PADPROBE™
FOR QUANTITATIVE CONTROL OF PAD SURFACE CONDITIONS AND WEAR

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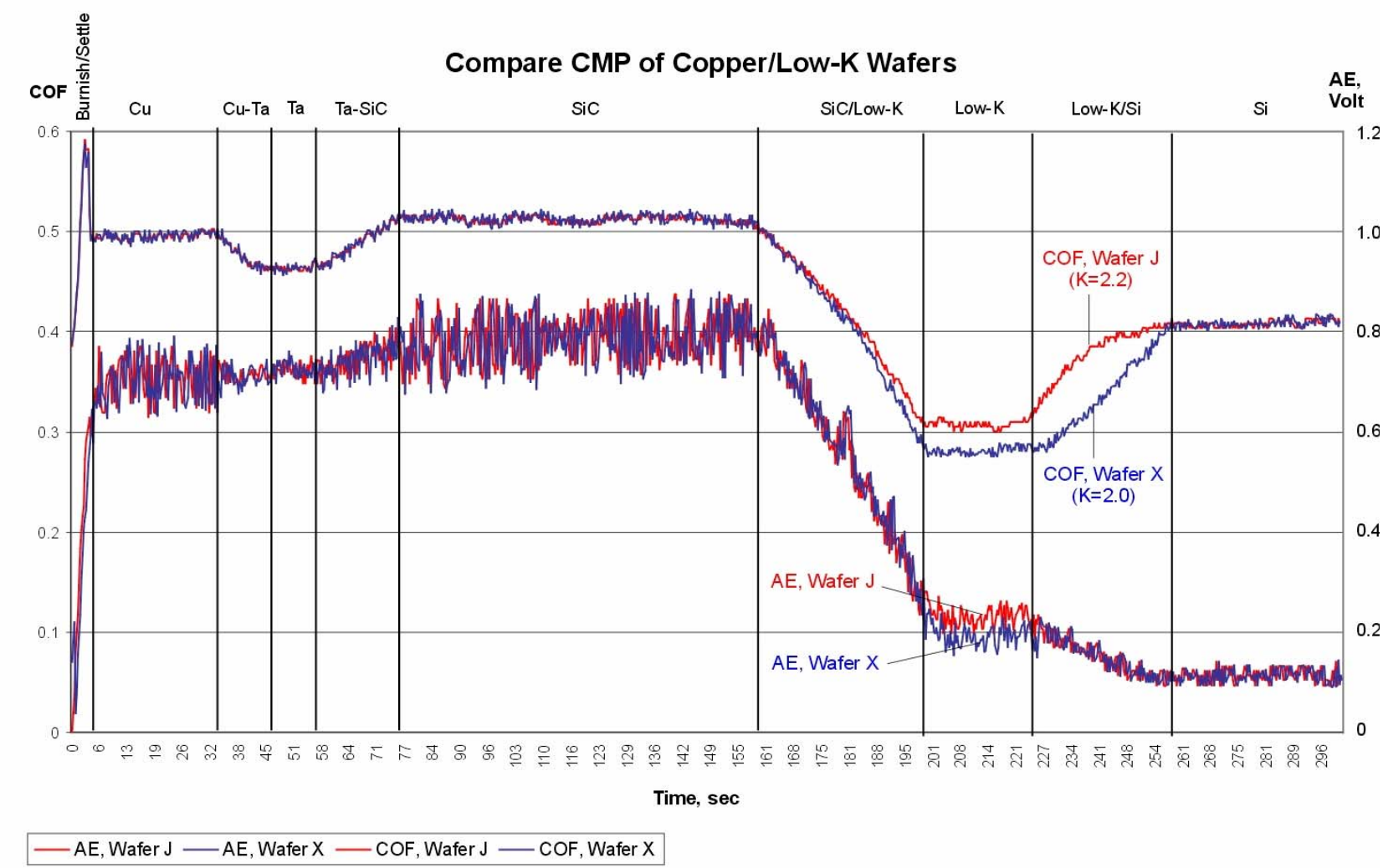
Sensor Technology

- 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:

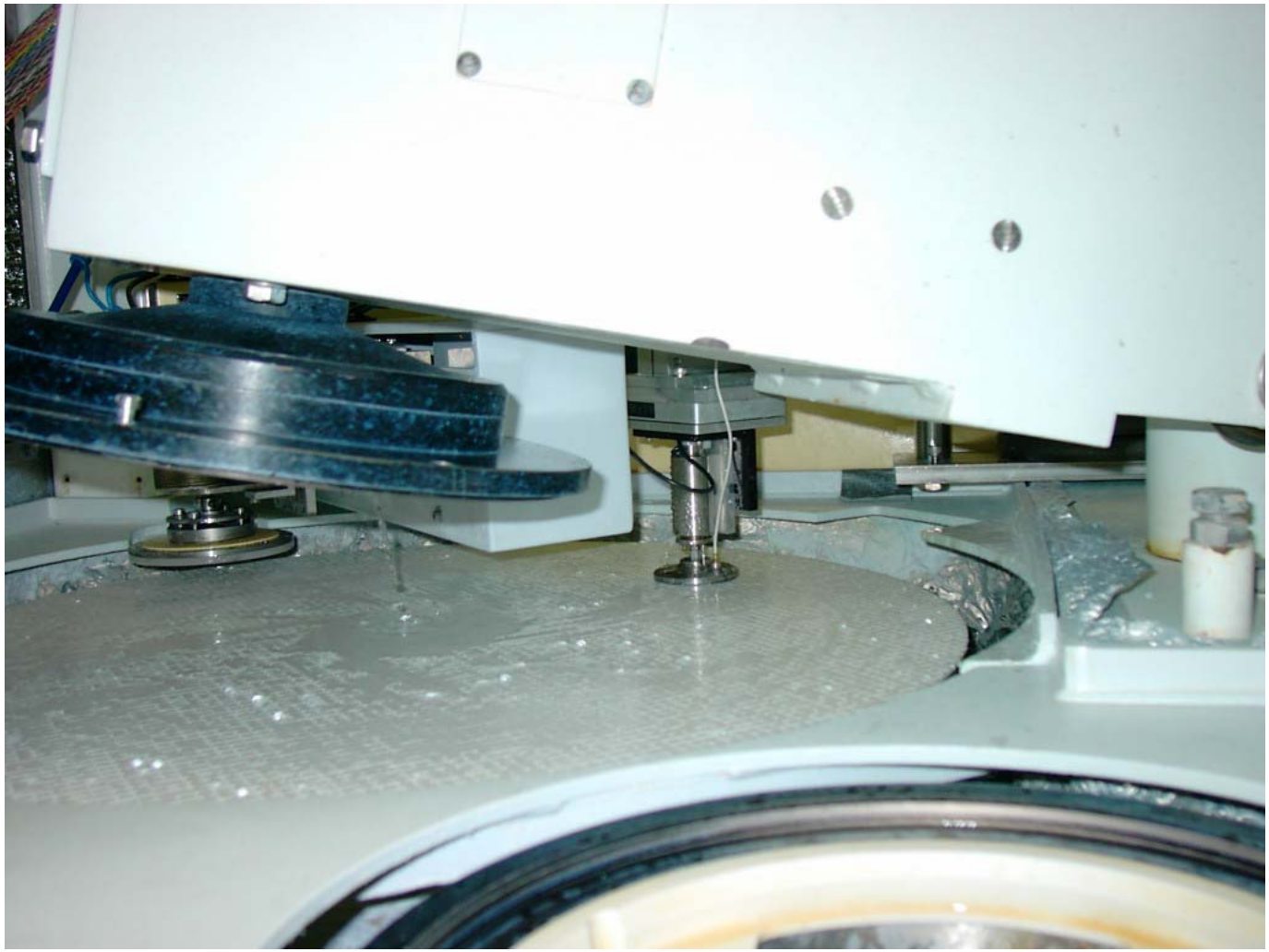
- Contacting materials (wafer, pad, chemicals, byproducts)
- Surface roughness (wafer pattern, pad conditioning)
- Presence of lubricant (water, slurry)
  - Flow rate
  - Distribution (pores, grooves)
  - Viscosity
- Relative speed
- Temperature
- Contact pressure

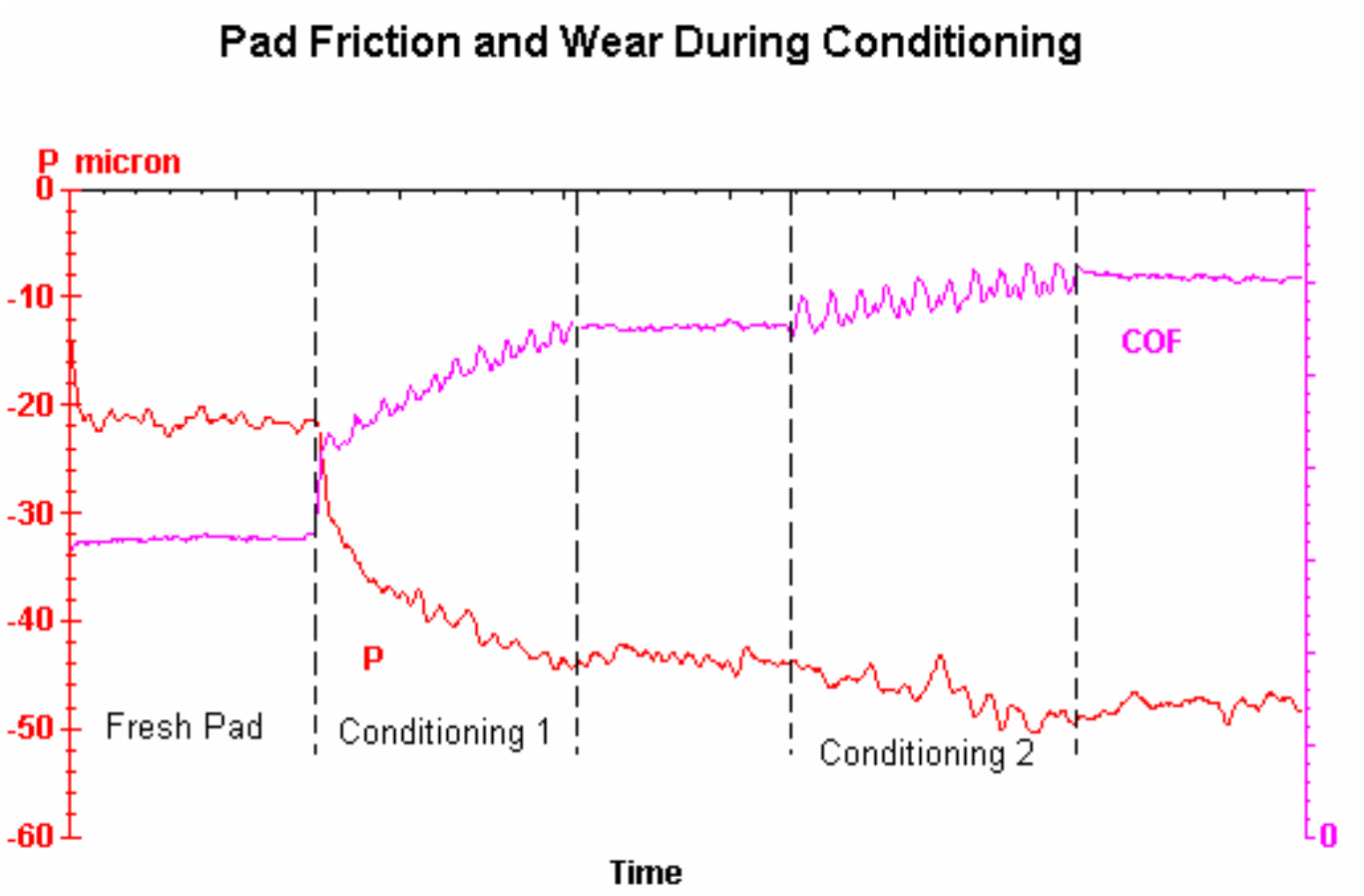
In-situ CMP Monitoring of Copper/Low-K Wafers

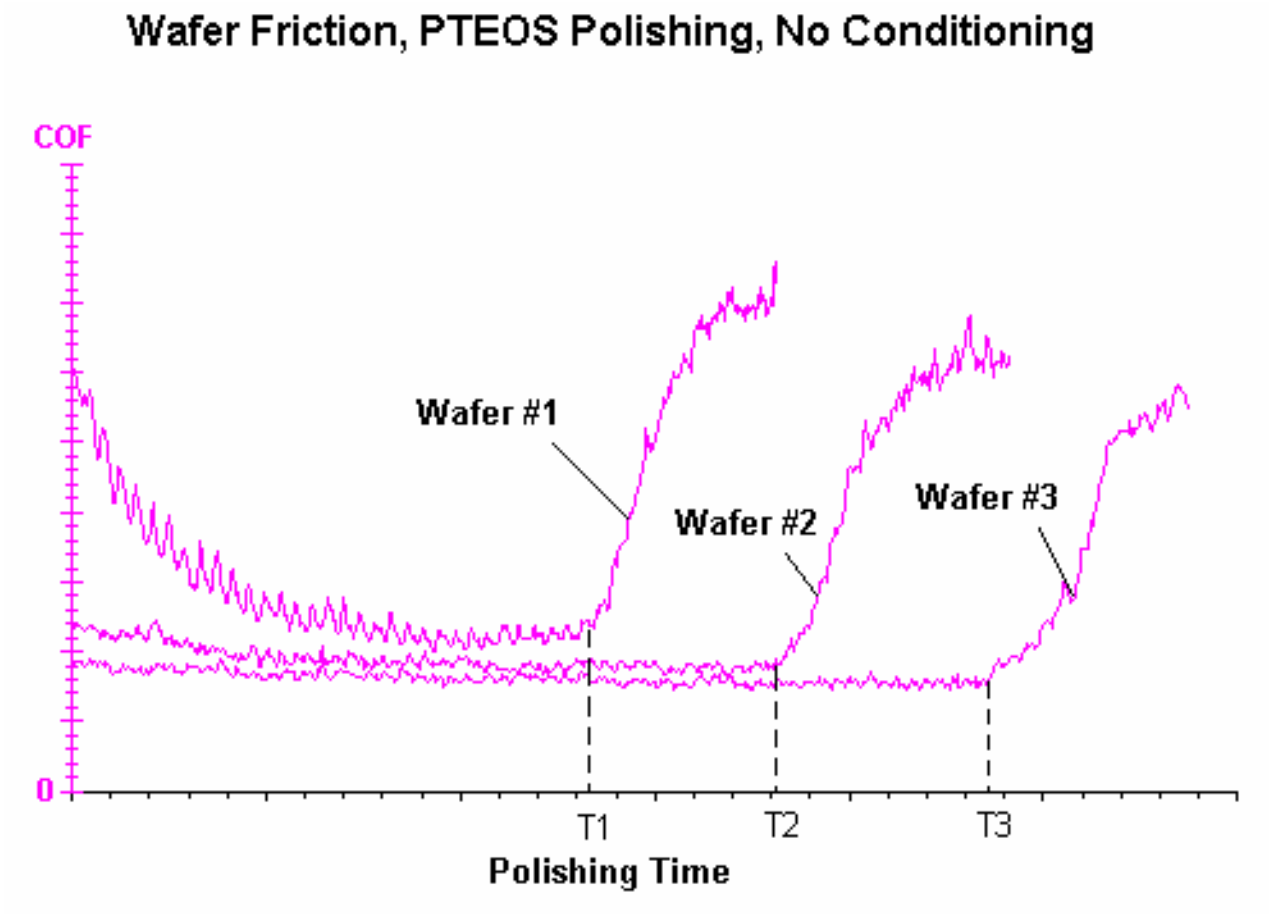


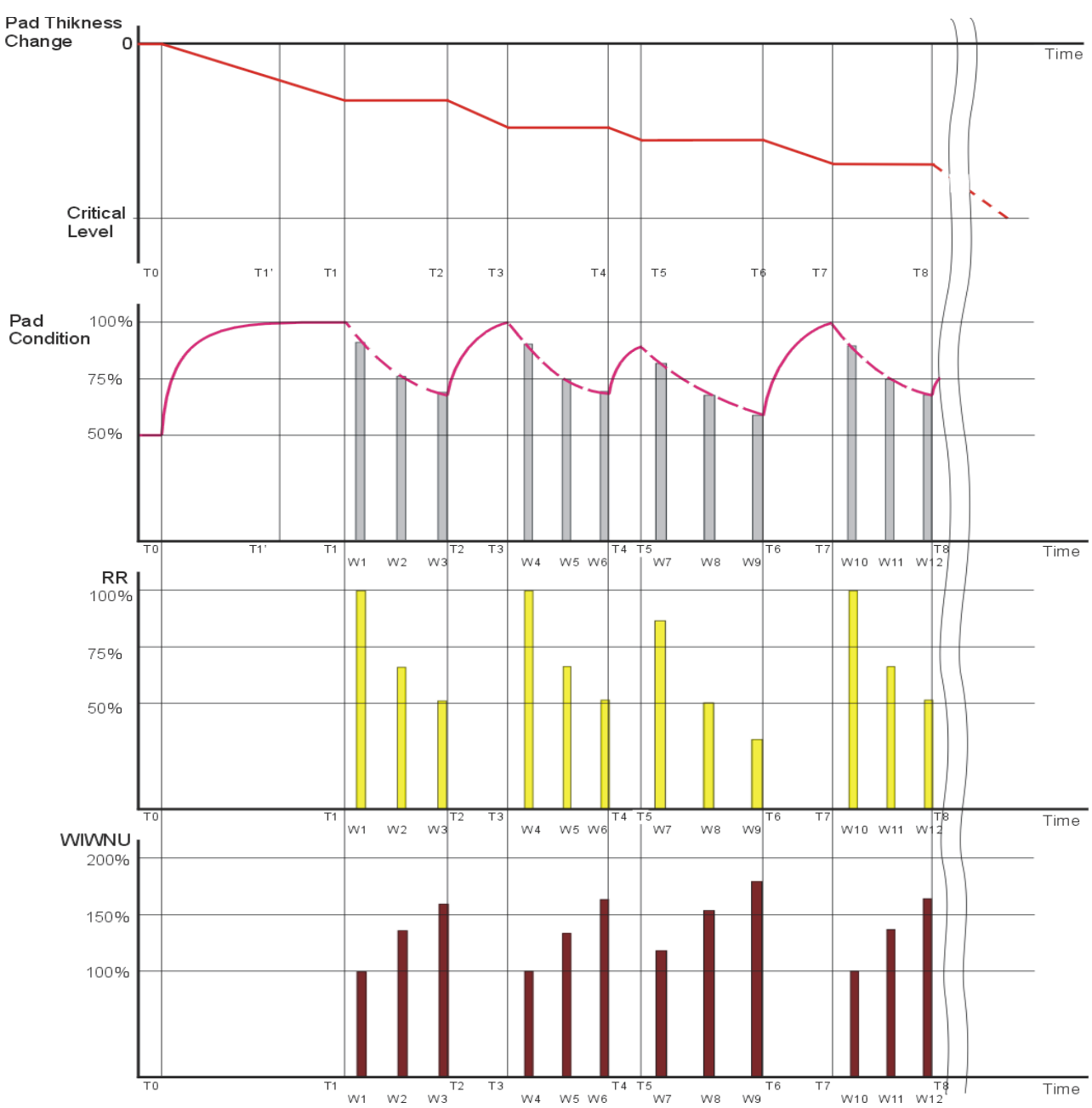
CETR

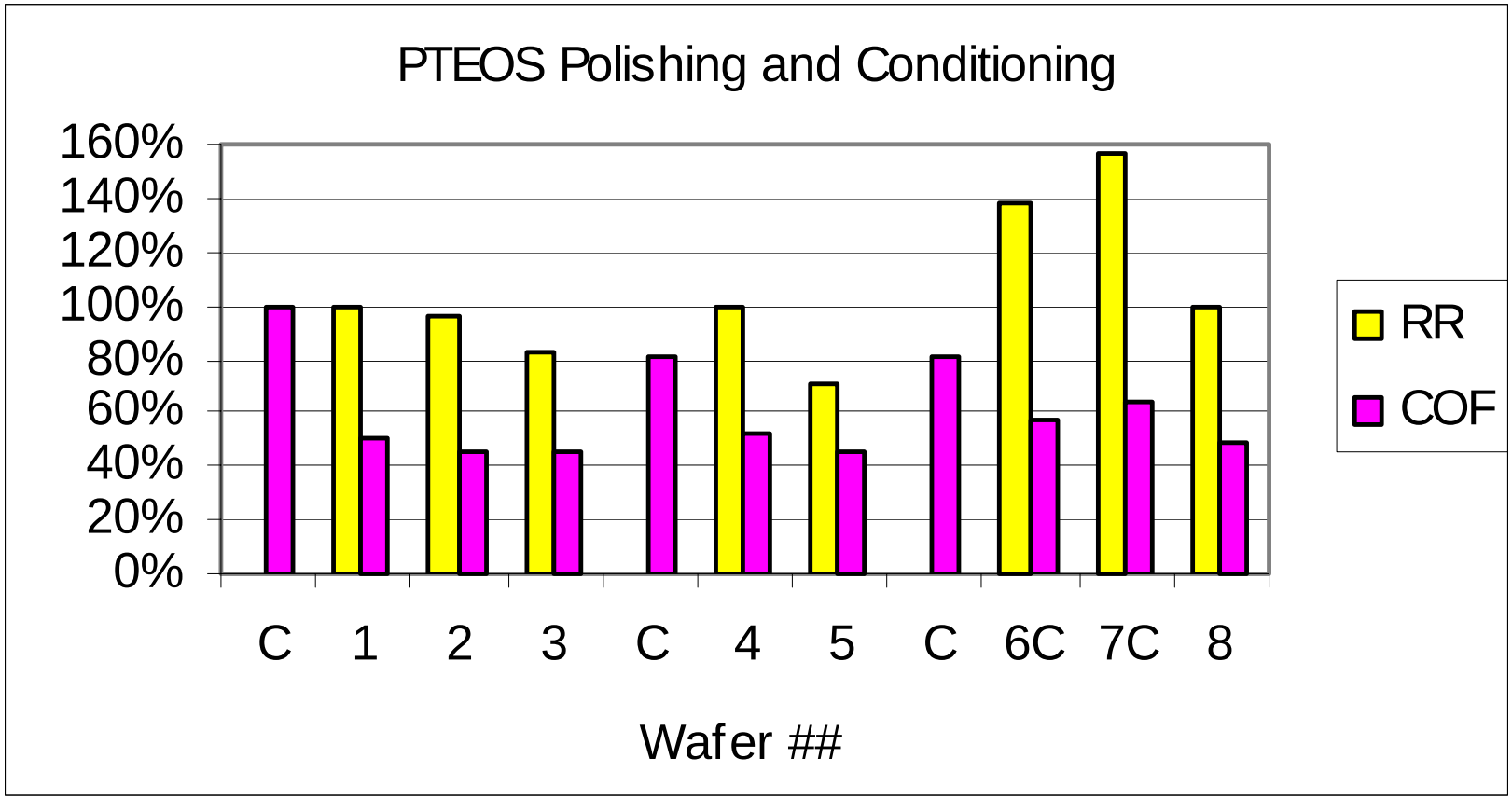

xycom
POWER ON
MACHINE ON
MACHINE ON
EMERG STOP
QUILL LOAD
TABLE LOAD
BACK PRESSURE BLOW OFF
WAFER CHUCK VACUUM
LOAD CHUCK VACUUM
DI WATER
SLURRY 1

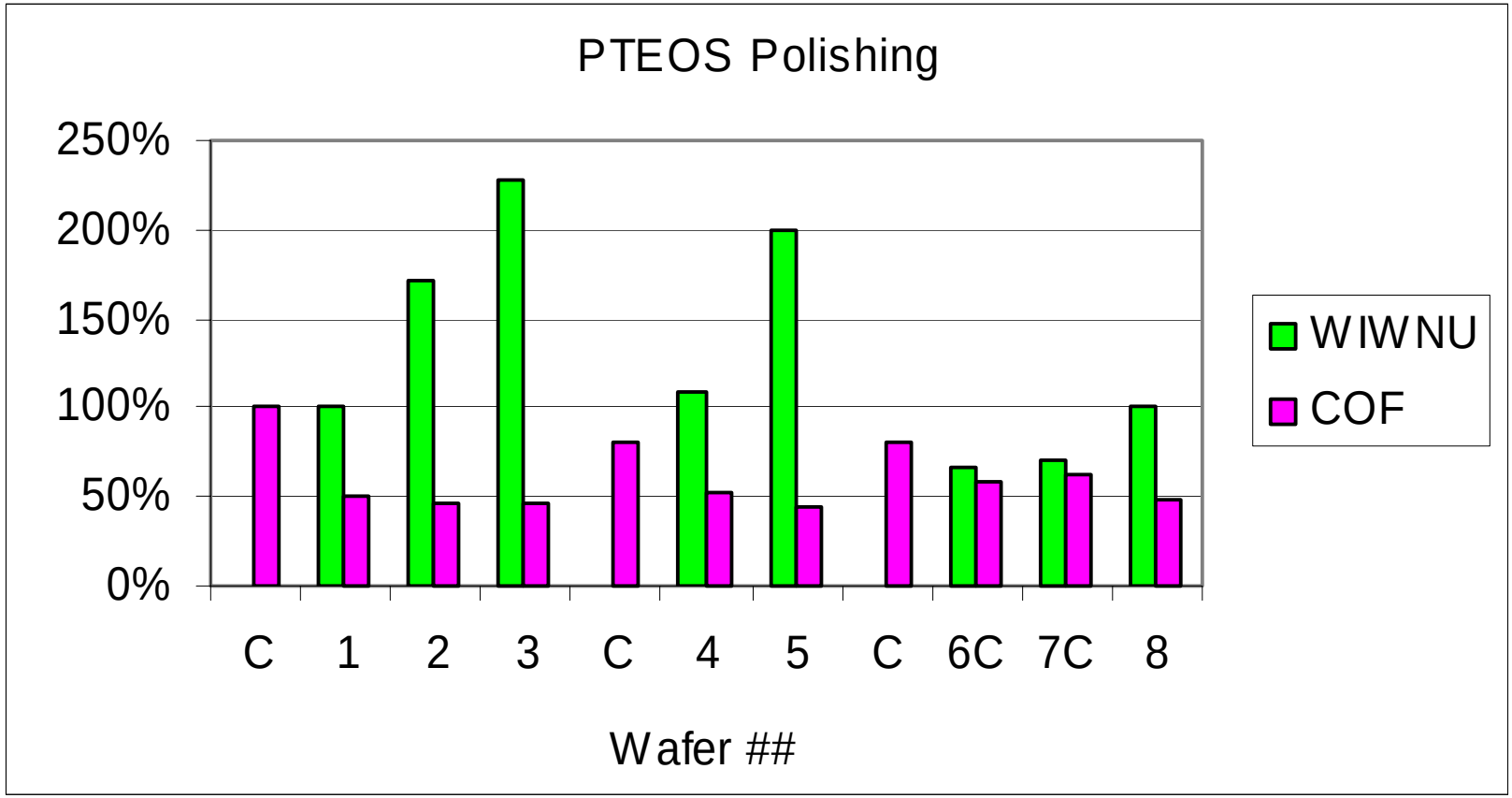


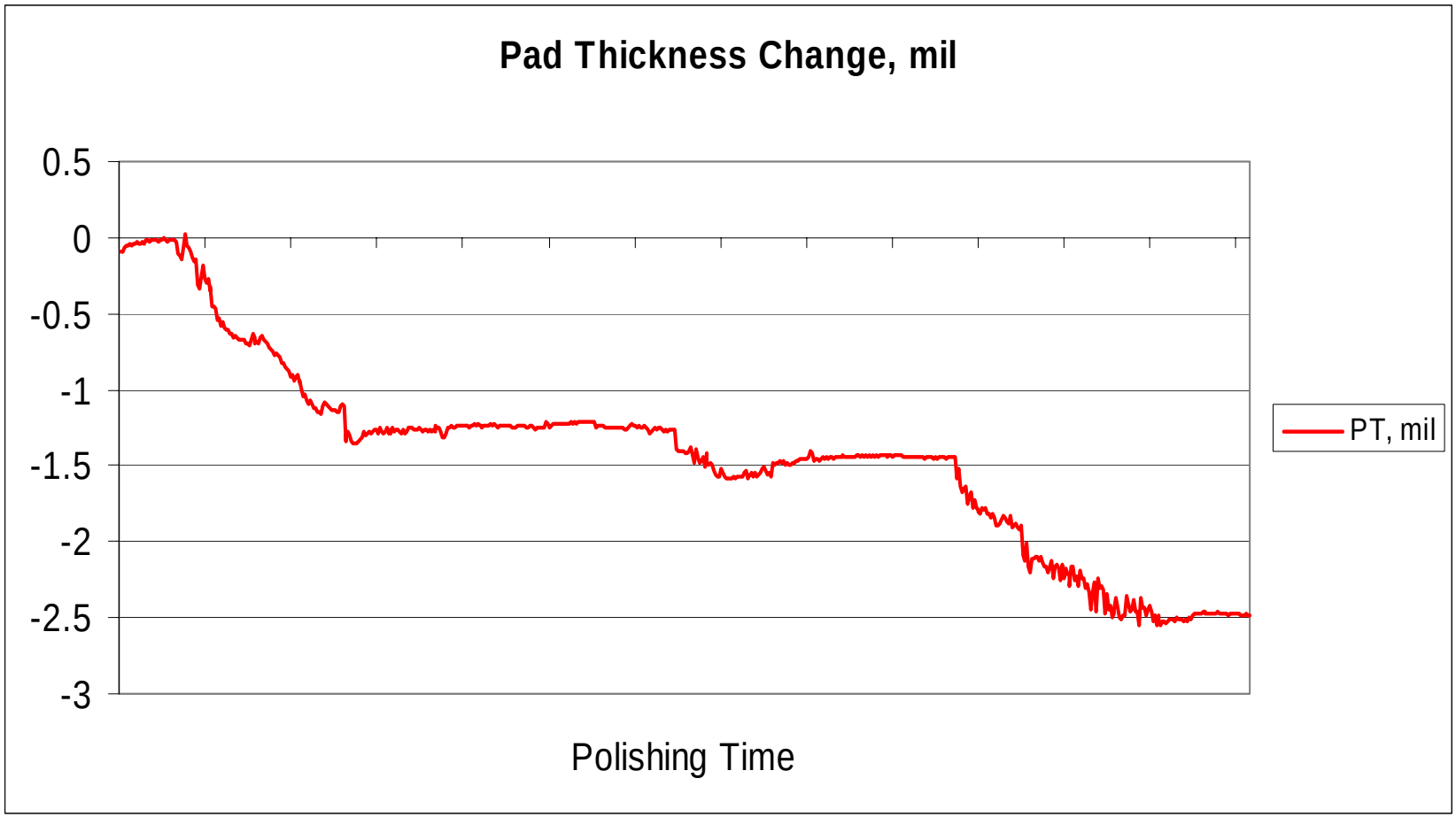

Pad Friction and Wear During Conditioning
P micron
0
-10
-20
-30
-40
-50
-60
COF
P
Fresh Pad
Conditioning 1
Conditioning 2
0
Time

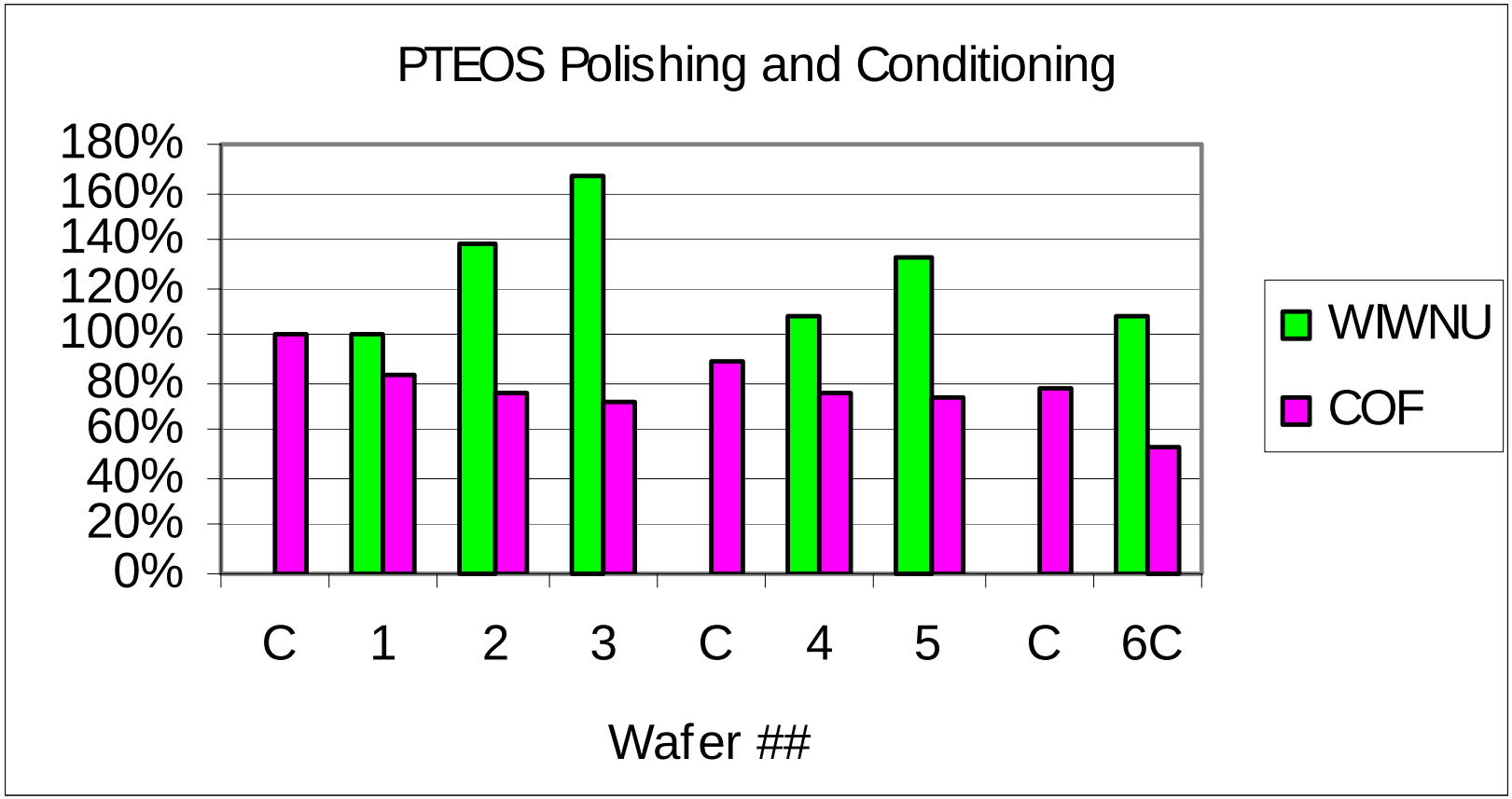

Wafer Friction, PTEOS Polishing, No Conditioning
COF
0
Wafer #1
Wafer #2
Wafer #3
T1
T2
T3
Polishing Time

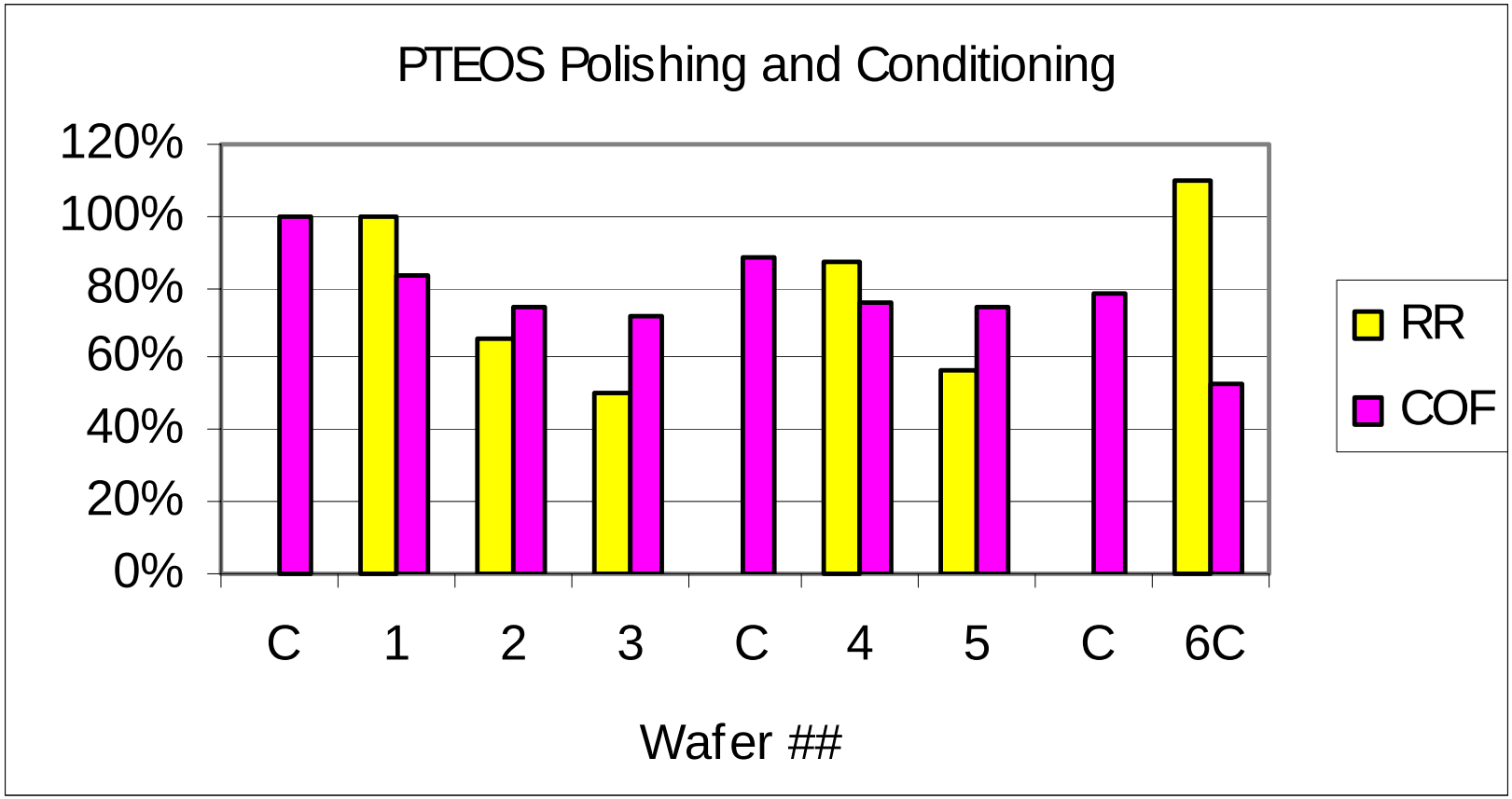

Pad Thikness Change
0
Time
Critical Level
T0
T1'
T1
T2
T3
T4
T5
T6
T7
T8
Pad Condition
100%
75%
50%
Time
W1
W2
W3
W4
W5
W6
W7
W8
W9
W10
W11
W12
RR
100%
75%
50%
Time
WIWNU
200%
150%
100%
Time

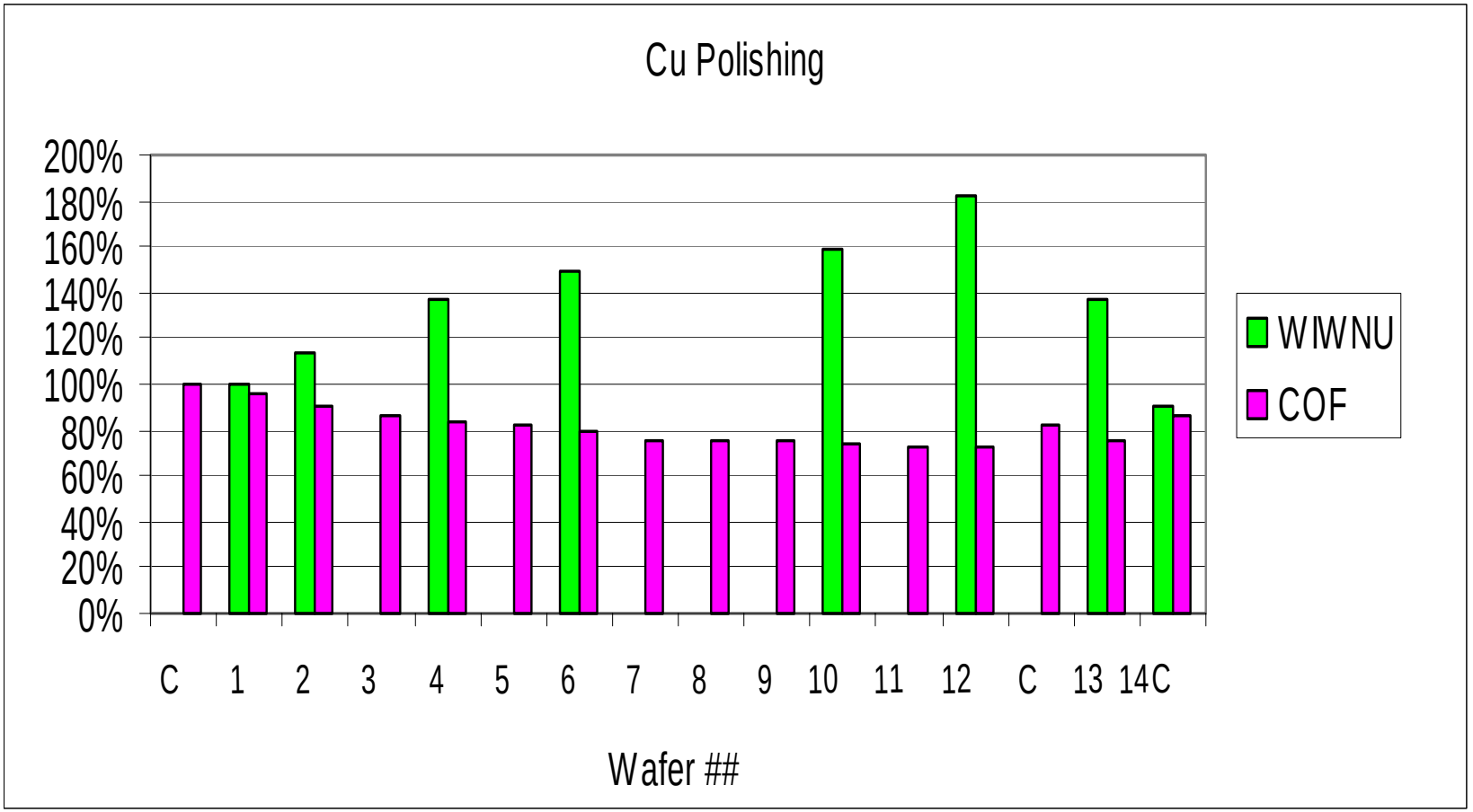

PTEOS Polishing and Conditioning
160%
140%
120%
100%
80%
60%
40%
20%
0%
C
1
2
3
C
4
5
C
6C
7C
8
Wafer ##
RR
COF


PTEOS Polishing
250%
200%
150%
100%
50%
0%
C
1
2
3
C
4
5
C
6C
7C
8
Wafer ##
WIWNU
COF


Pad Thickness Change, mil
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
Polishing Time
PT, mil


PTEOS Polishing and Conditioning
180%
160%
140%
120%
100%
80%
60%
40%
20%
0%
C
1
2
3
C
4
5
C
6C
Wafer ##
WIWNU
COF


PTEOS Polishing and Conditioning
120%
100%
80%
60%
40%
20%
0%
C
1
2
3
C
4
5
C
6C
Wafer ##
RR
COF


Cu Polishing
200%
180%
160%
140%
120%
100%
80%
60%
40%
20%
0%
C 1 2 3 4 5 6 7 8 9 10 11 12 C 13 14C
Wafer ##
WIWNU
COF

EFFECTIVENESS OF PadProbe

Effect of Accurate Determination of Critical Pad Wear and Time for Pad Replacement					
	Without PadPro	With PadProbe			
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 v	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			
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

Assumptons: 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.