



PADPROBE™
FOR QUANTITATIVE CONTROL
OF PAD SURFACE CONDITIONS
AND WEAR

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Sensor Technology

- Strain-gauge force and torque sensors:
 - Novel, patented, high-sensitivity, low-drift, very high repeatability
- High-frequency optical and acoustic sensors:
 - Novel, high-sensitivity, peak-detection
- Precision mechanical assemblies
- Real-time data acquisition & analysis

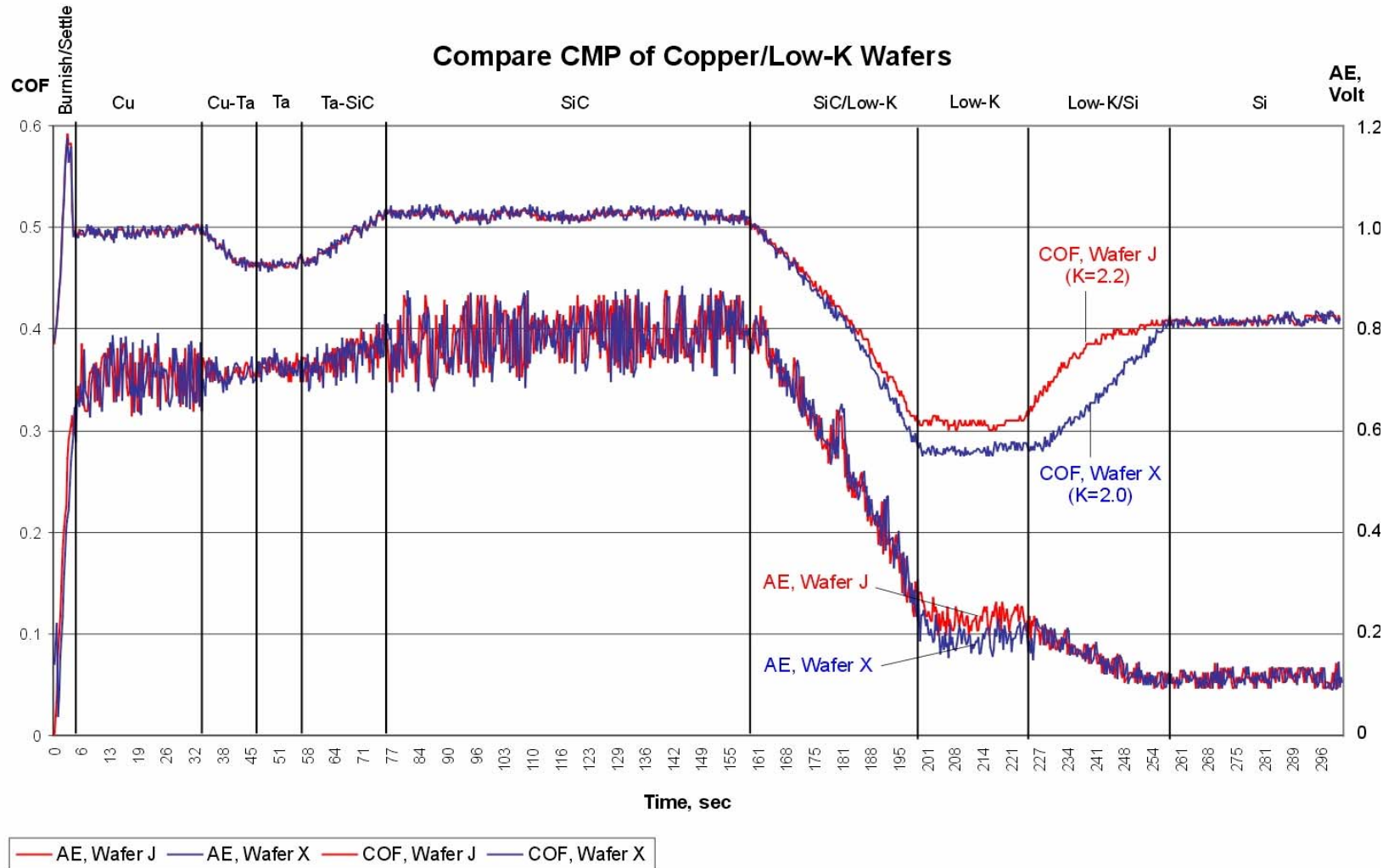


Coefficient of Friction (COF) as a function of:

- Contacting materials (wafer, pad, chemicals, byproducts)
- Surface roughness (wafer pattern, pad conditioning)
- Presence of lubricant (water, slurry)
 - Flow rate
 - Distribution (pores, grooves)
 - Viscosity
- Relative speed
- Temperature
- Contact pressure



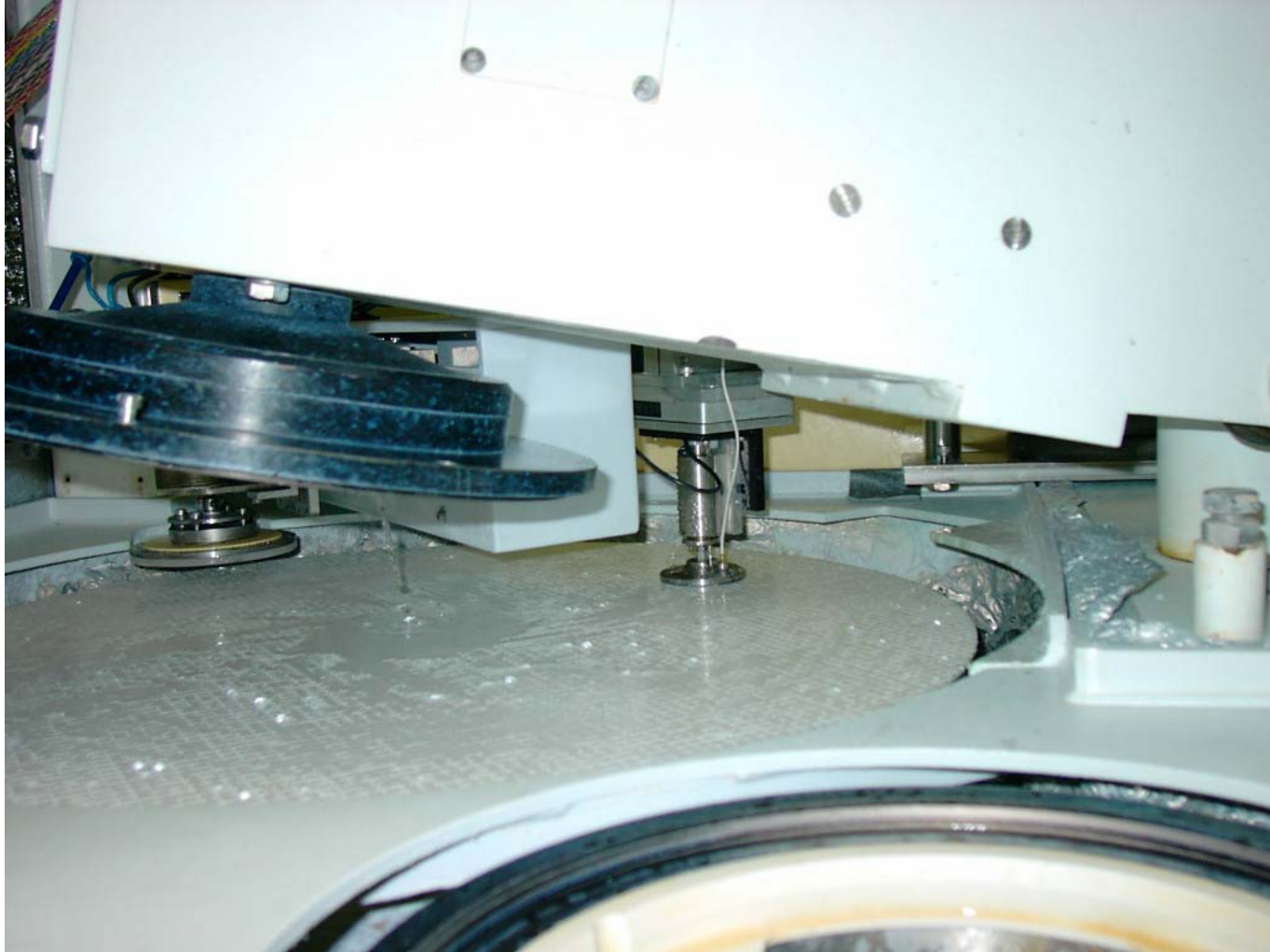
In-situ CMP Monitoring of Copper/Low-K Wafers



CETR

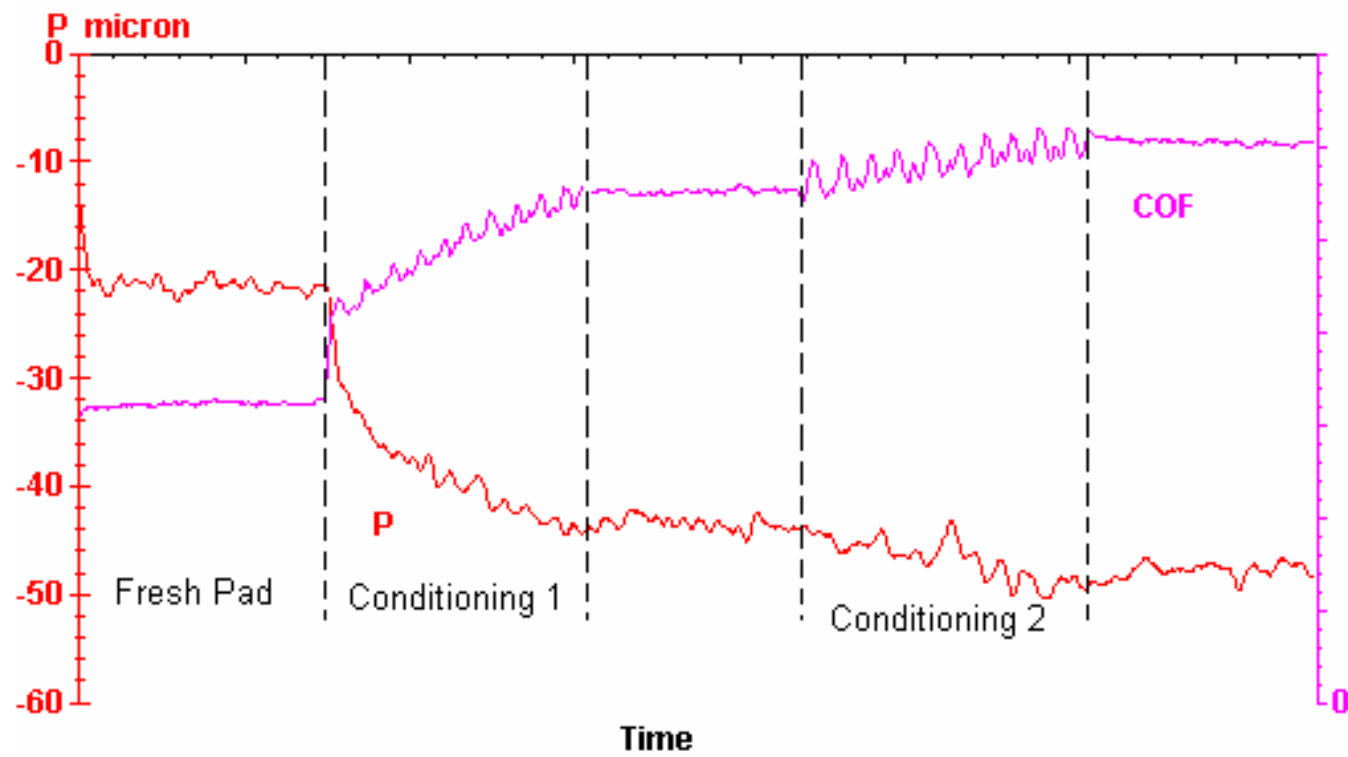


CETR



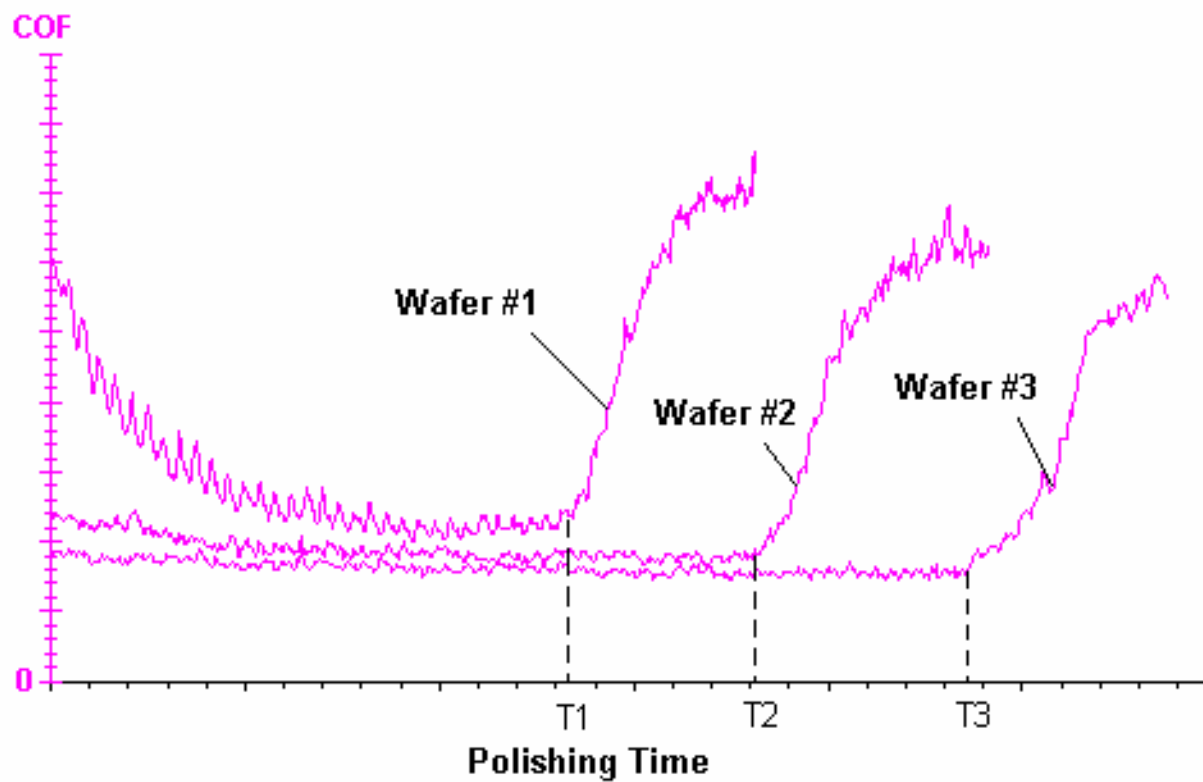


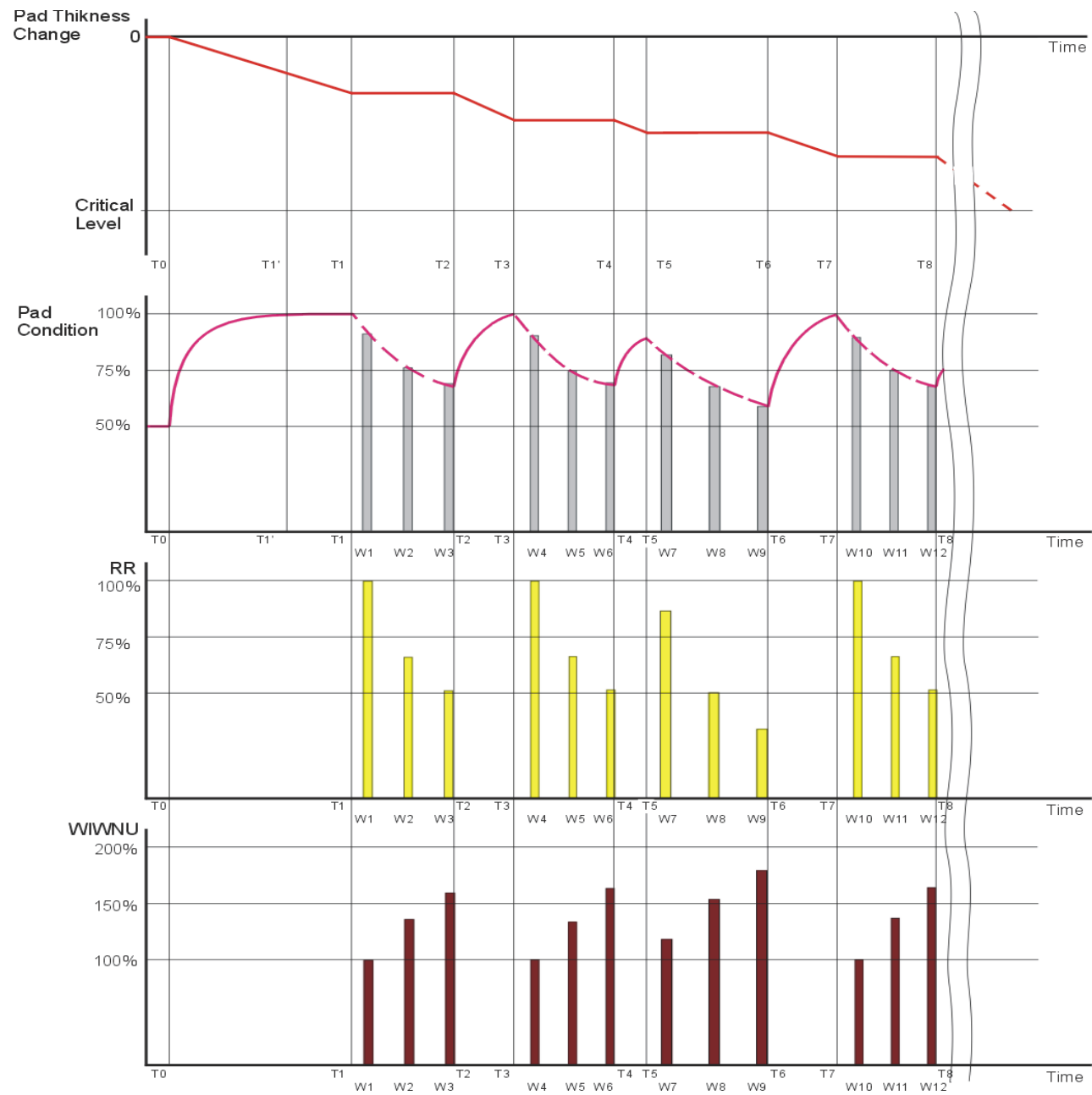
Pad Friction and Wear During Conditioning

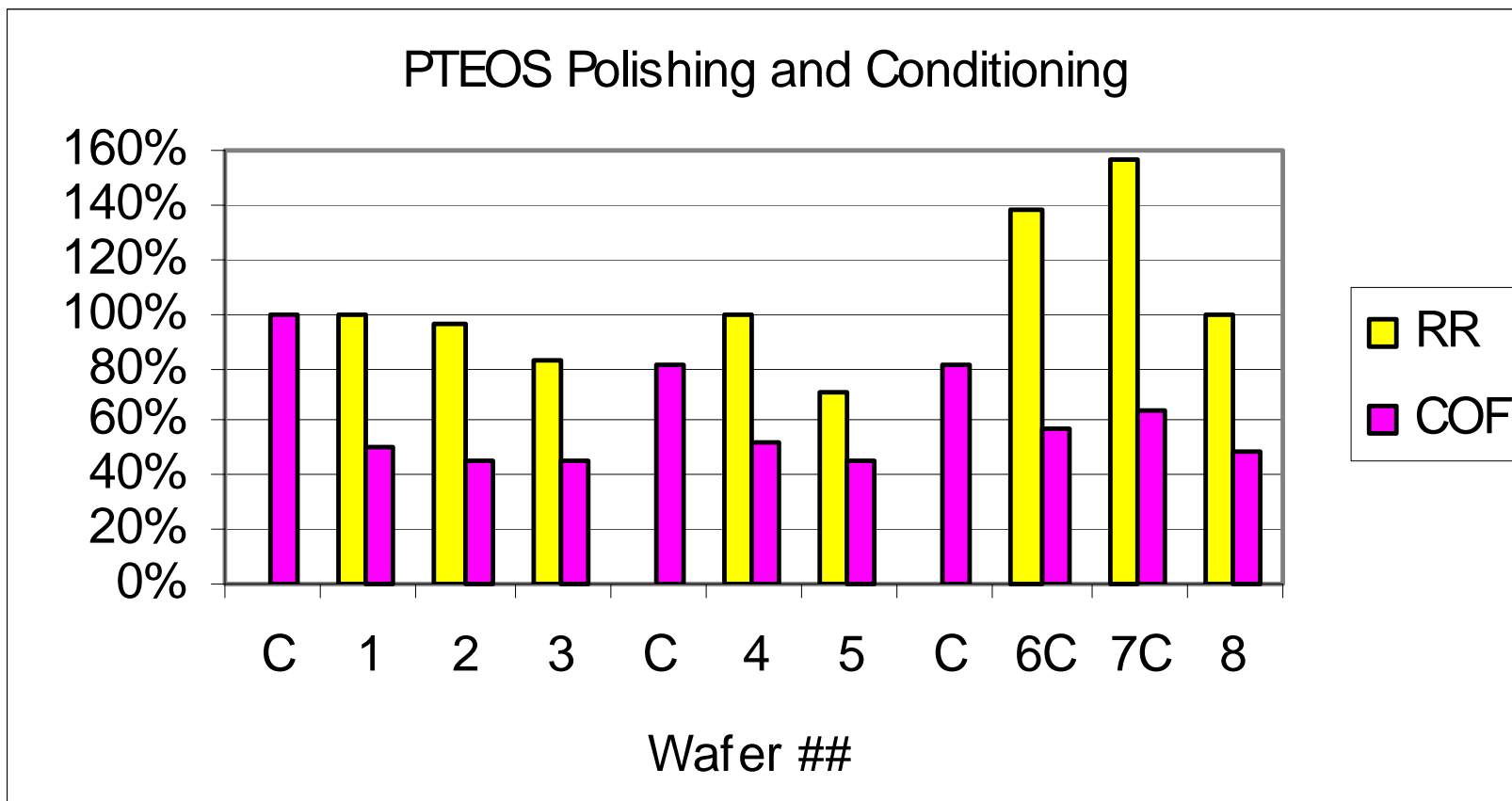


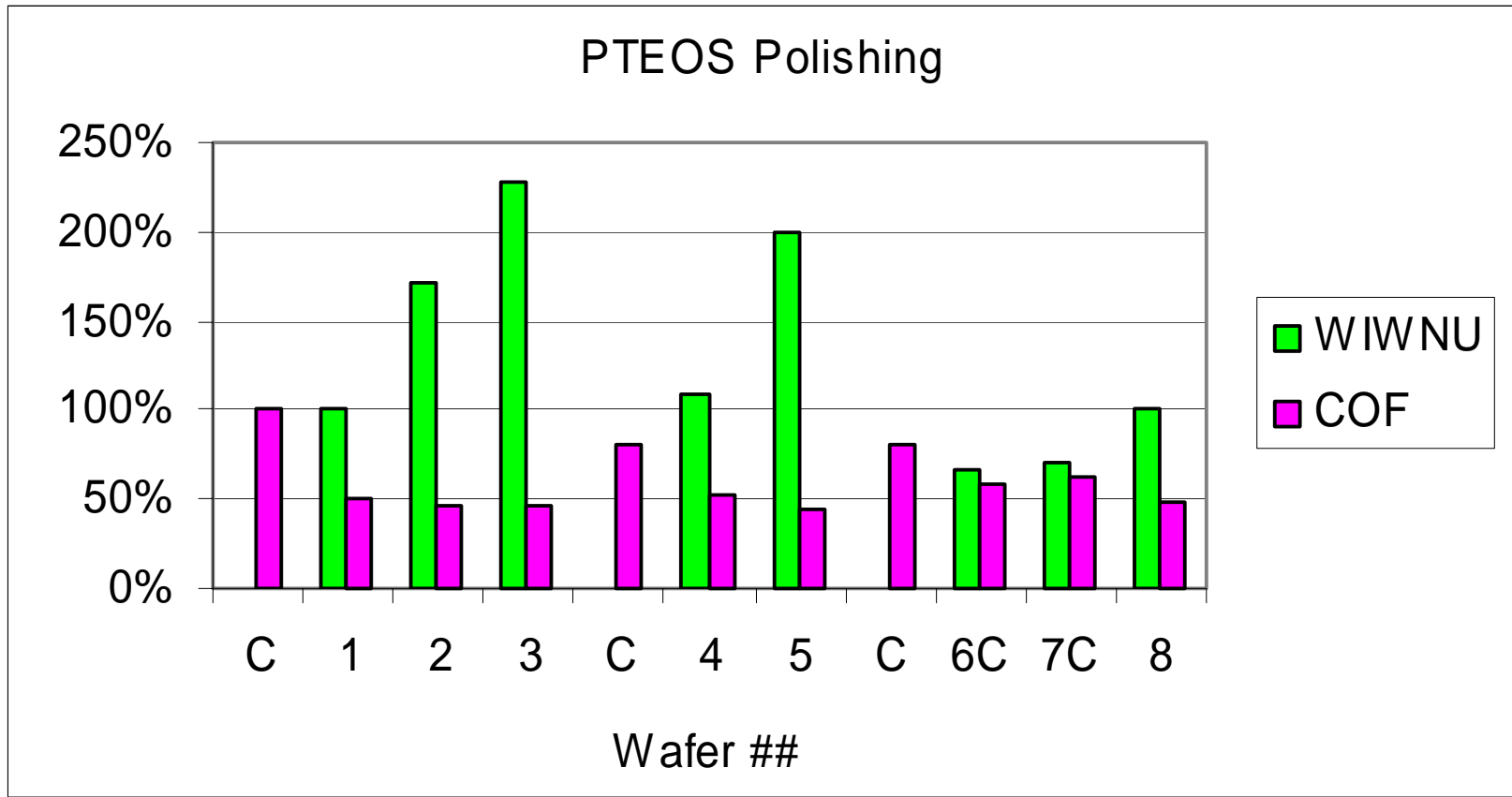


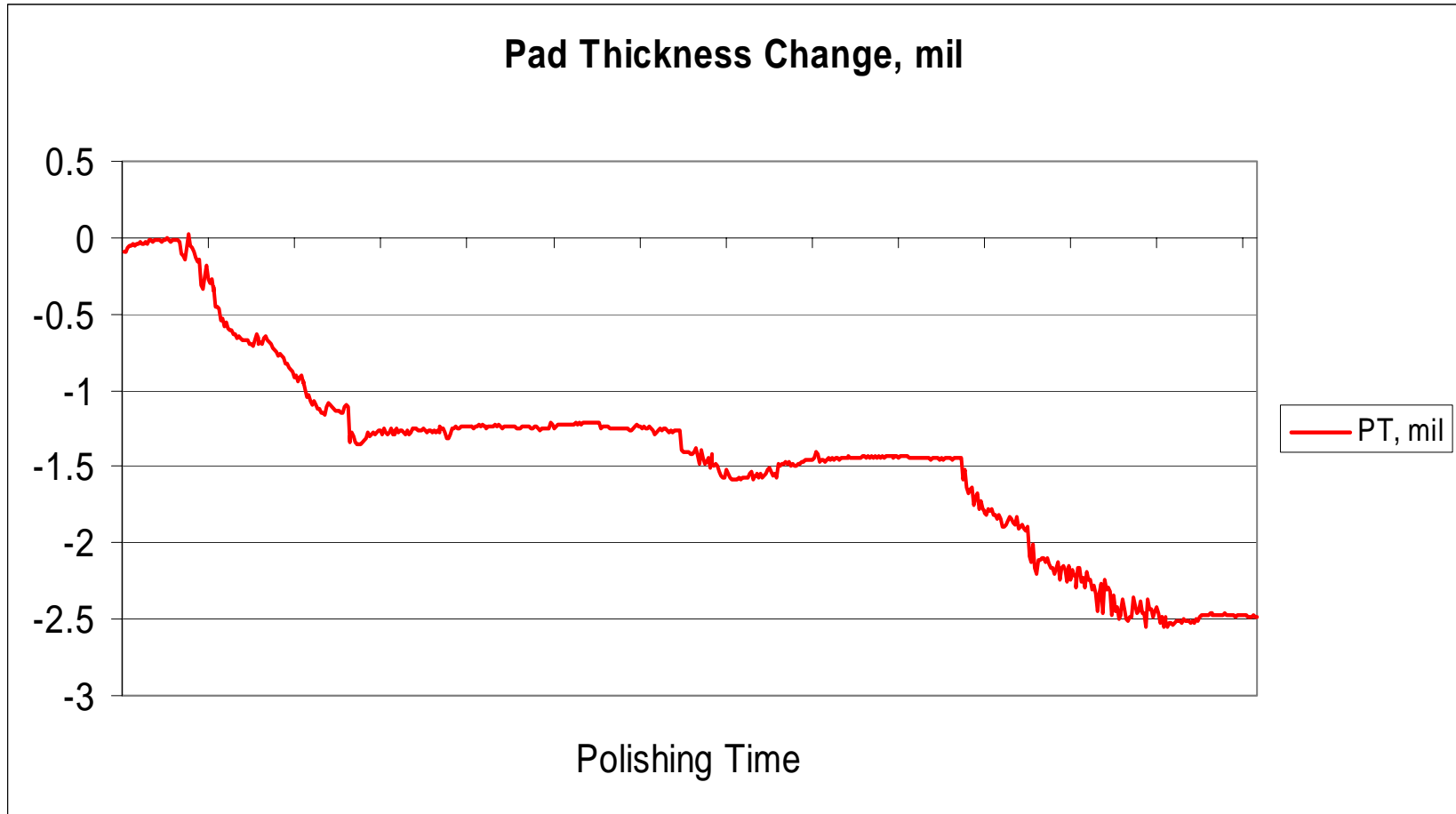
Wafer Friction, PTEOS Polishing, No Conditioning

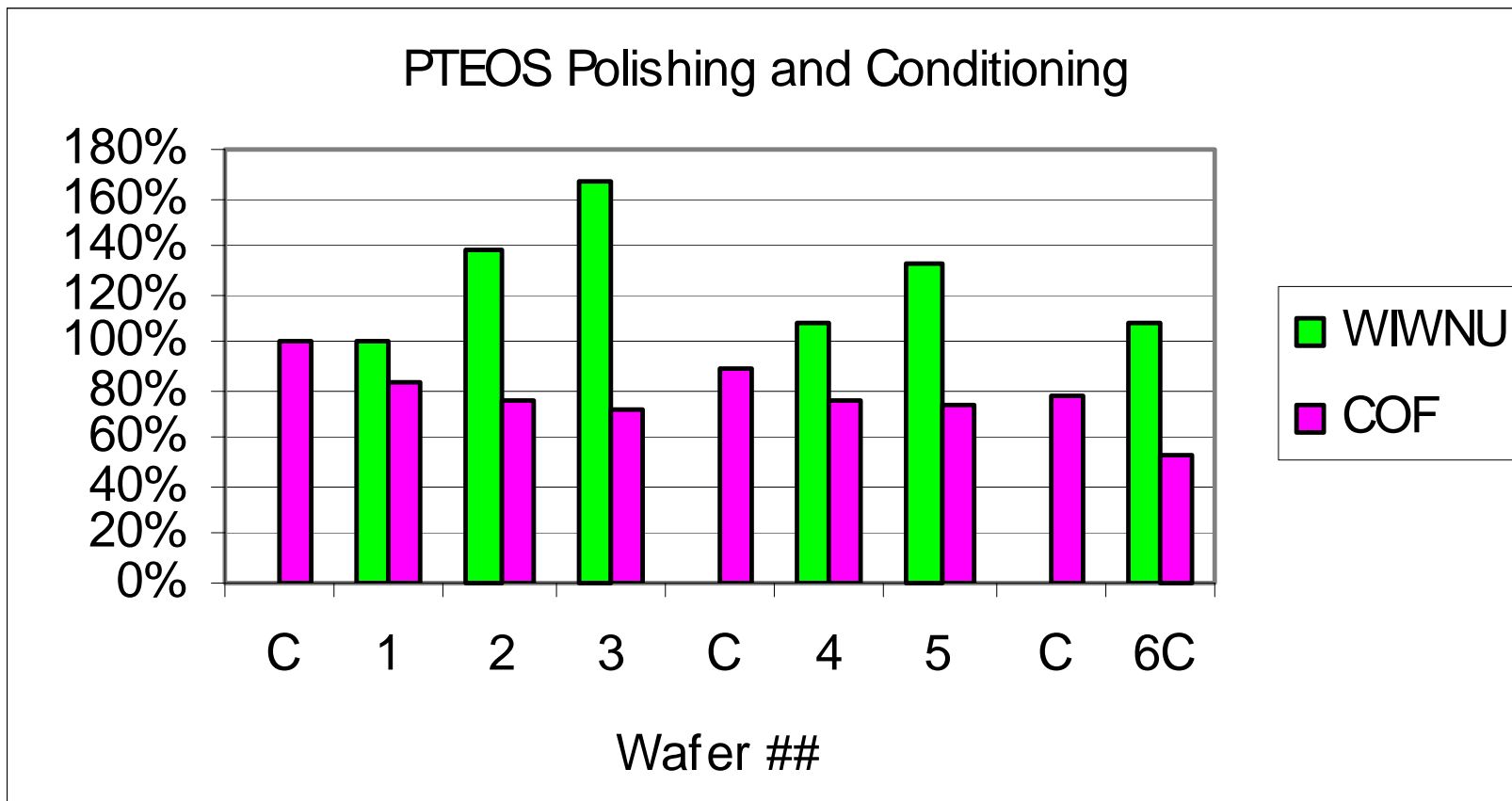


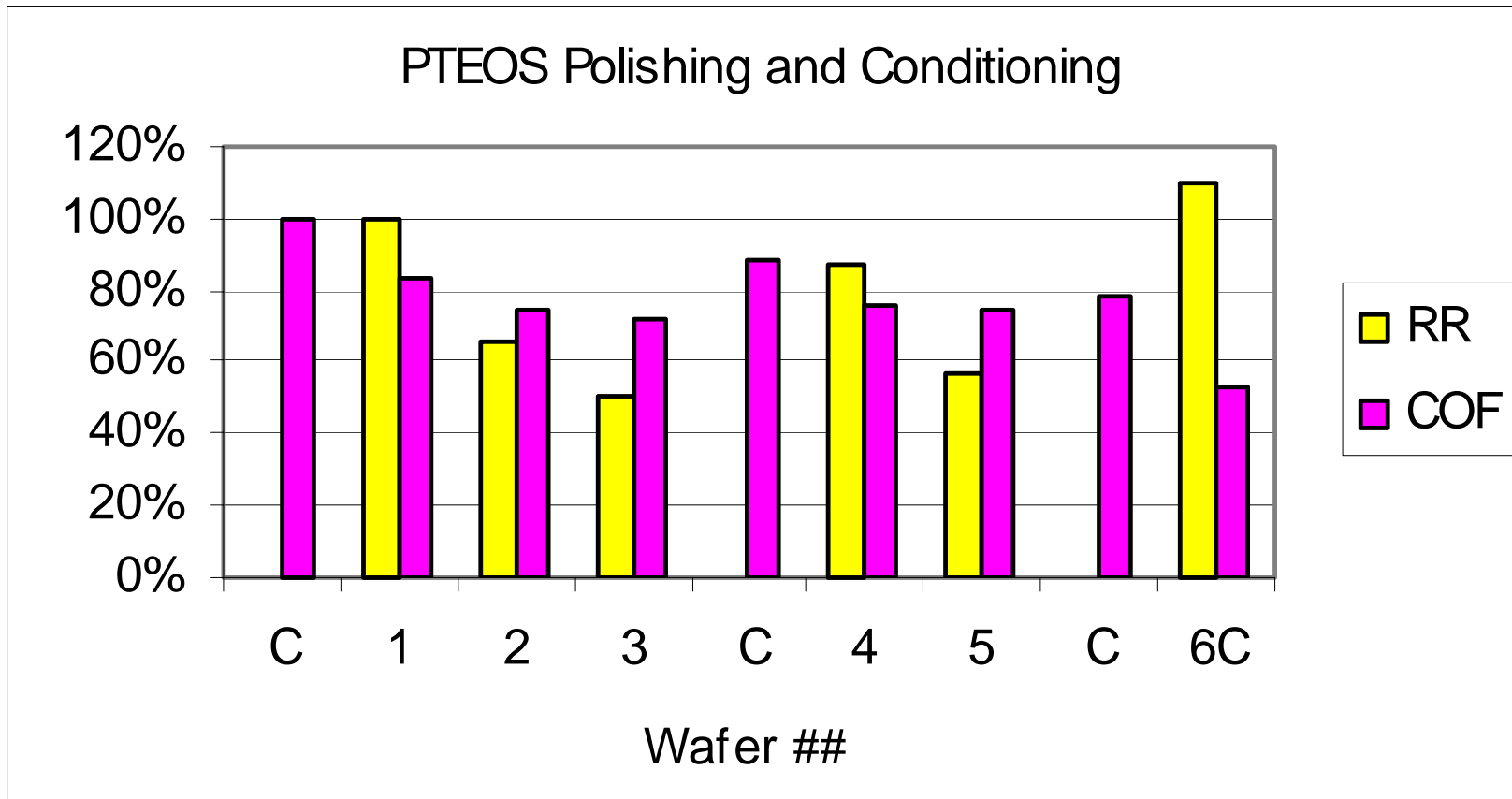


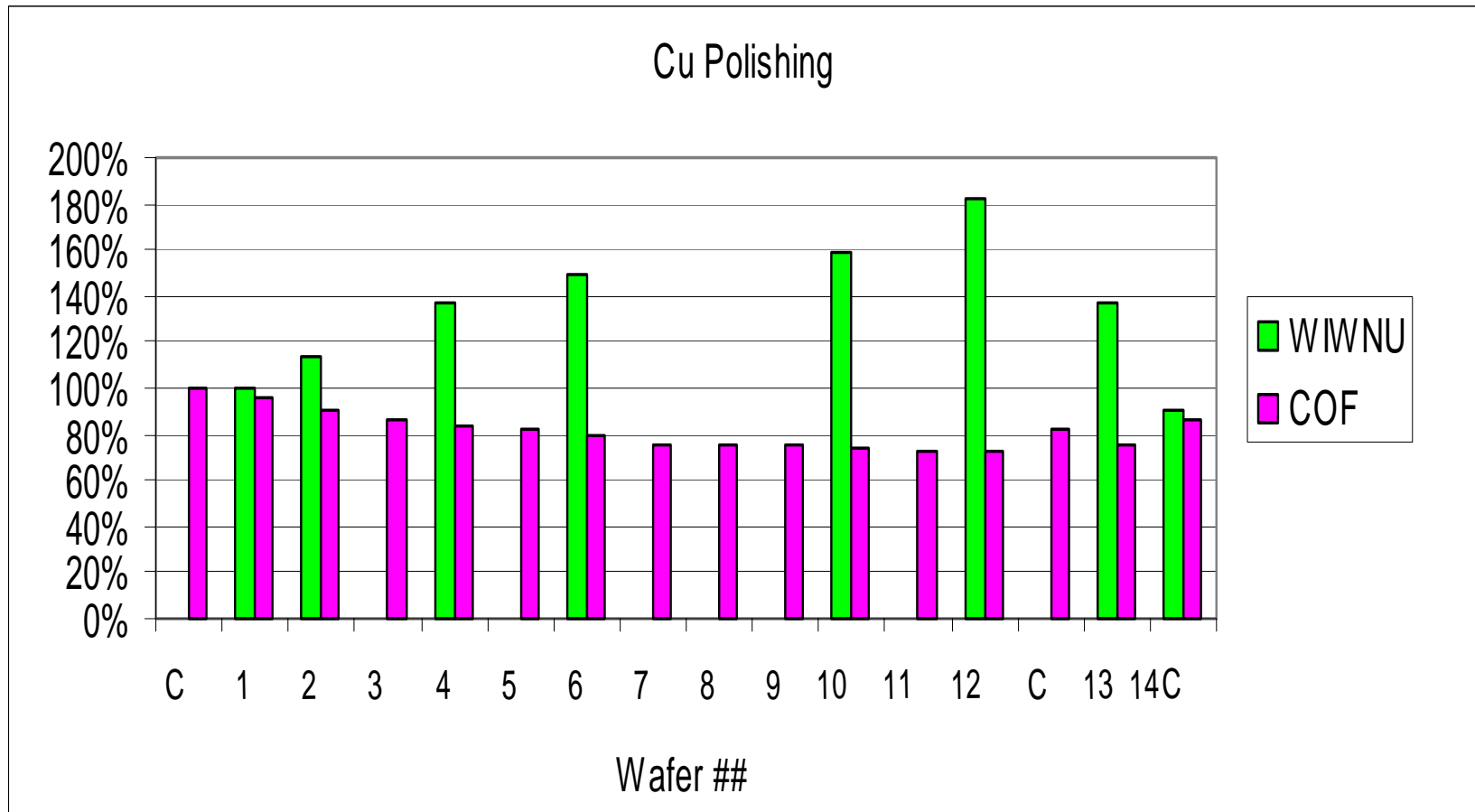














EFFECTIVENESS OF PadProbe

Effect of Accurate Determination of Critical Pad Wear and Time for Pad Replacement					
	Without PadPro	With PadProbe			
	600	700	800	900	1000
Number of polished wafers per pad	600	700	800	900	1000
Pads per 10,000 wafers	16.7	14.3	12.5	11.1	10.0
Cost of pads per 10,000 wafers (assumed pad price	\$8,333	\$7,143	\$6,250	\$5,556	\$5,000
Pads cost saving per 10,000 wafers	-	\$1,190	\$2,083	\$2,777	\$3,333

Assumptions: Currently, pad is replaced after a conservatively predetermined number of polished wafers,

while the PadProbe will allow the fab to safely increase the number of polished wafers for as long as

pad wear is smaller than the critical wear



Effect of Time Saving due to Less Frequent Pad Replacements and Shortened Pre-Conditioning					
	Without PadProbe	With PadProbe			
Number of polished wafers per pad	600	700	800	900	1000
Pad replacements per 10,000 wafers	17	15	13	12	10
Total down-time due to pad replacement per 10,000 wafers	8.5	7.5	6.5	6.0	5.0
Time saved on pad replacements per 10,000 wafers,	-	1.0	2.0	2.5	3.5
Number of pad pre-conditionings per 10,000 wafers	17	15	13	12	10
Total time of pad pre-conditioning, per 10,000 wafers	4.3	3.0	2.6	2.4	2.0
Time saved on shortened pre-conditioning per 10,000 wafers,		1.3	1.7	1.9	2.3
Total time saving per 10,000 wafers, hr	-	2.3	3.7	4.4	5.8

Assumptions: Pad price - \$500, Wafer price - \$ 1,000

Pad replacement time - 30 min.

Pad pre-conditioning time: without PadProbe - 15 min., with PadProbe - 12 min



Effect of Reduced Number of Defective Wafers per Pad due to Determination of Pad Condition					
	Without PadProbe	With PadProbe			
	-	1	2	3	4
Reduction in pad-caused defected wafers, per pad	-	1	2	3	4
Wafers cost saving per pad (assumed wafer cost \$1000)		\$ 1,000	\$ 2,000	\$ 3,000	\$ 4,000
Cost saving per 10,000 wafers (assumed \$1000/wafer, 1000 wafers/pad)		\$ 10,000	\$ 20,000	\$ 30,000	\$ 40,000
Cost saving per 10,000 wafers (assumed \$5000/wafer, 700 wafers/pad)		\$71,429	\$142,857	\$214,286	\$285,714

Assumptions: Currently, non-optimal pad condition is not detected and causes defected wafers,

while the PadProbe will allow the fab to avoid defected wafers, as long as PadCondition stays constant



Conclusions:

1. The PadProbe™ is fully capable of repeatable and accurate characterization of pad surface state and conditioning process.
2. The PadProbe™ allows for either periodic or continuous in-situ, in-process control of two critical CMP parameters:
 - Pad Wear (dynamics of Pad Thickness Change) and
 - Pad Condition (dynamics and level of Pad Friction).
3. The PadProbe™ can be easily installed on any CMP tool and is completely non-invasive for the CMP process.