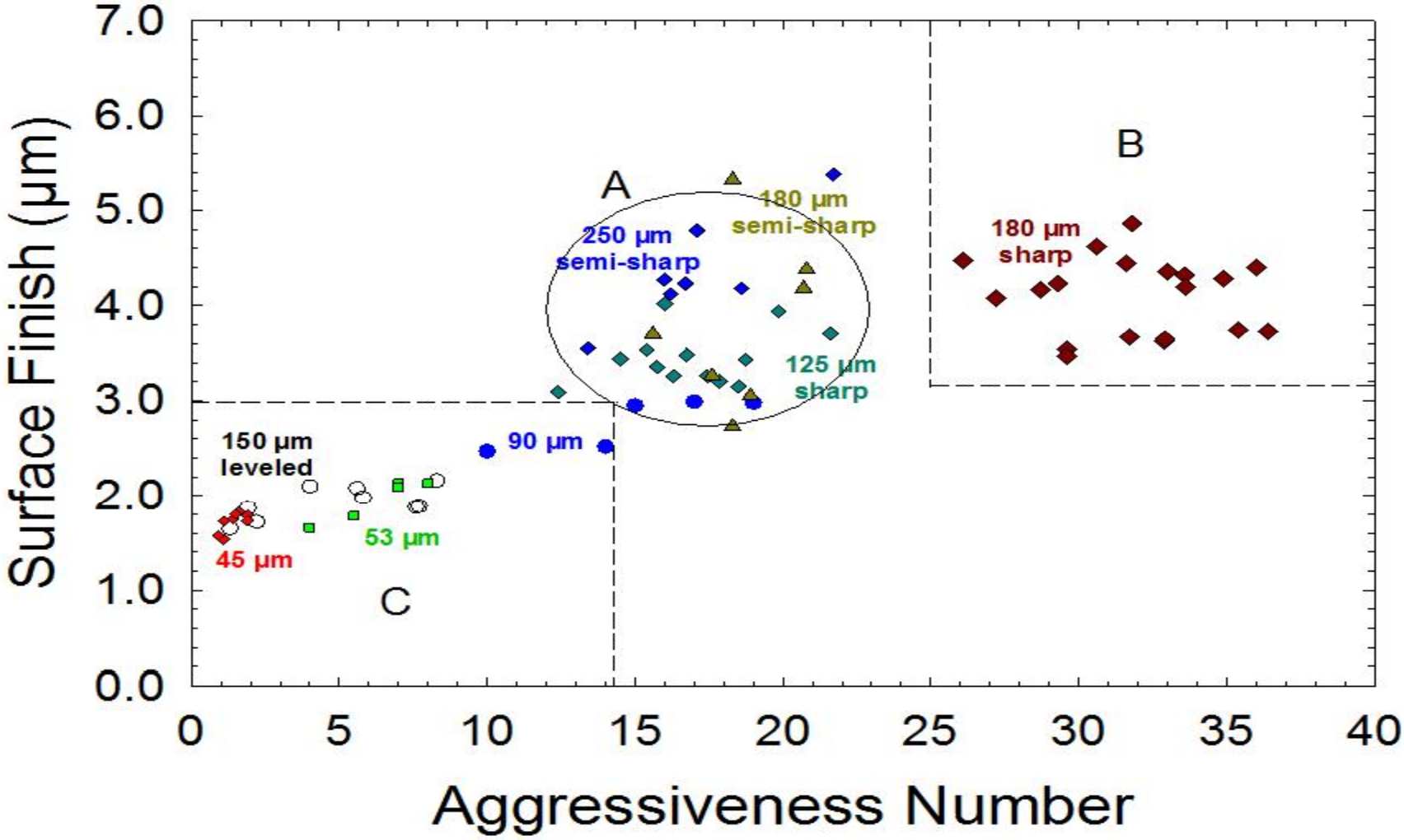
3M CuCMP Experimental Reflexion Setup

- Testing was conducted on 300 mm Reflexion platen and 200 mm head.
- 3D in-situ pad wear measurements were employed during polishing to measure pad wear and pad profile.
- 4 types of commercial 3M Conditioner designs were employed from various levels of aggressiveness for this study.
- Evaluation was conducted with 2 HVM Cu Slurries Y and Z.
- Tested 4 pads, IC1010 and 3 next generation pads B, C and D. Note: all 3 pads are softer and more porous than the IC1010.

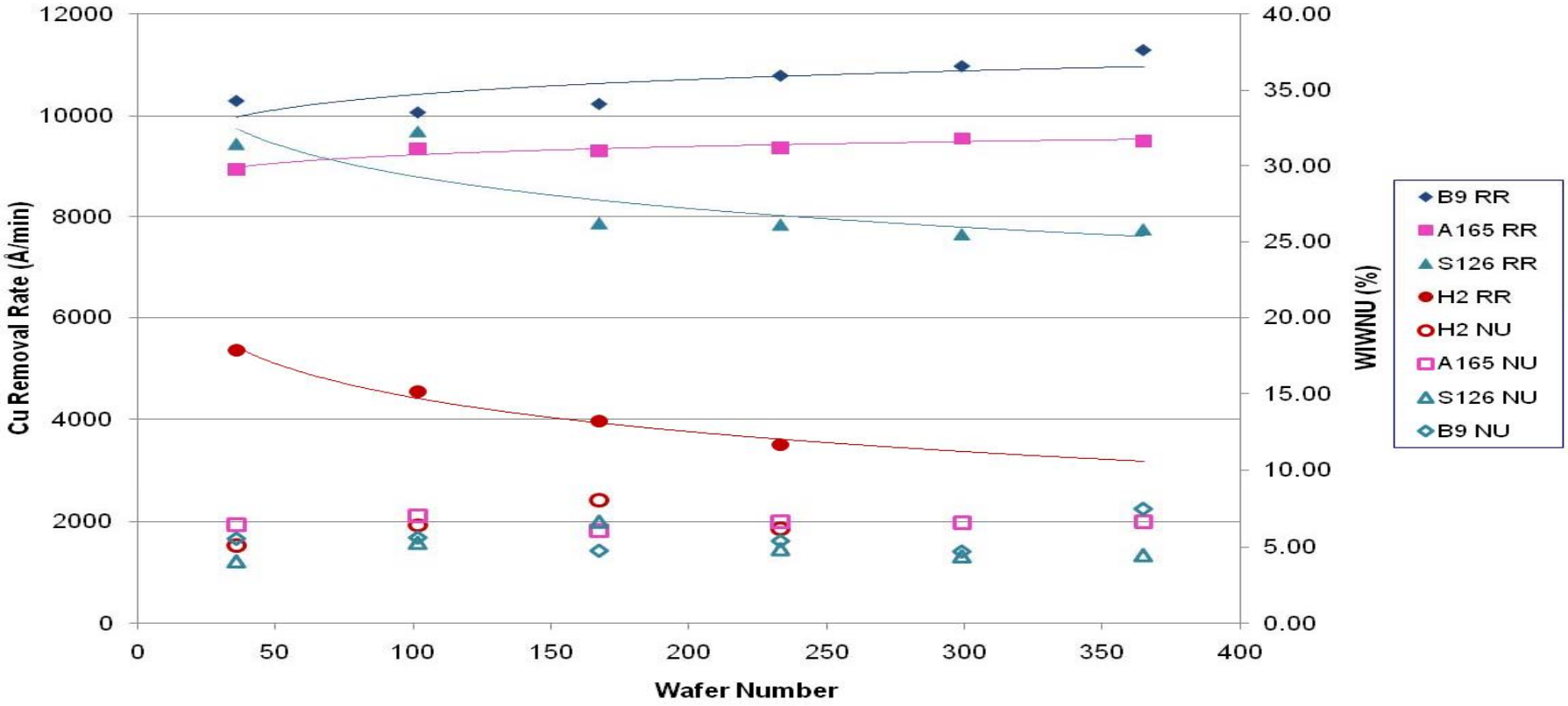
SUMMARY OF 3M CONDITIONER PROPERTIES TESTED

	H2	S126	B9	A165
Diamond Size (µm)	63	151	181	251
Diamond Type	Type 2, blocky	Type 3 semi blocky	Type 9, sharp	Type 4, semi sharp
Aggressiveness (BL range)	1 - 3	9 - 11	25 - 35	15 - 19
Surface Finish (µm)	1.65 - 1.77	1.73 - 2.42	3.12 - 3.67	2.95 - 5.0

PAD SURFACE FINISH AND AGGRESSIVENESS



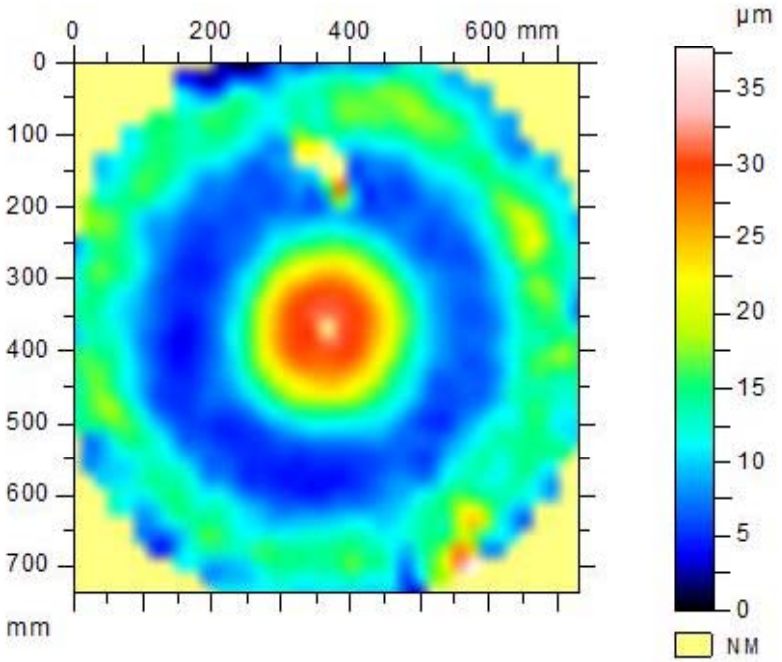
Marathon Testing with Cu slurry Y and IC1010



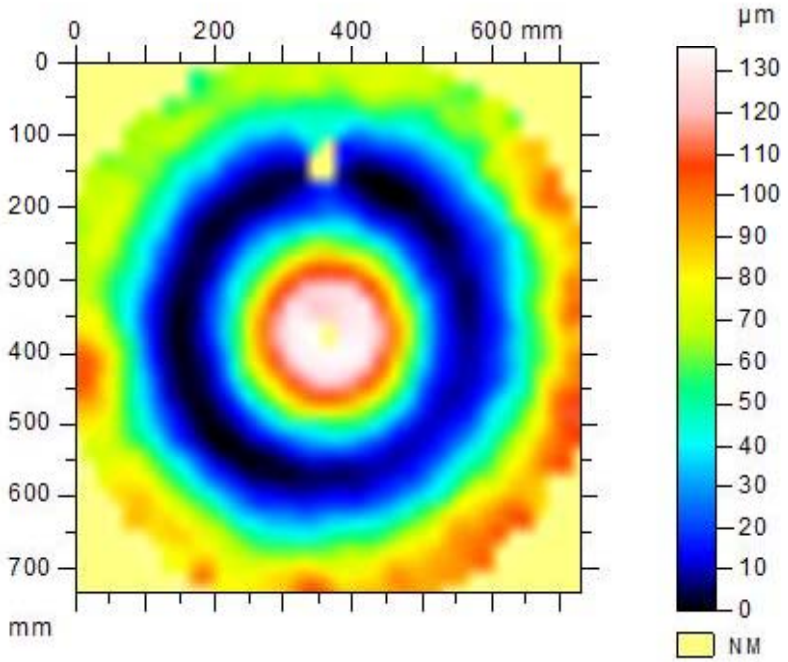
Removal rates were highest and more stable for the most aggressive conditioners.

3D In-Situ Pad Wear Rate and Profile with Cu Slurry Y IC1010 Pad (after 350 wafers)

Used to generate pad profiles and measure pad wear



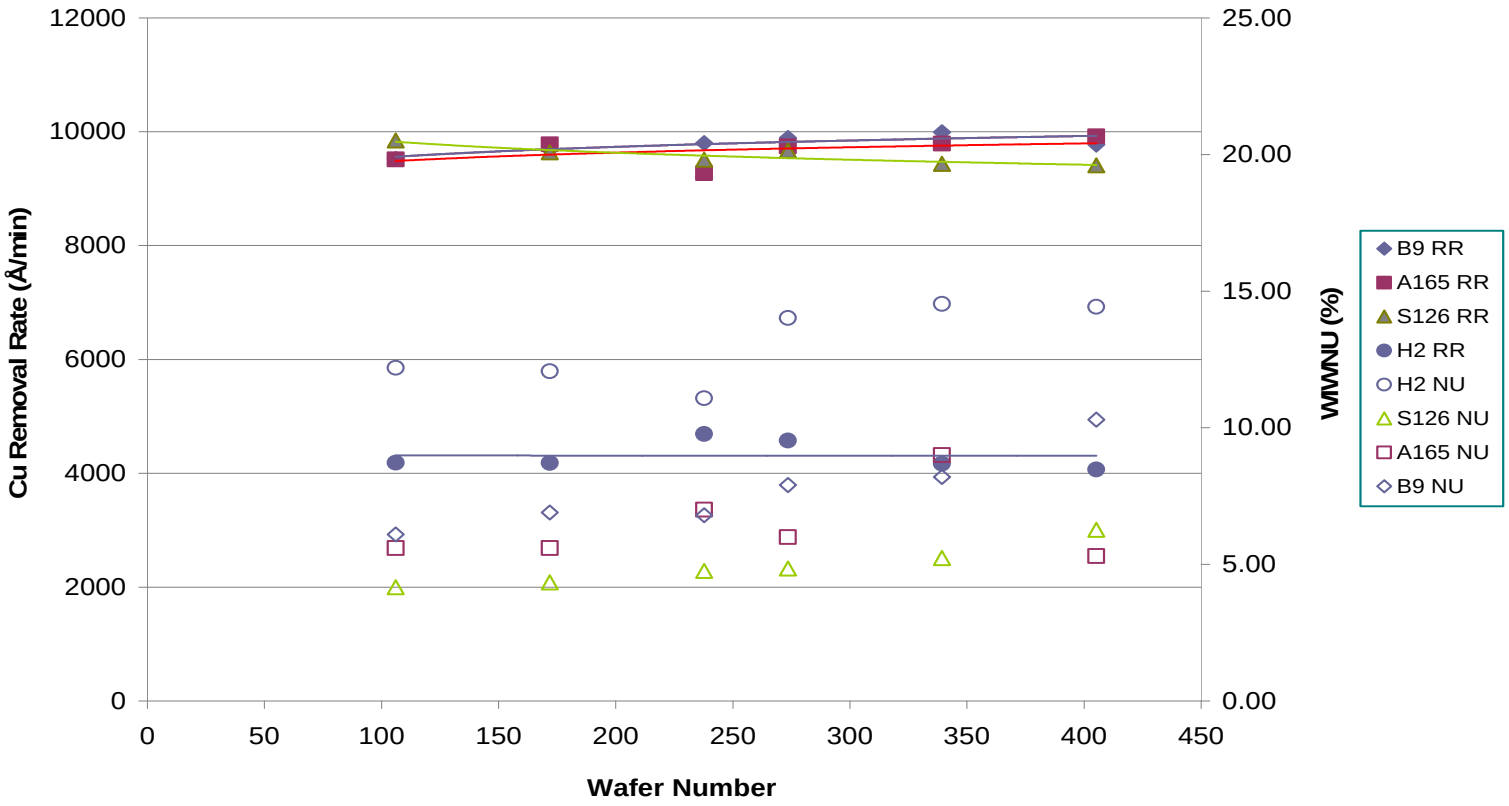
a) S126 Pad Wear Profile



b) B9 Pad Wear Profile

Higher PWR with more aggressive disk B9 vs S126

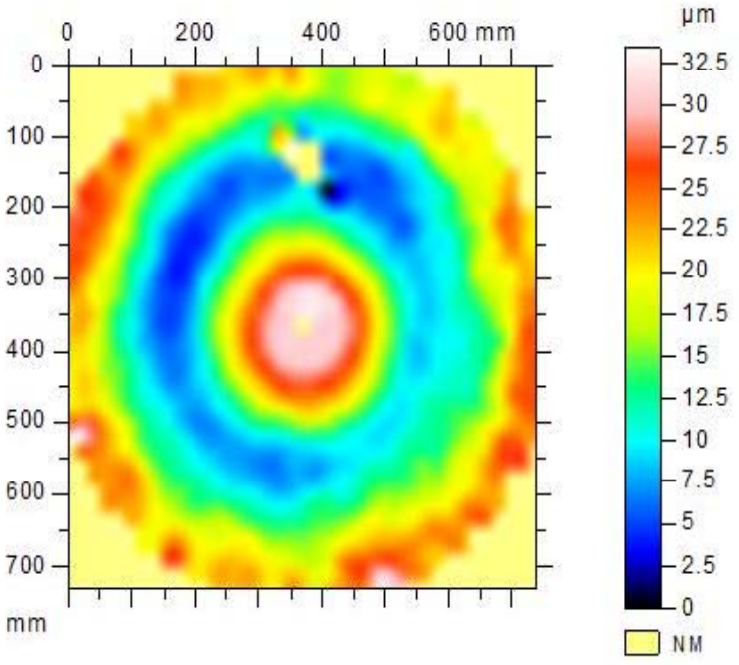
Marathon Testing with Cu Slurry Y and Next Generation Pad B



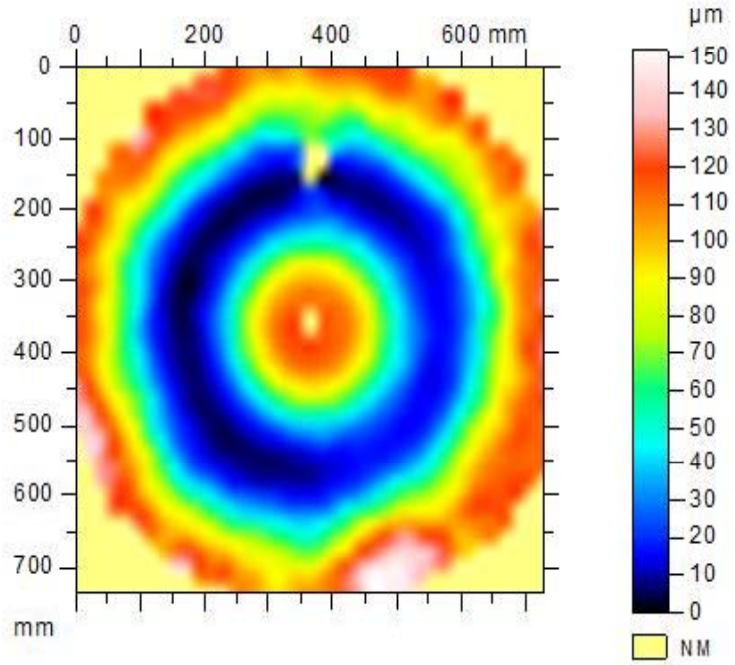
RR is similar and non-uniformity is better with one of the less aggressive disks, S126 compared to aggressive disks

In-Situ Pad Wear Rate and Profile with Cu Slurry Y and Next Generation Pad B (After 350 wafers)

Used to generate pad profiles and measure pad wear



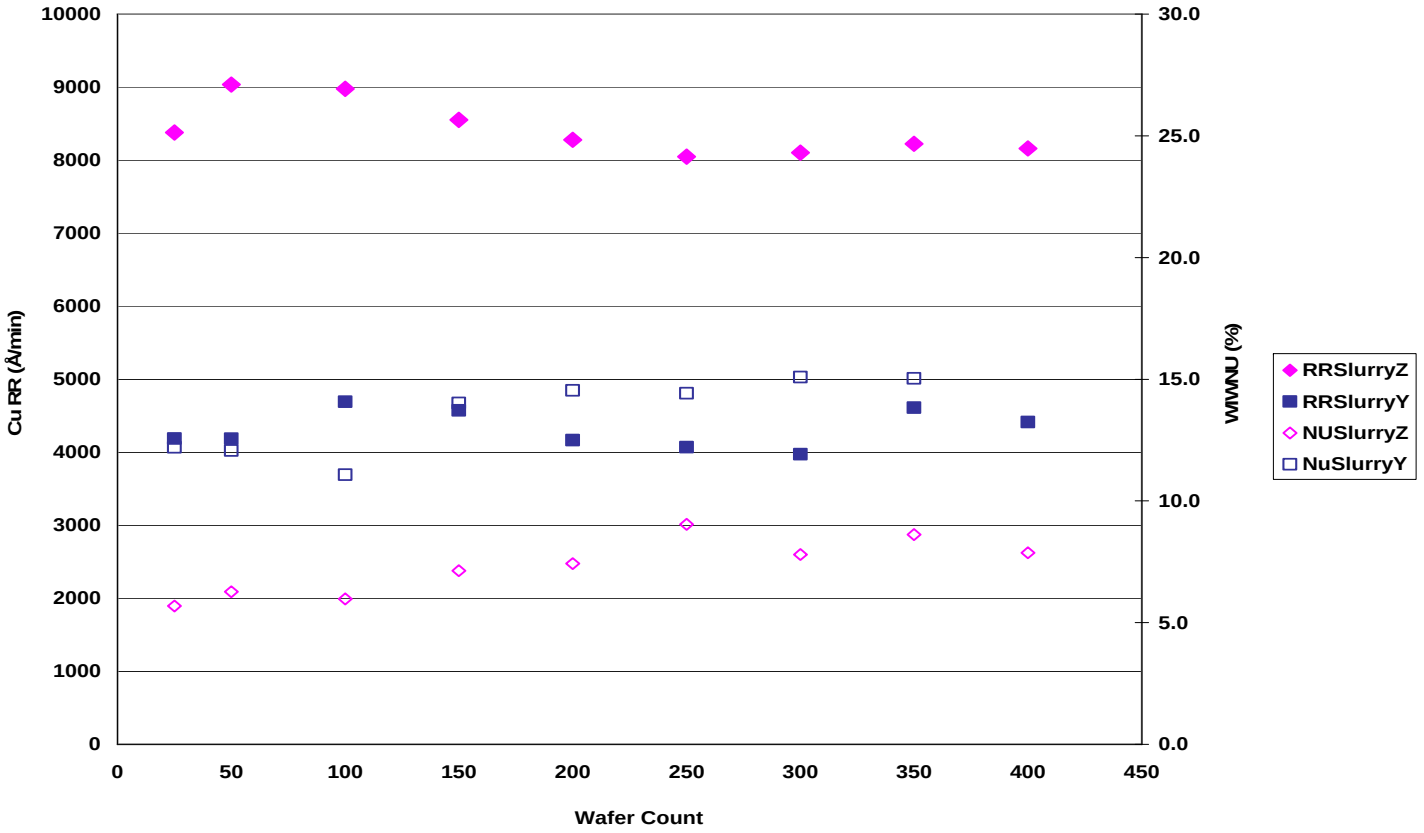
a) S126 Pad Wear Profile



b) B9 Pad Wear Profile

High PWR with B9 vs S126 on next generation pad B in spite of similar RR

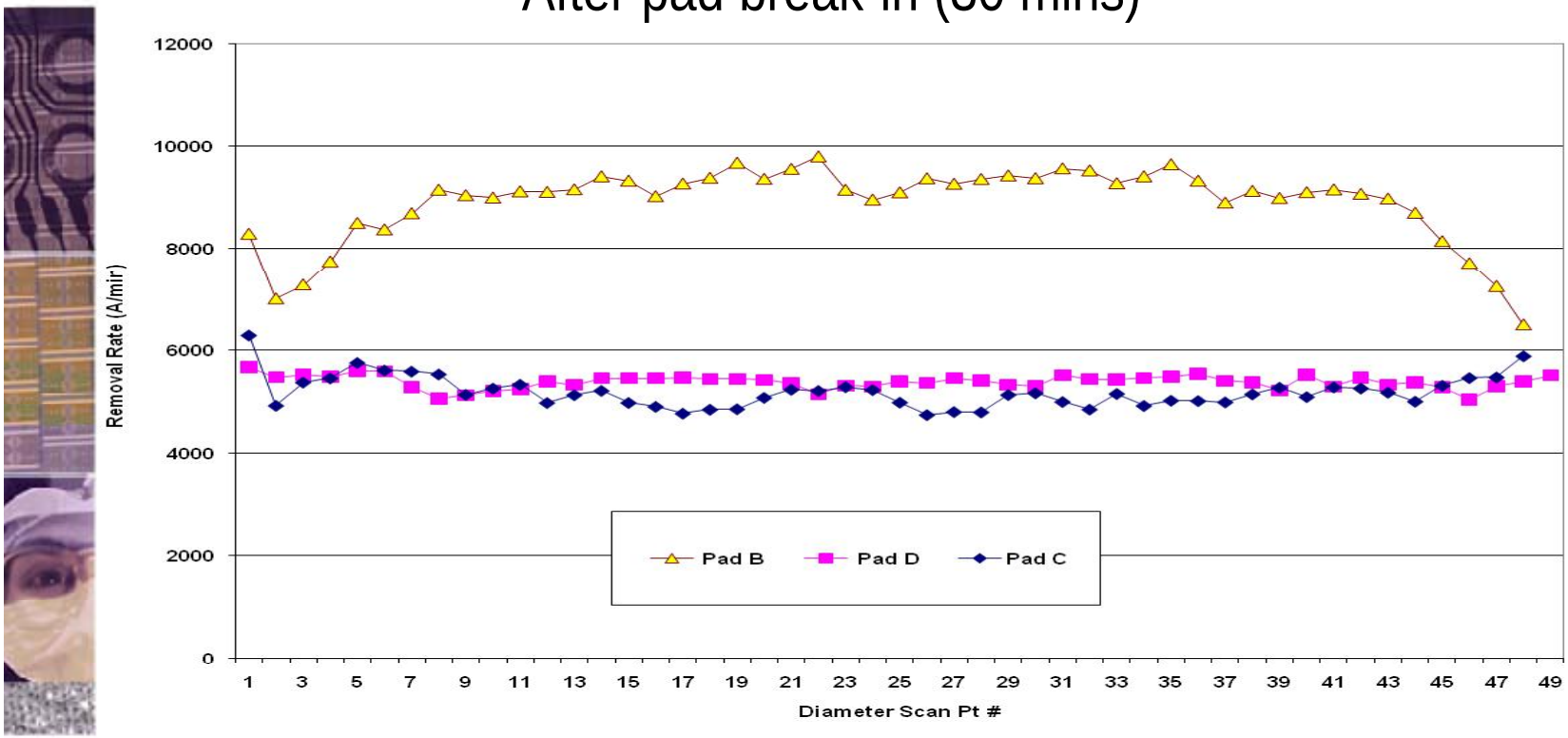
Interaction between different copper slurries Z and Y using low aggressive “H2” disk with next gen pad B



RR is **2X** higher with slurry Z than slurry Y

RR between three next gen pads with low aggressive “H2” disk for copper Z slurry

After pad break-in (30 mins)



RR is higher for pad B compared to pads C and D with same H2 disk

SUMMARY

- For IC1010, conditioner aggressiveness strongly influences the effectiveness of the conditioner.
- Removal rate and non uniformity are highest and most stable for the most aggressive conditioning disks with IC1010.
- In contrast, for next generation pads, the interaction between pad, conditioner, and slurry is more complicated and nuanced.
- The choice of conditioner will be greatly influenced by the type of pad and slurry used. A robust system must be developed between all three consumables for ideal wafer performance and stability.
- NEXT STEP: 3M continues to collaborate with pad and slurry vendors and OEM's to help understand the fundamentals which influence the conditioner on wafer planarization efficiency and defectivity.

ACKNOWLEDGMENTS

- The authors would like to thank the pad and slurry vendors for providing materials for this work.
- Thanks to Adam Painter and Matt Fritz, 3M Company, EMMD Laboratory, for their assistance in generating and analyzing the data.