AIR LIQUIDE
ELECTRONICS

Effects of Slurry Distribution using Diaphragm and Centrifugal pumps on the Defectivity in a Cu CMP Process

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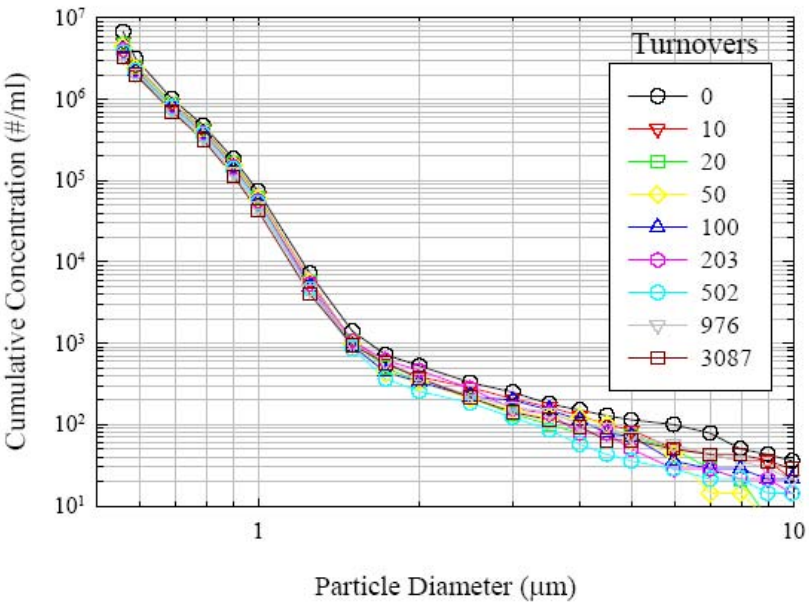
Objective

- To study the effects of scratches on wafers as a function of pump design in a re-circulating slurry distribution system
  - Positive displacement pump: Diaphragm
  - Centrifugal magnetically levitated pump: Levitronix (BPS-3)

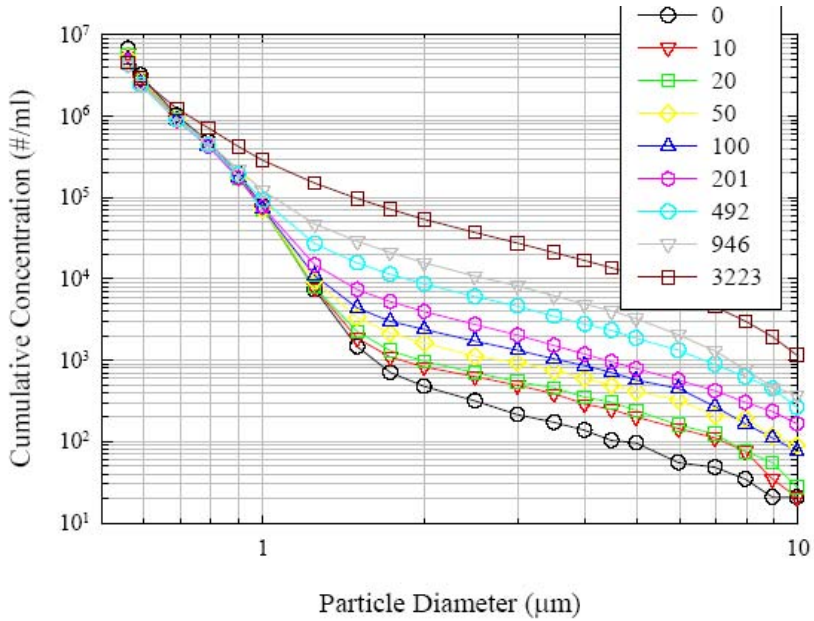
Pump Affects on Cabot iCue® 600Y75 Copper CMP Slurry

- Pump Affects on Re-circulating Slurry Distribution System
- BPS-3 Large Particles (>1um) decreases with Increased Turnovers
- Pump A Large Particles Increase with Increased Turnovers

Levitronix BPS-3



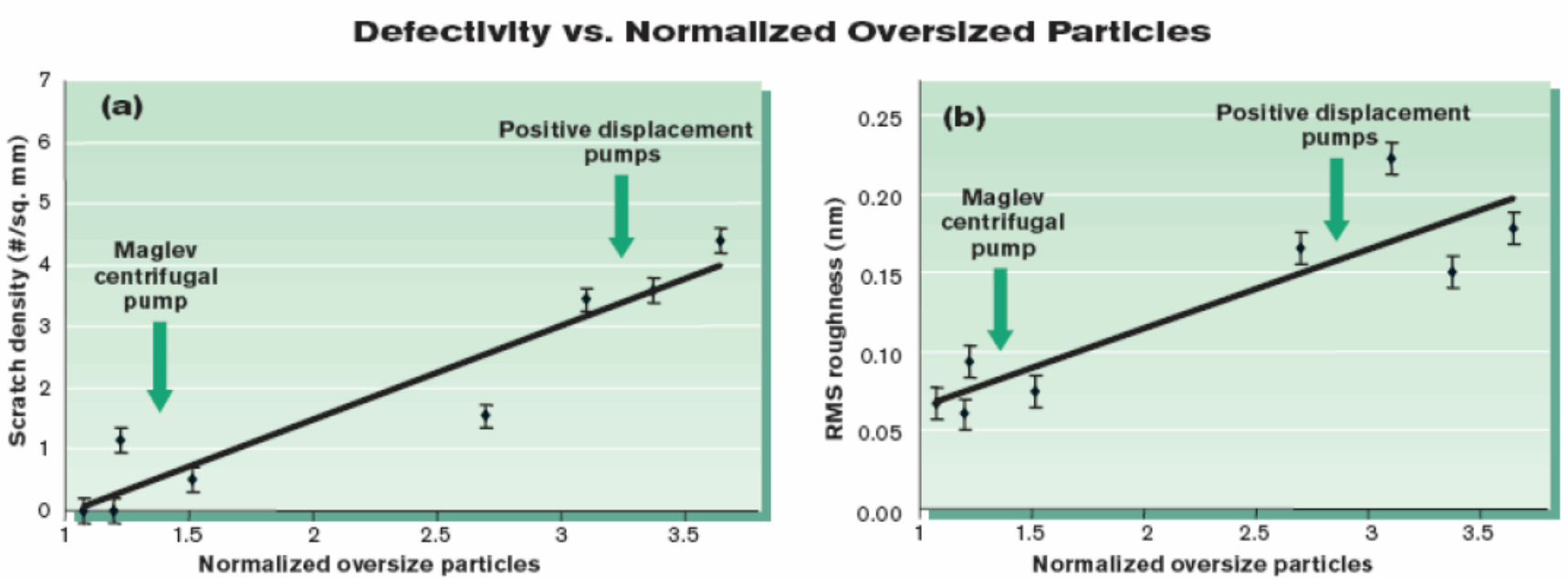
Diaphragm



(Comparison of Four Pump Systems on the Particle Size Distribution of Cabot iCue® 600Y75 Slurry
Mark Litchy – CT Associates, Inc. 11/8/2006)

Pumps and Their Affects on CMP Defectivity

- CMP slurries that consist of particles and chemicals could be the most critical consumable in the semiconductor industry1,2,
- However, some studies have shown that positive displacement pumps (e.g., bellows and a diaphragm) may generate high shear stress and tend to agglomerate particles during slurry handling.3,6
- Aggregated particles in the slurries not only could reduce the lifetime of filters,7 but could also cause surface defectivity during the CMP process. 8,914

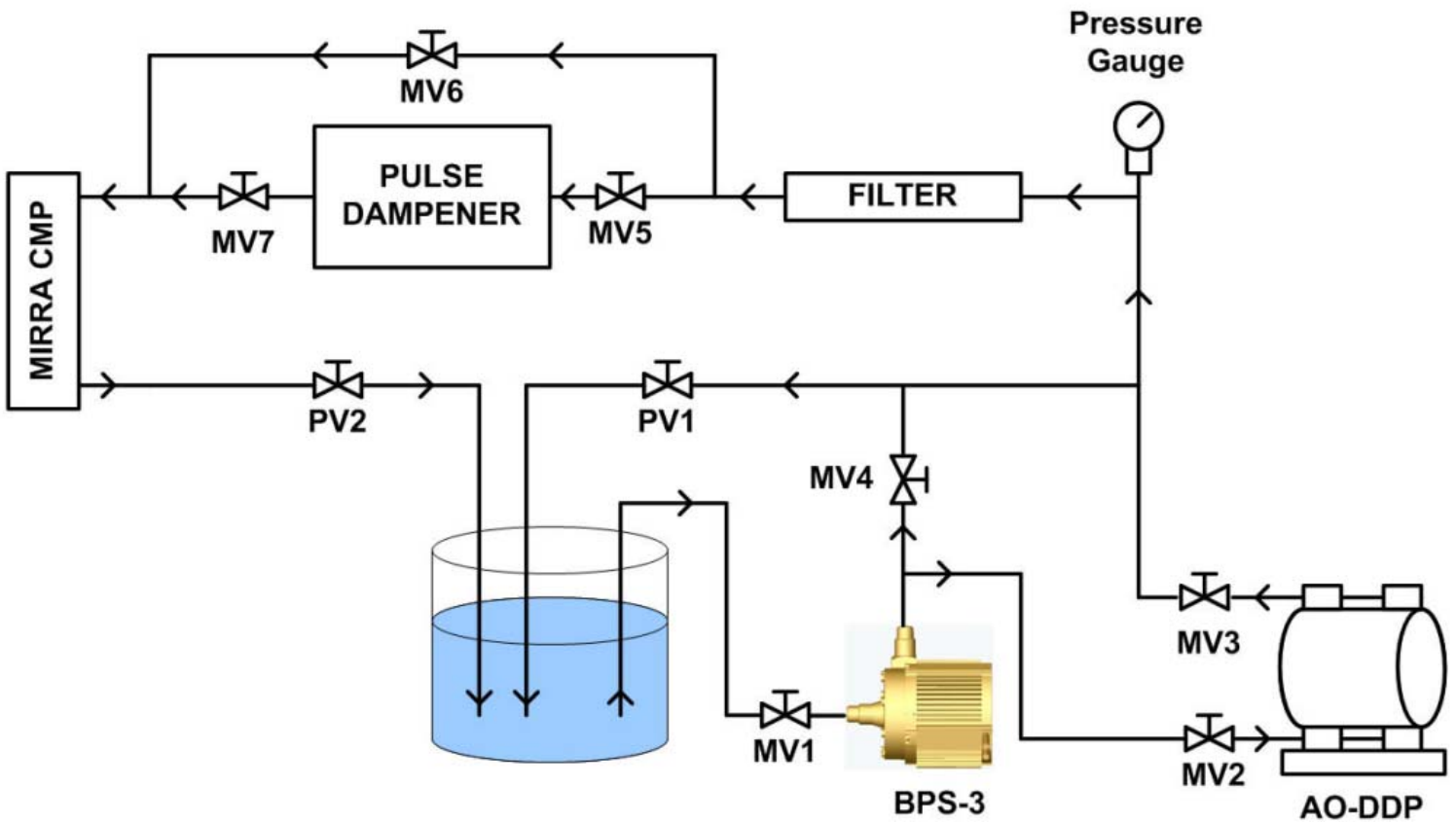


(How Pump-Induced Particles Affect Low-k CMP Defectivity, Semiconductor International, September 2008, F.C. Chang, S. Tanawade and Rajiv Singh, Dept. of Materials Science and Engineering and Particle Engineering Research Center, University of Florida, Gainesville, Fla., http://mse.ufl.edu)

Experimental Set up

- Tool set
  - Integrated 200 mm MirraMesa
  - Tencor SP1
  - KLA 2139
- Consumables
  - Platen 1 & 2 Pads = IC1010, Slurry = C600Y-75
  - Platen 3 Pad = Polytex, Slurry = Hitachi T-805
  - Megasonic = 1:60 CuClean 3.3
  - Brush Module 1 & 2 Brushes = Rippey, CuClean 865
- Blanket Wafer Processing
  - All blanket wafers were polished for 60 sec. at Step 1, then 30 sec. at Step 2
- Pattern Wafer Processing
  - Pattern wafers were all completely clear of unwanted Cu and end pointed with in 3 seconds of each other at step 1
    - Wafers were processed for 40 seconds at step 2

Layout of Re-Circulating Slurry Distribution Loop at the Air Liquide CMP Applications Lab



Wafer Information and Slurry Turn Over

- Wafer Data
  - Pattern: MIT-854, low-k (BD1)
  - Blanket:
    - TEOS
    - Low-k
    - Cu ECD
  - All wafers were polished and then cleaned with Air Liquide PCMPC
- C600Y-75 turn over ~ 6,000X
  - Flow rate = (90 L/min)
- T-805 turn over ~ 7,000X
  - Flow rate = (110 L/min)
- After each wafer split the slurry was replaced before the next pump was tested

Experimental Wafer Split Table

			Film Type			
Pump Type	Pattern	TEOS Dummies	TEOS PC	BD1 PC	Cu Dummies	Cu PC
Diaphragm	Full Process Qual (particles and MRR)					
Diaphragm	0	100	0	0	5	0
Diaphragm	2	0	3	3	0	3
Diaphragm	0	100	0	0	5	0
Diaphragm	2	0	3	3	0	3
Diaphragm	0	100	0	0	5	0
Diaphragm	2	0	3	3	0	3
	6	300	9	9	15	9
Levitronix	Full Process Qual (particles and MRR)					
Levitronix	0	100	0	0	5	0
Levitronix	2	0	3	3	0	3
Levitronix	0	100	0	0	5	0
Levitronix	2	0	3	3	0	3
Levitronix	0	100	0	0	5	0
Levitronix	2	0	3	3	0	3
	6	300	9	9	15	9
Diaphragm	Full Process Qual (particles and MRR)					
Diaphragm	0	100	0	0	5	0
Diaphragm	2	0	3	3	0	3
Diaphragm	0	100	0	0	5	0
Diaphragm	2	0	3	3	0	3
Diaphragm	0	100	0	0	5	0
Diaphragm	2	0	3	3	0	3
	6	300	9	9	15	9

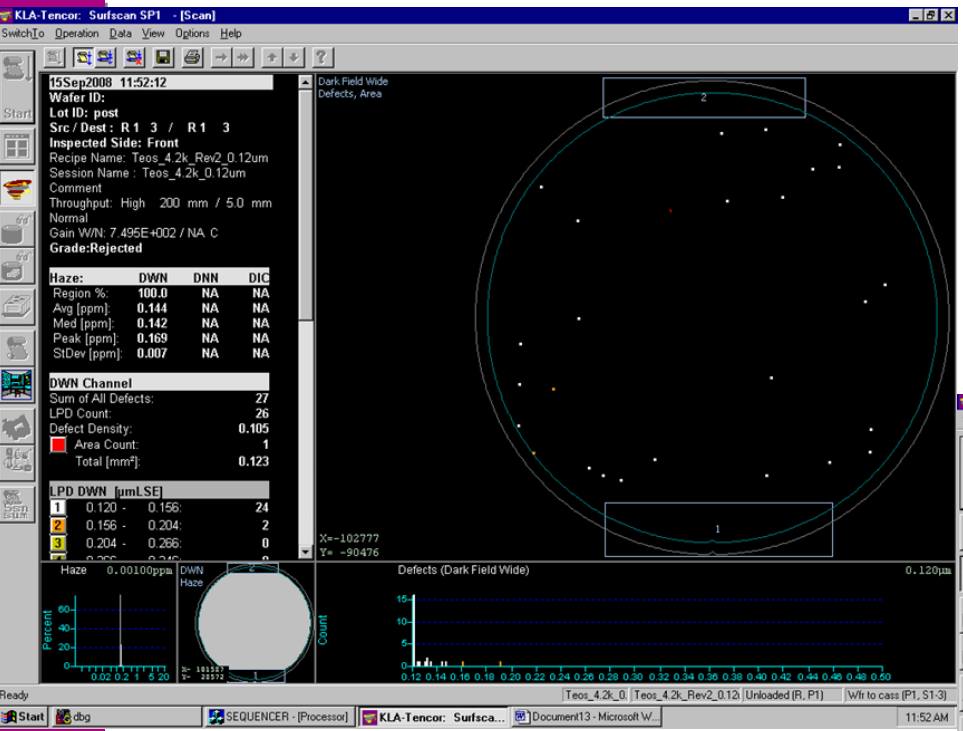
Split 1

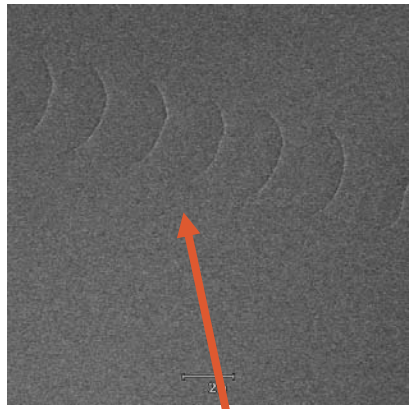
Split 2

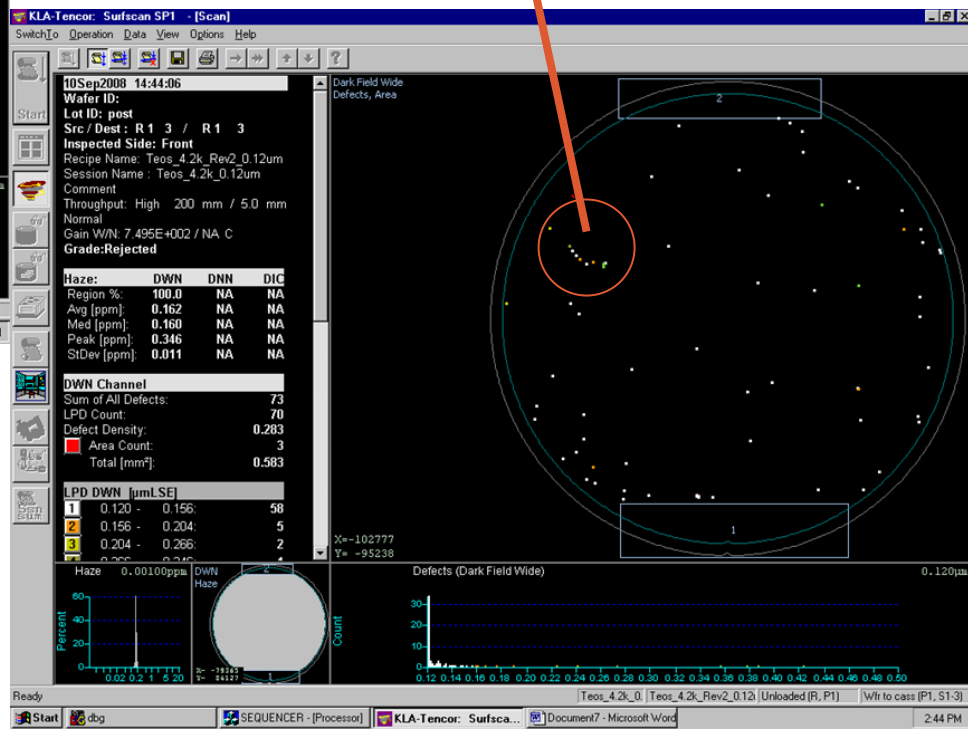
Split 3

Experimental Data

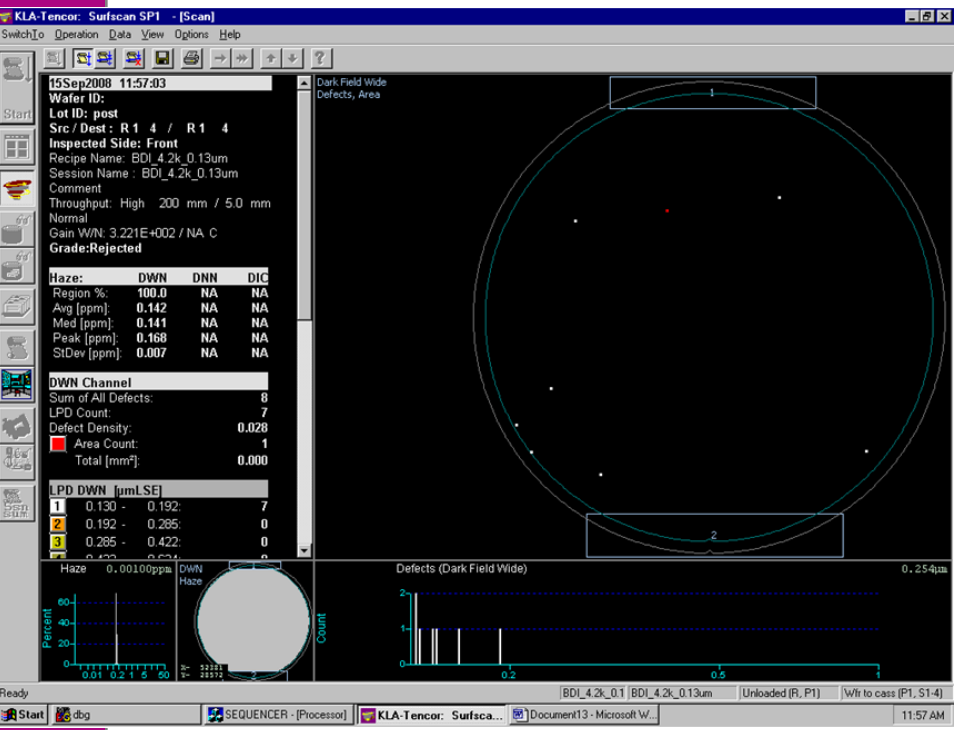
Representative TEOS blanket wafer maps with and without scratches: Inspected at 0.12 um

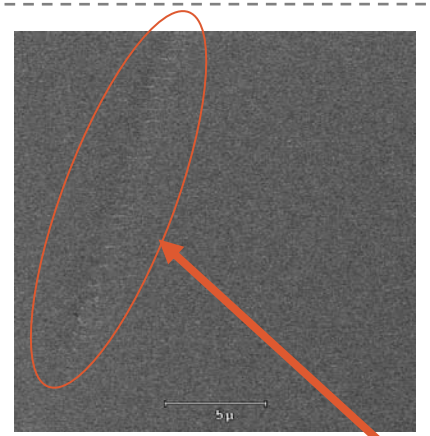


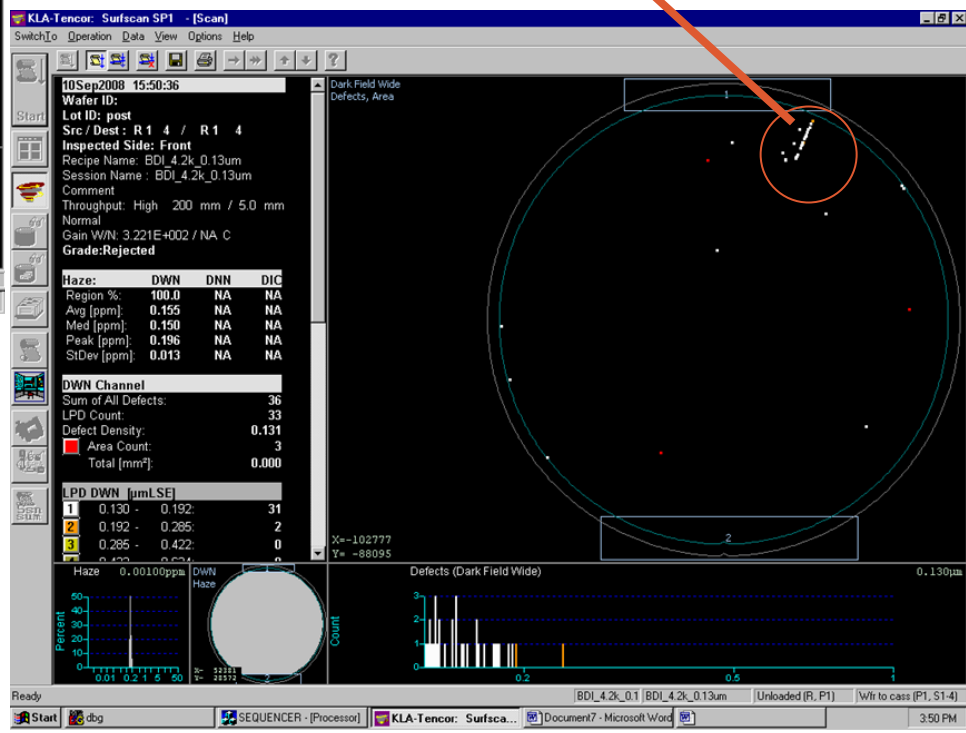




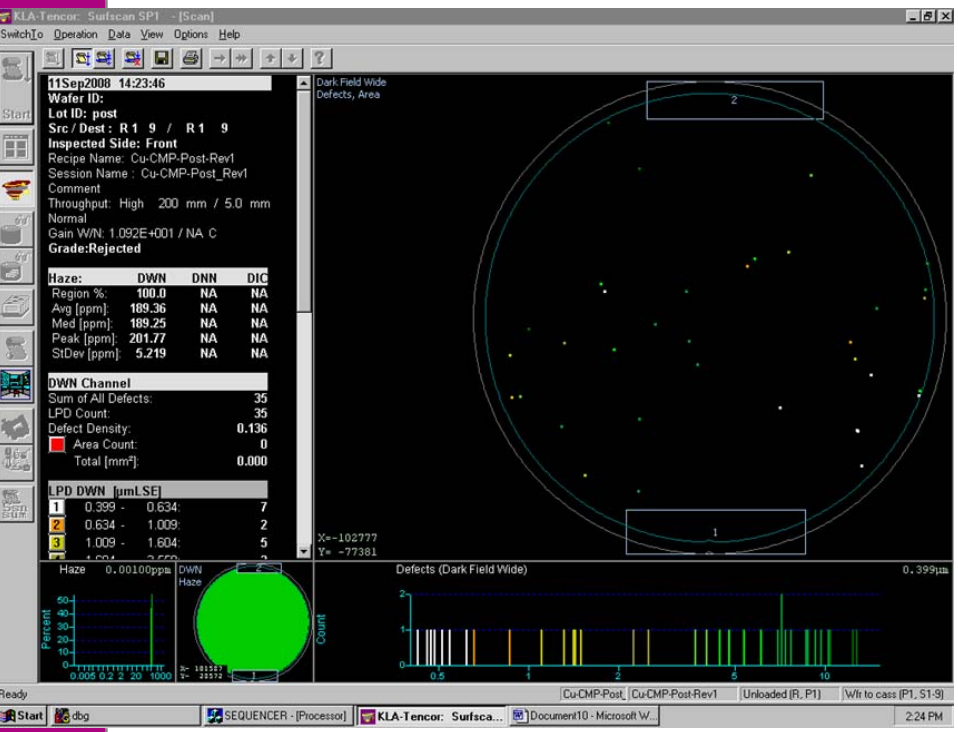
Representative BD1 blanket wafer maps with and without scratches : Inspected at 0.13 um

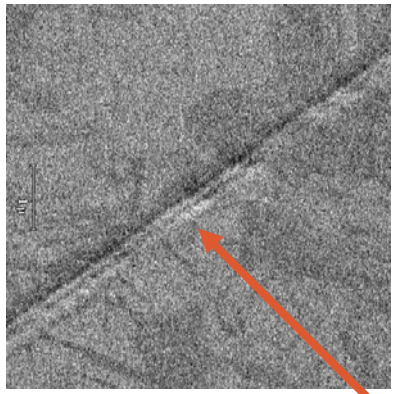


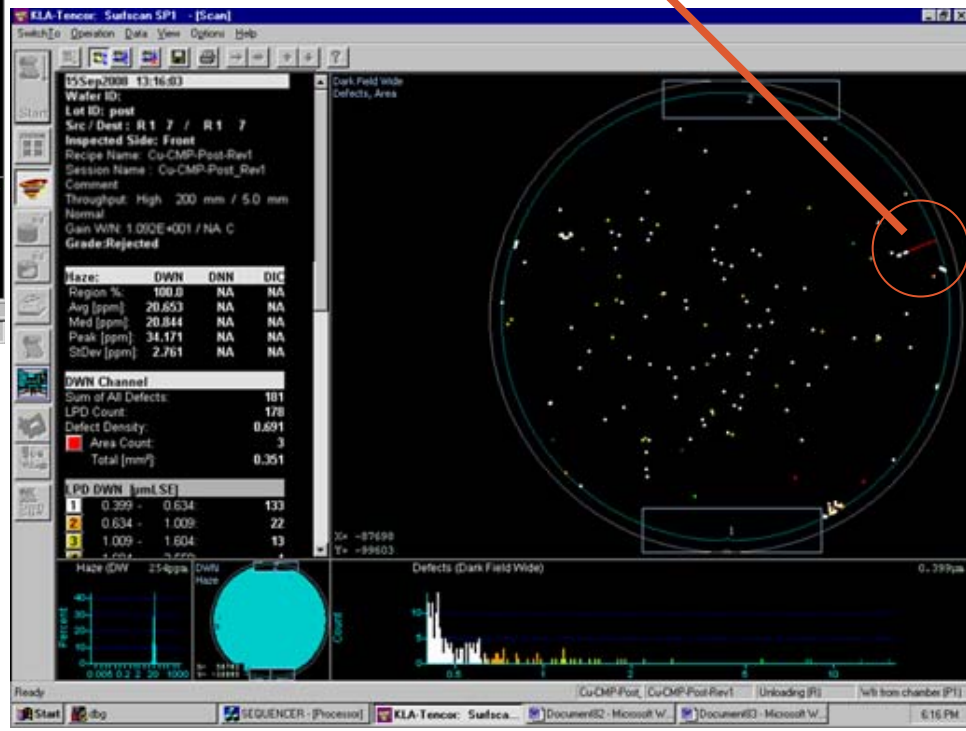




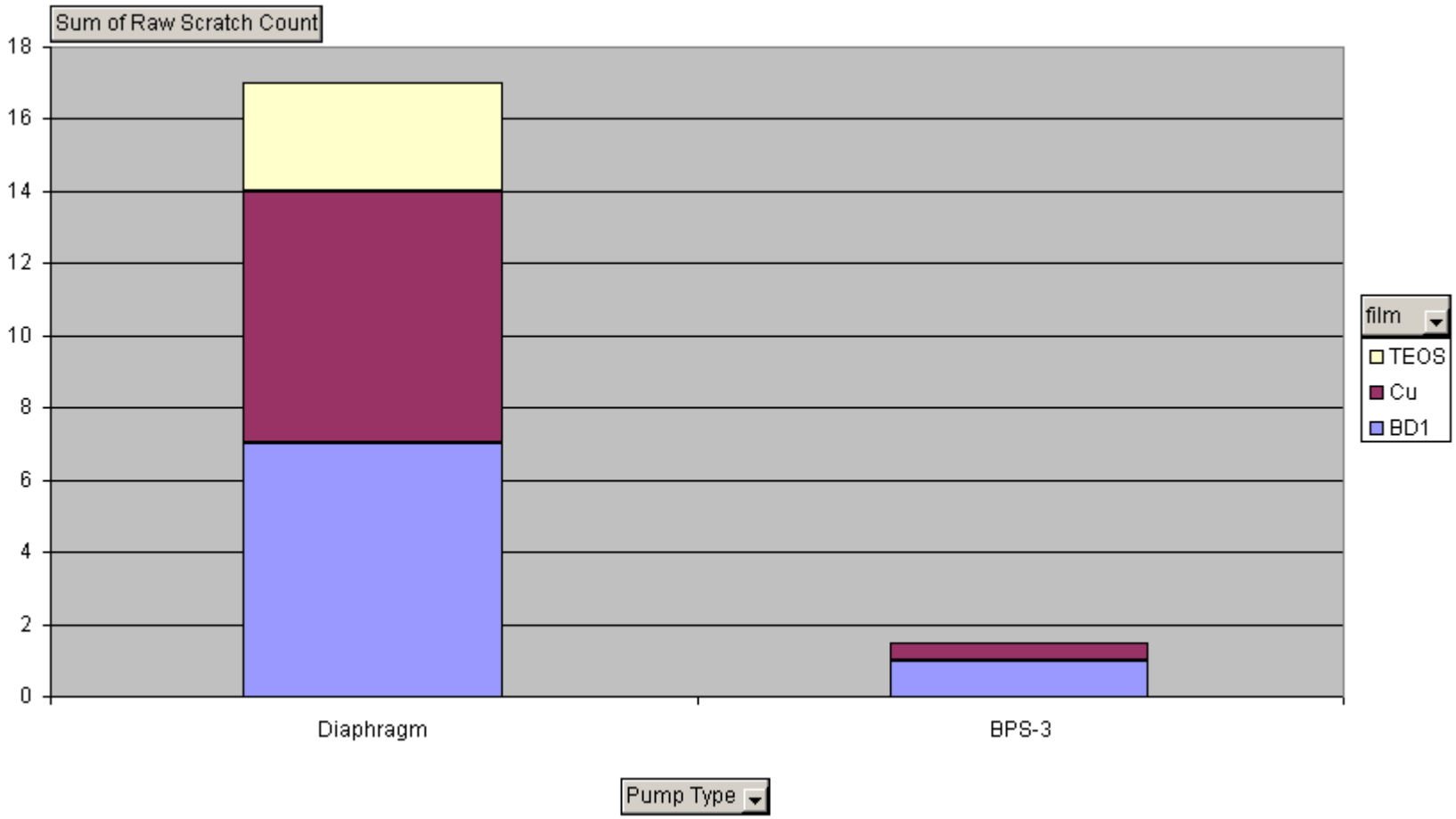
Representative Cu blanket wafer maps with and without scratches : Inspected at 0.4um



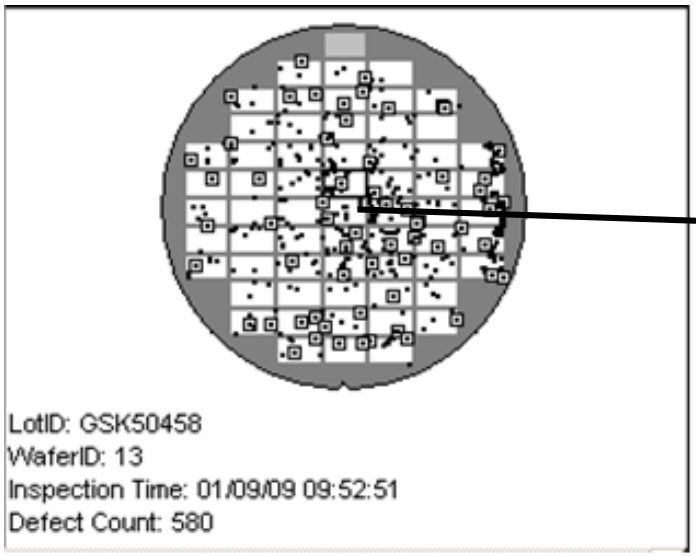


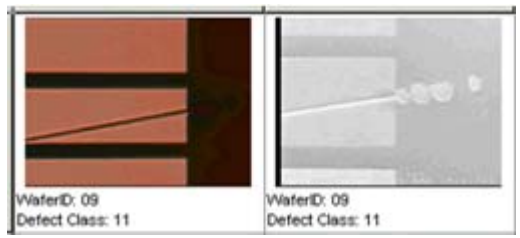


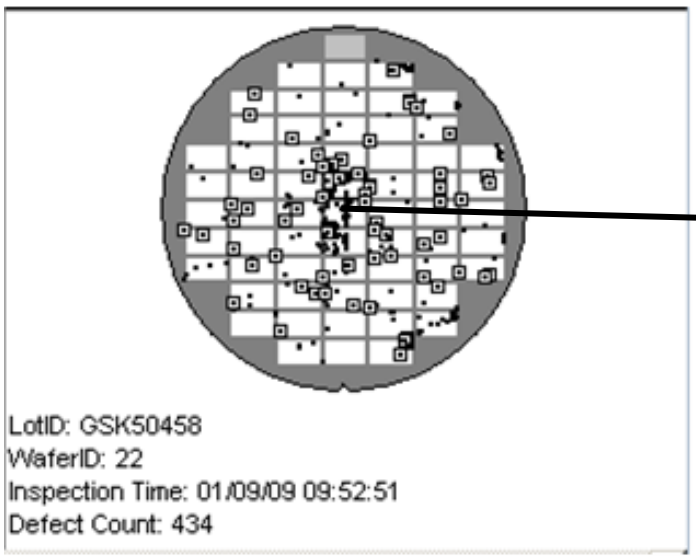
As Processed Blanket Wafer Scratch Defect Summary

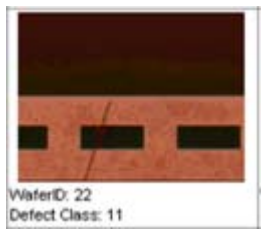


Representative Pattern Wafer Map: Inspected at 0.39px / 0.25um

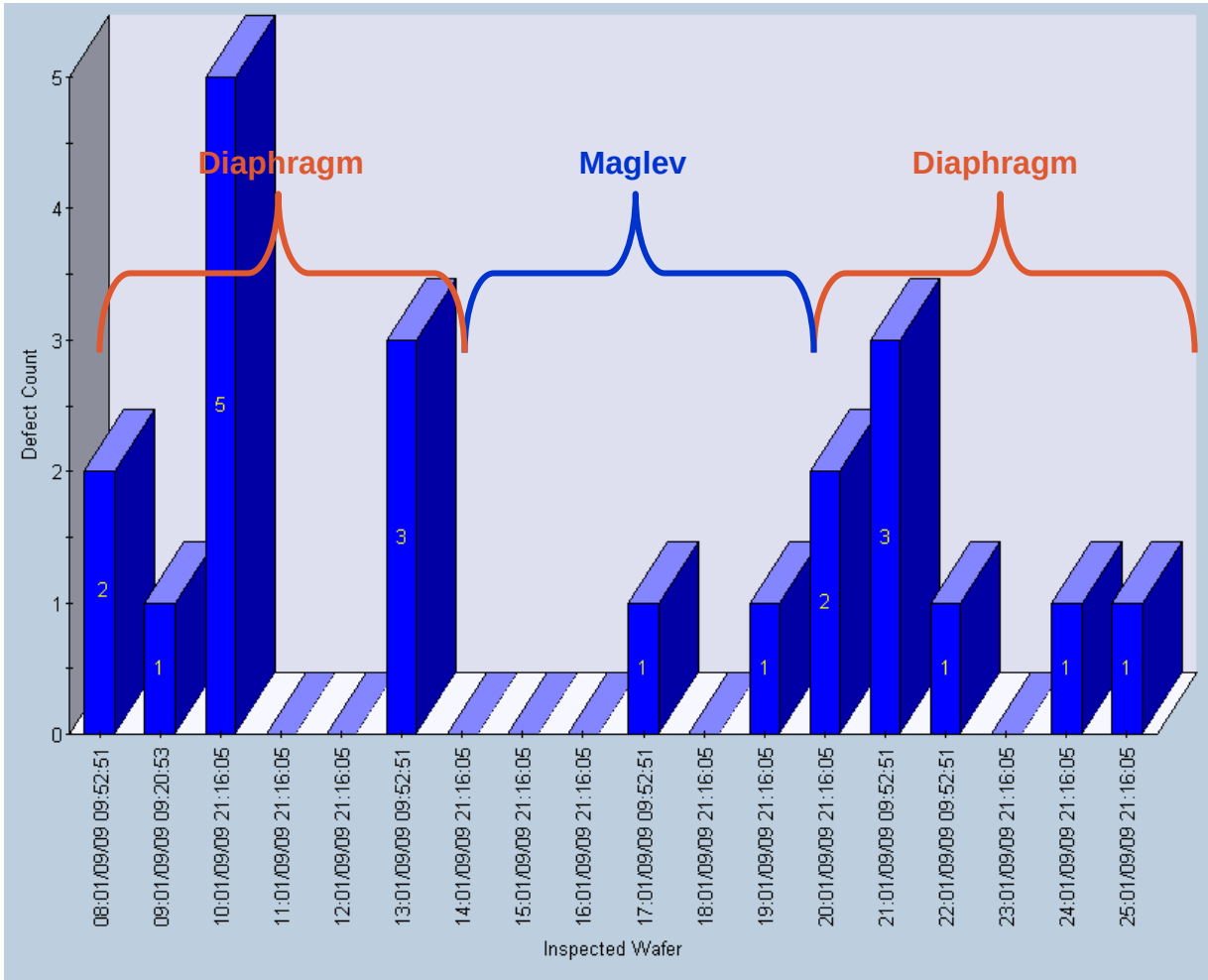






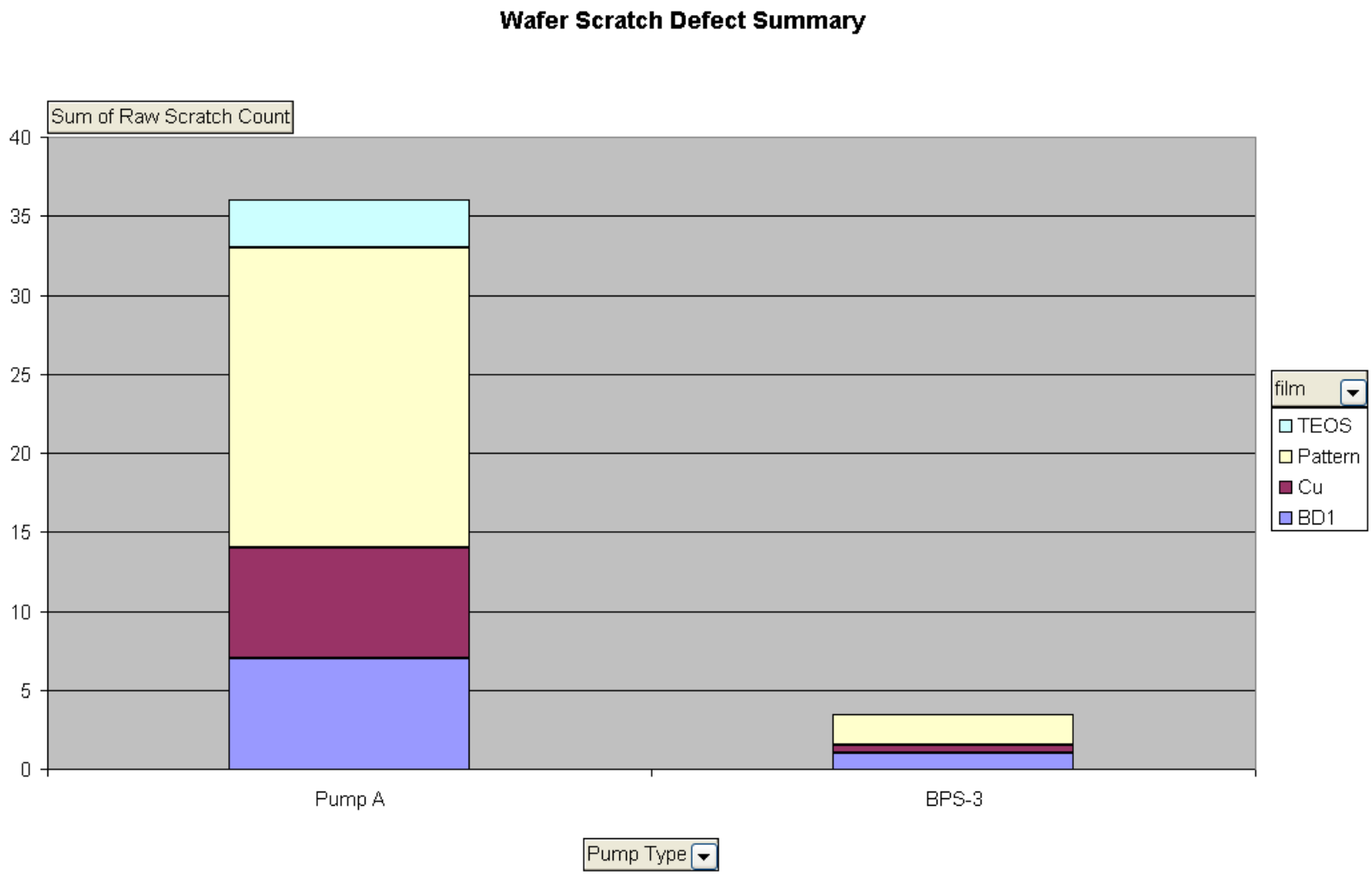


As Processed Pattern Wafer Scratch Defect Summary



Inspection and Data Provided by Independent Source

As Processed Blanket and Pattern Wafer Scratch Defect Summary



Summary

- Slurry Handling Plays an Important Role in CMP process defectivity
  - The experimental data showed that the magnetically levitated pump gave an approximate 10X reduction in scratch defectivity as compared to a similar air-operated double diaphragm pump
  - The post CMP scratch performance was turned “on/off” by simply changing pump type in the slurry distribution handling system
- Data shows slurry handling has the biggest affect on post polish copper and pattern wafers WRT scratches
- Reducing the number of oversize particles (>1um) in CMP slurries can drastically improve post CMP scratch defectivity