Morgan
Advanced Materials

A Test Methodology for Comparing the Performance of CMP Conditioners

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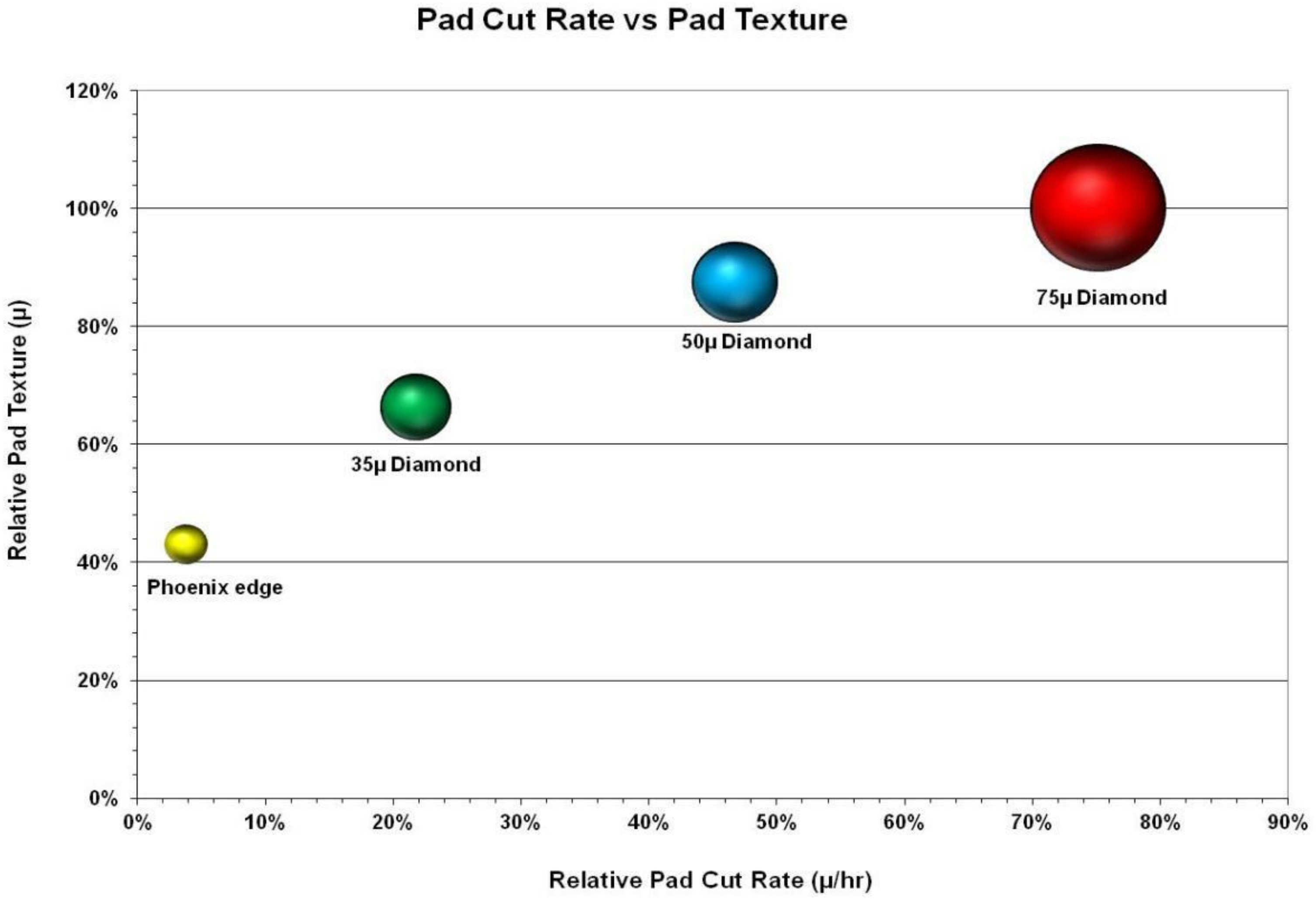
Introduction

- Disclaimer
- Conditioner Ranking
- Role of a CMP Pad Conditioner
- Screening of Conditioners for Aggressiveness
  - Pad Cut Rate vs. Pad Texture
  - Diamond Protrusion or Roughness
- Screen process parameters
- Use optimized parameters for analysis

Disclaimer

The idea behind this approach to compare conditioners has come from collaborations with Entrepix, Araca, and Cabot Microelectronics. The ideas presented are a combination of ideas from all the companies on the testing of conditioners. The author is only attempting to put them in a specific plan to fairly compare conditioner.

Conditioner Ranking by Aggressiveness



The Dual Role of a CMP Conditioner

1. Pad break-in tool

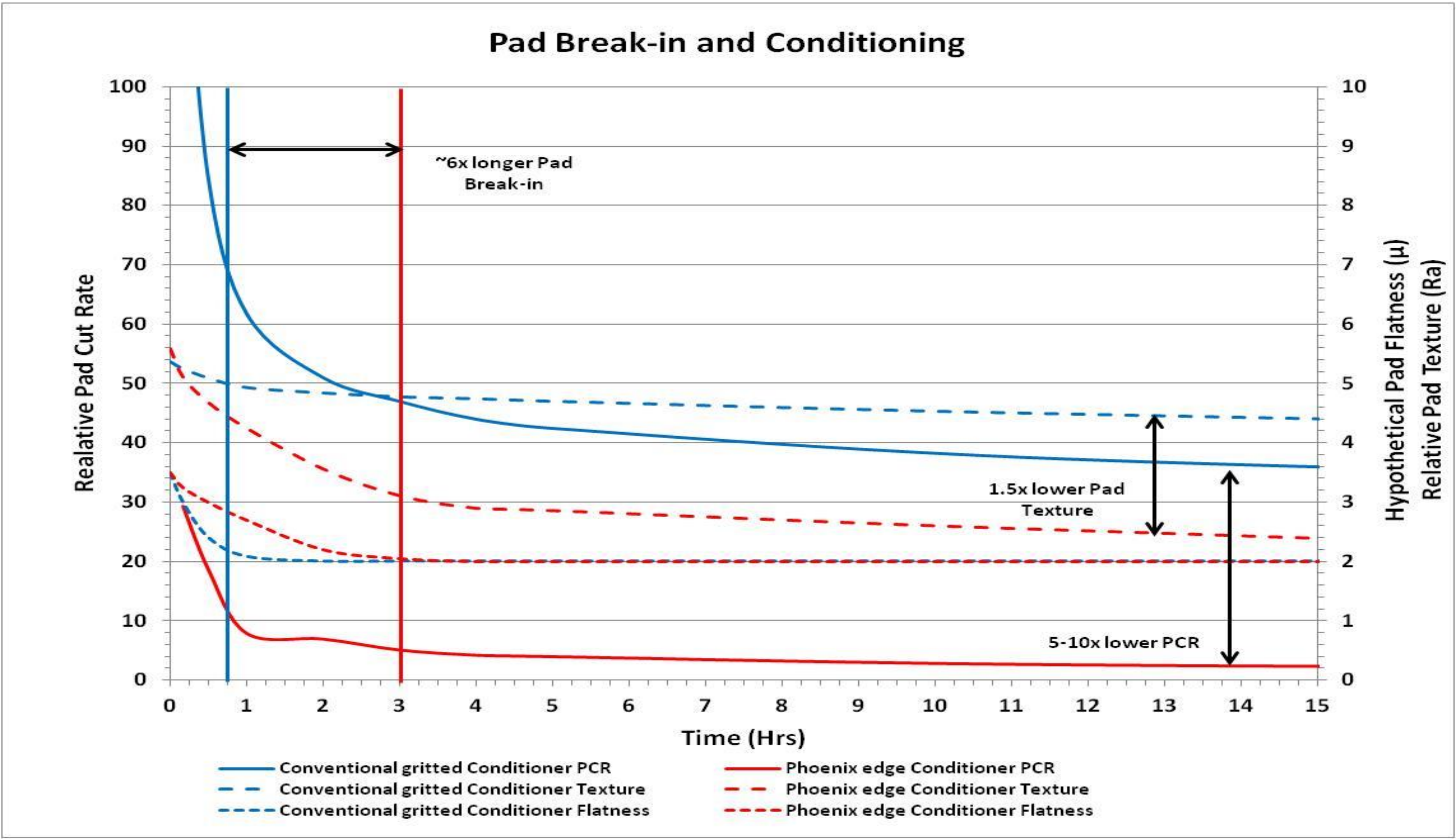
   For a typical hard polyurethane pad thickness may vary by as much as ±20 microns from pad center to pad edge. Therefore the pad needs to be broken-in to a certain pad flatness and pad surface roughness before wafer polishing. This is typically done by conditioning the pad for 30 minutes prior to processing any wafers. Therefore an aggressive conditioner works best for breaking in a pad.

2. Pad conditioning

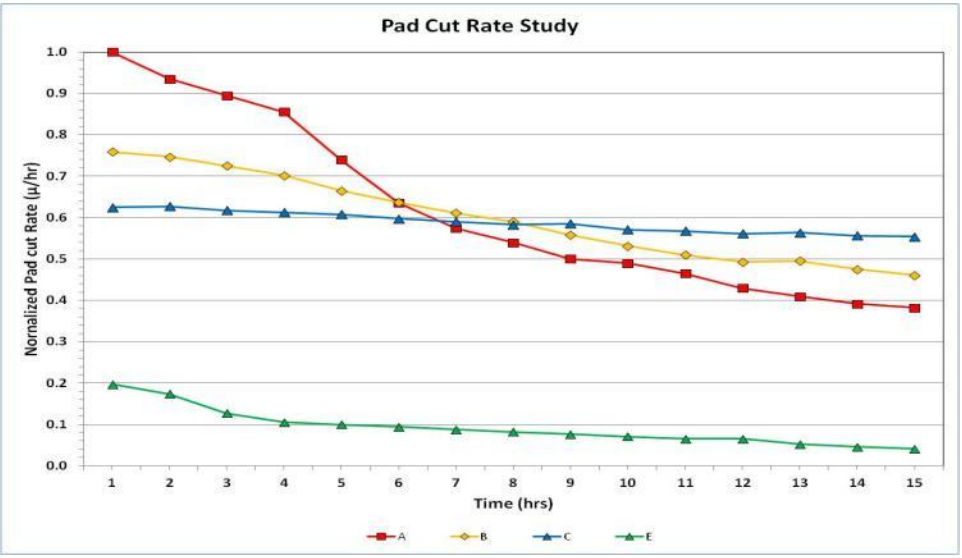
   During wafer production the conditioner is used to clean the pad surface of debris and maintain the condition of the pad surface. A less aggressive pad conditioner is preferred to maintain a smoother pad texture while still cleaning the pad. Such a conditioner will extend the pad life and increase the number of wafers processed per pad change.

Note: the ideal conditioner is not the ideal pad break-in tool

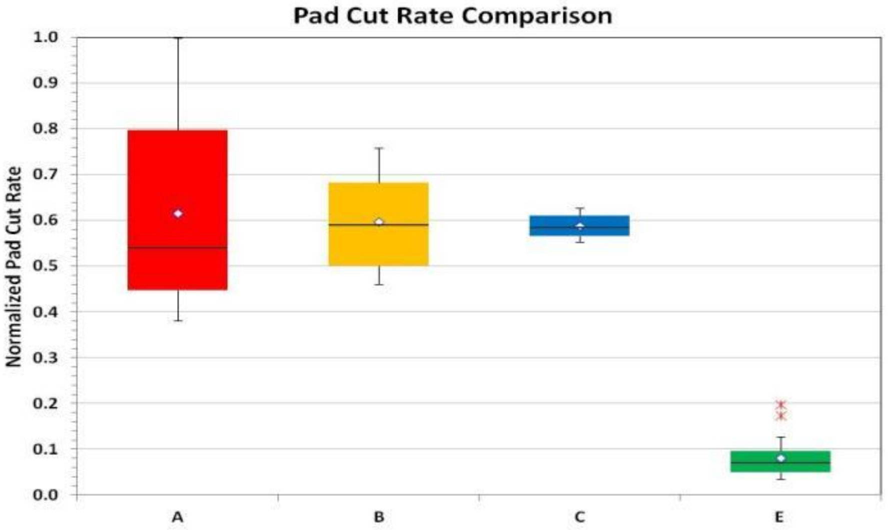
Problem Statement (Graphical)



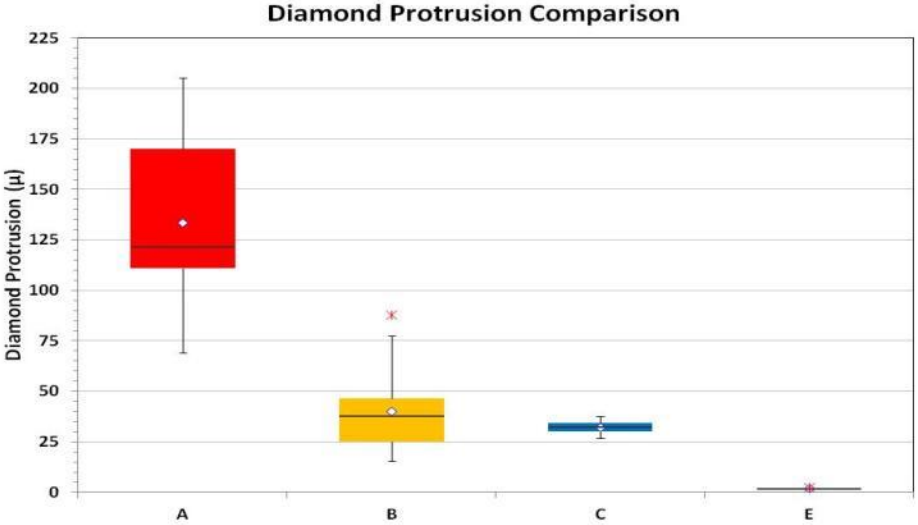
Pad Cut Rate, Texture, & Diamond Protrusion



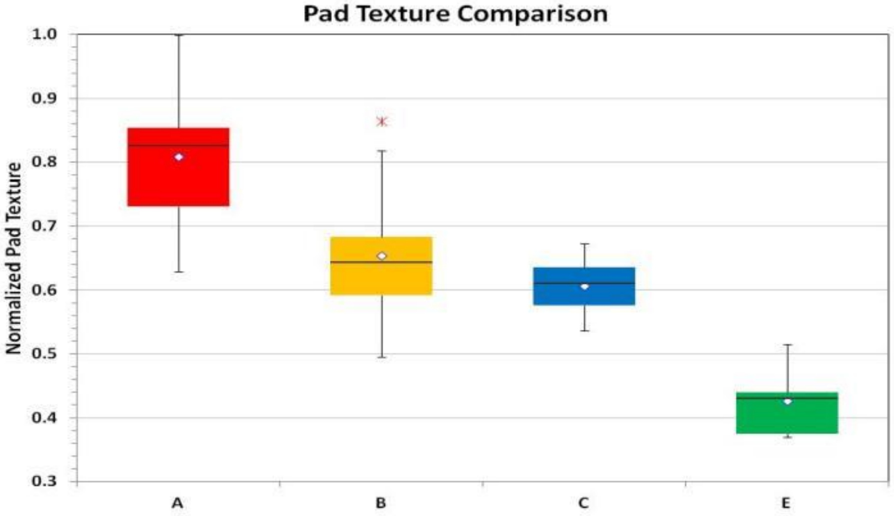
Pad Cut Rate Study



Pad Cut Rate Comparison

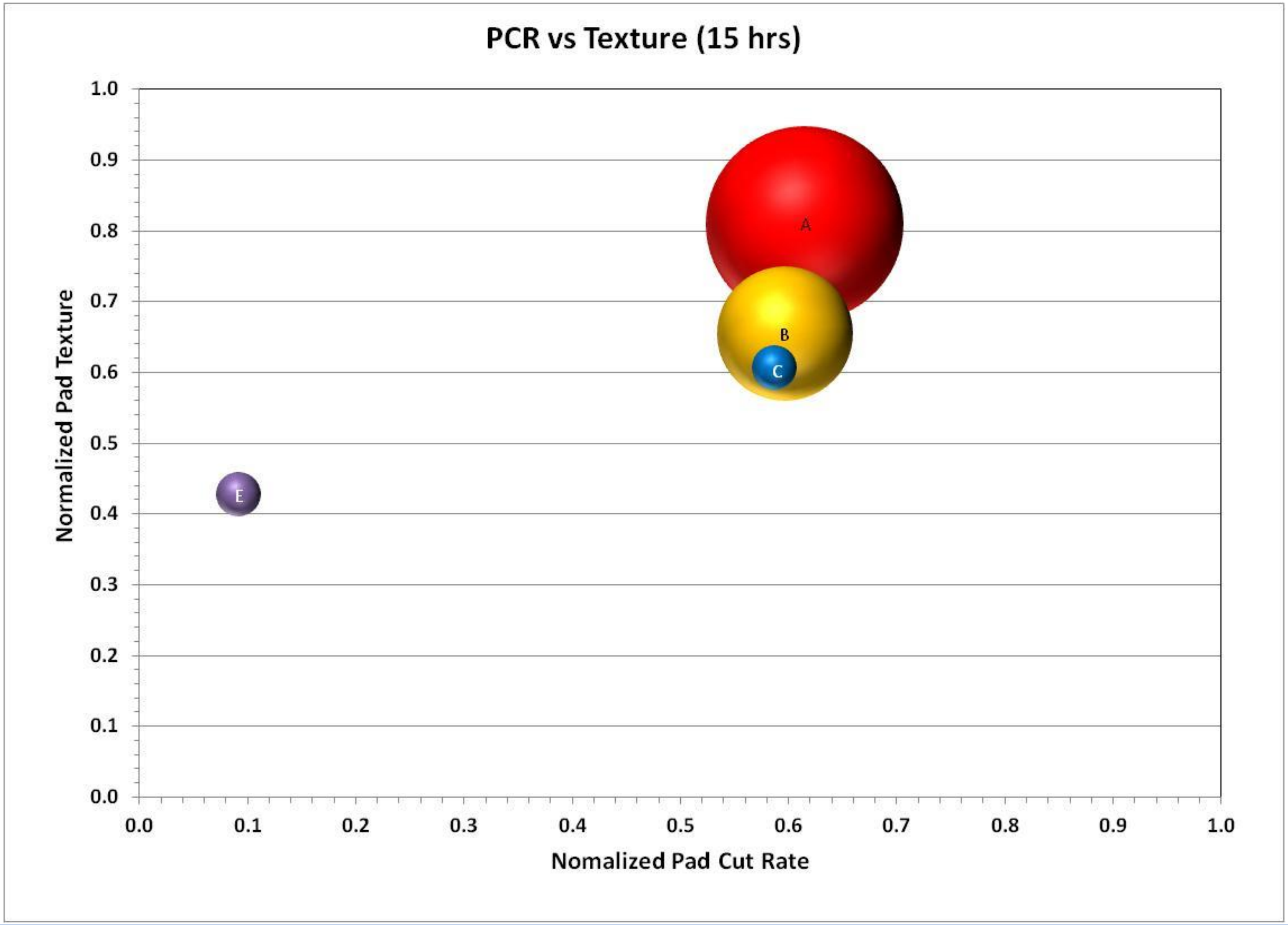


Diamond Protrusion Comparison



Pad Texture Comparison

Pad Cut Rate vs. Texture

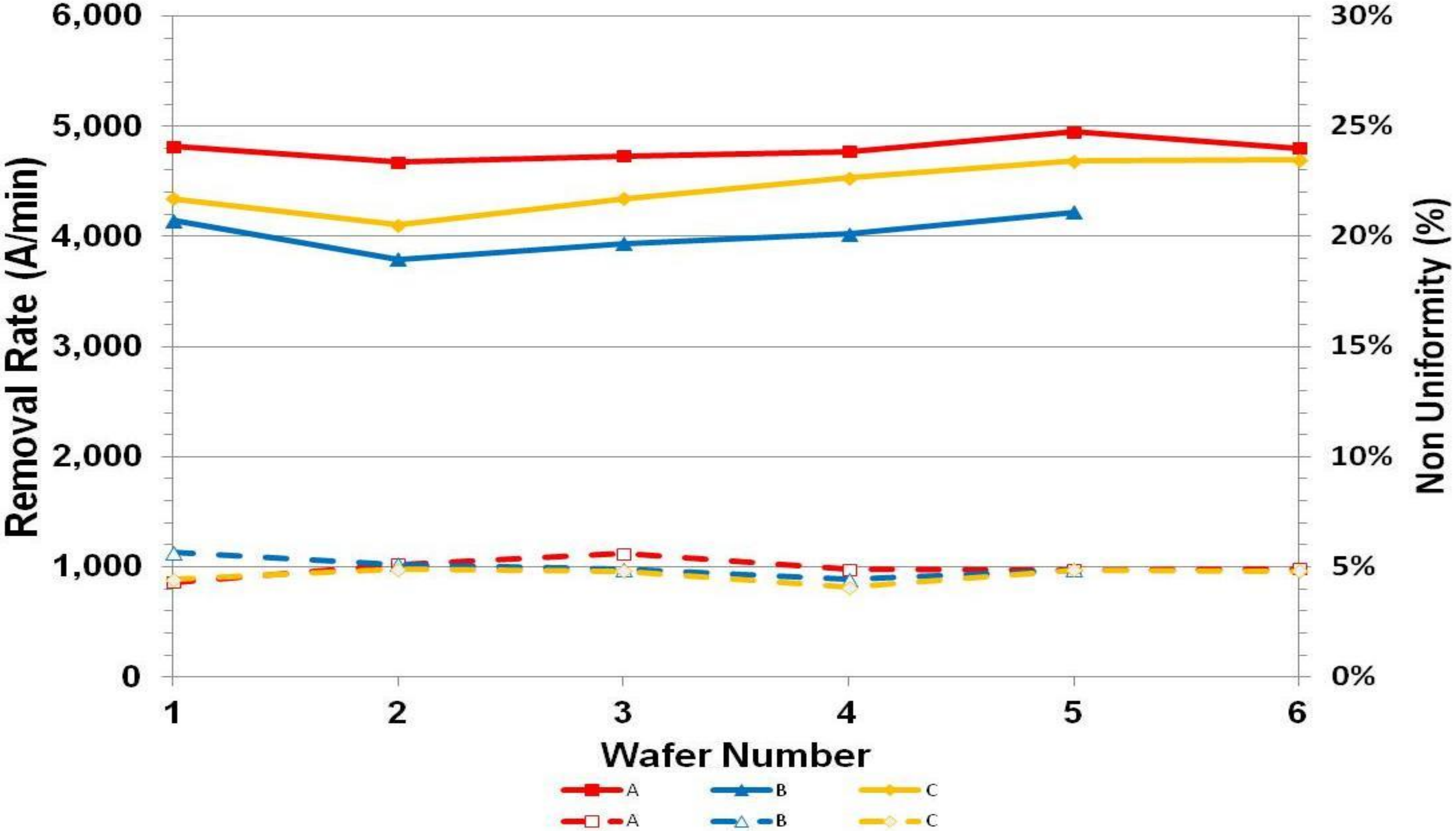


Typical Conditioner Comparison

Typically data for CMP conditioners will compare the material removal rate (MRR) and uniformity of one conditioner to another for several wafers. Based on the results, the examiner will come to some conclusions that one conditioner performed better than another. However, these tests typically are done with one set of tool parameters for platen speed, down force, conditioner rotation speed, conditioner sweep, and so on and may not be the optimized for each conditioner being tested.

The following example gives the MRR and uniformity for several wafers (ex 5-6) for three conditioners at the same conditions.

Examples of Typical Conditioner Comparison



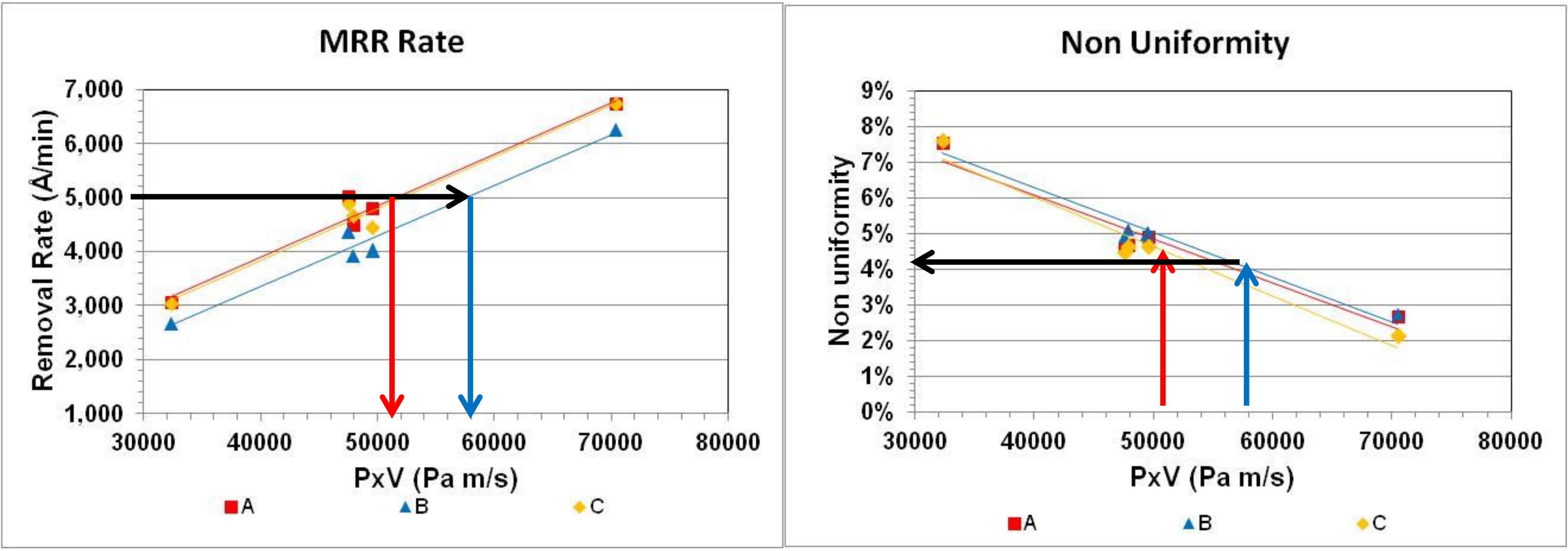
One would conclude that Conditioner A is better than B and slightly better than C

New Screening Method

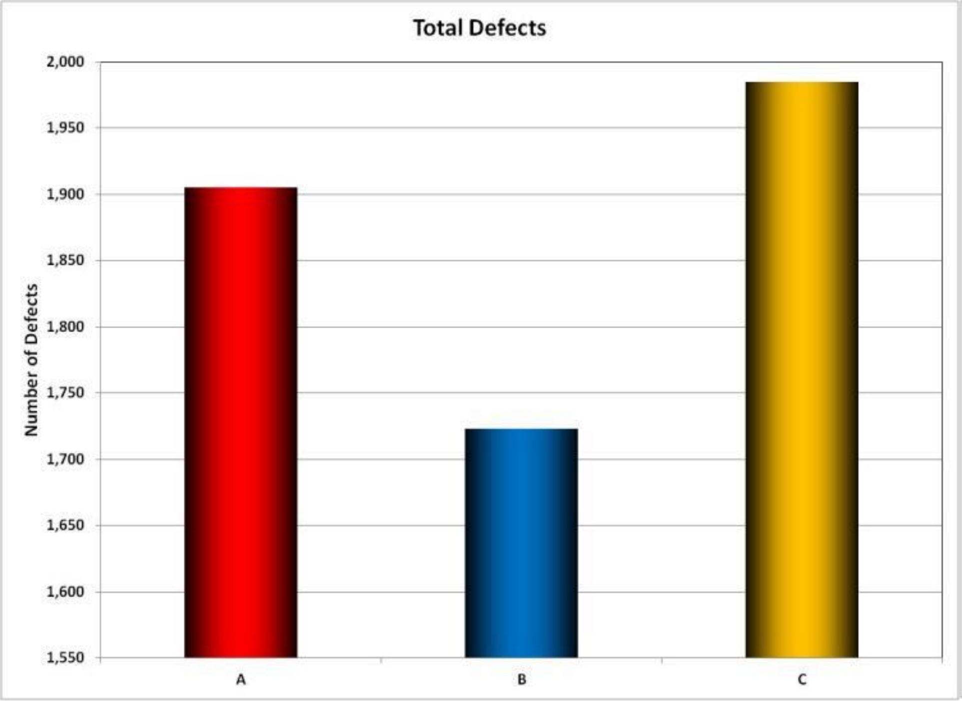
The idea of this test method is to first do a DOE on the tool parameters for each conditioner to determine the parameters for each conditioner being tested that gives similar MRR and uniformity. The parameters for one conditioner probably will not be the same as for another conditioner. Once the comparable tool parameters are established then other conditioner performance characteristic such as defects, dishing, erosion, MRR stability, etc can be compared for each conditioner.

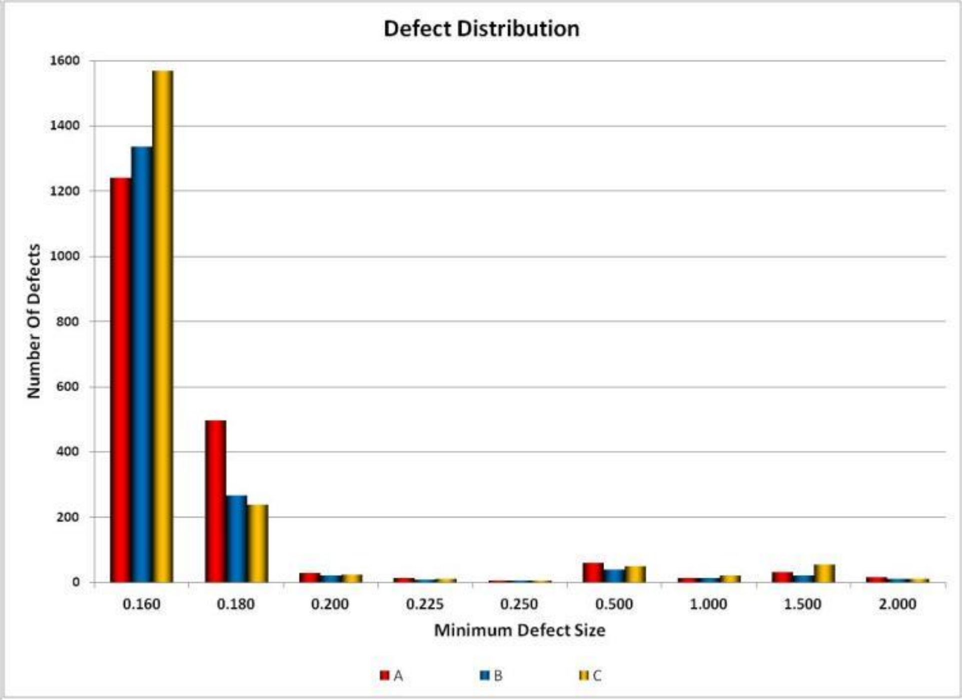
Example of New Screening Method

Perform DOE and measure MRR and Uniformity for several platen speeds and pressures. Then plot the results for MRR and uniformity verses pressure times velocity. Determine the PV value that give similar MRR & Uniformity.



Defect Comparison Analysis

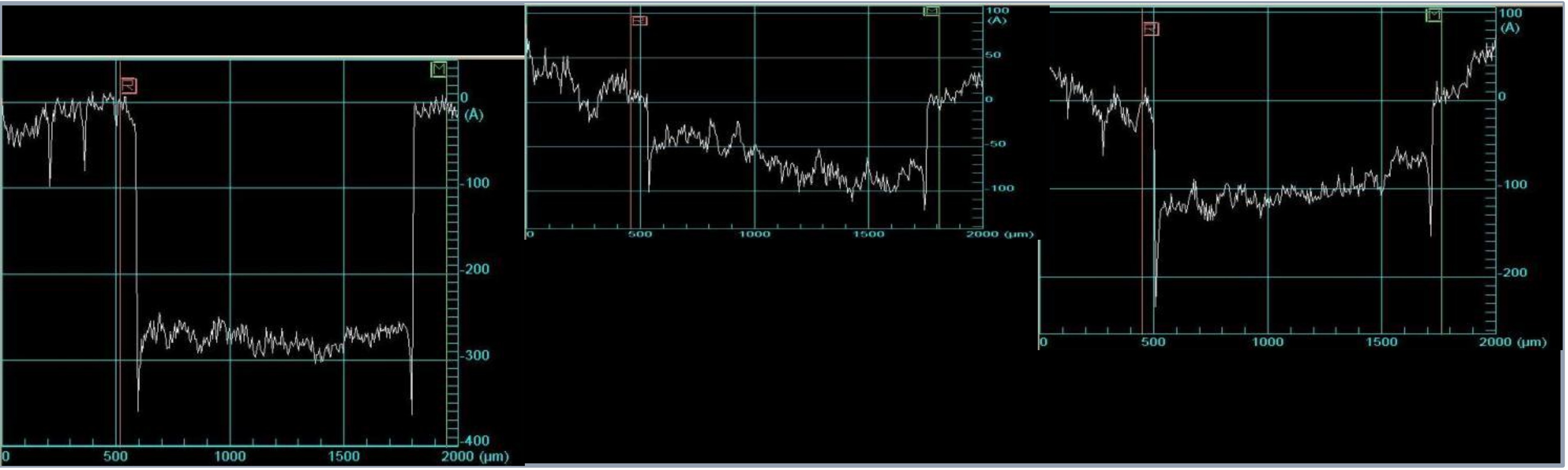




- Conditioner A & C had very similar MRR and Uniformity values for the screening test. However, conditioner A has less total defects
- Conditioner B had the lowest MRR in the screening test, and the lowest number of defects.

Dishing Comparison

Average Overpolish Erosion (Å)			
%Over Polish	A	B	C
0%	175	50	38
20%	700	625	550
40%	1100	750	750



- Conditioner B & C have significantly lower erosion than conditioner A. Conditioner C is slightly better than B.

Summary of Example

	Std Method		Screening Method		Total	Erosion		
Conditioner	**MRR**	**Uniformity**	**MRR**	**Uniformity**	**Defects**	**0%**	**20**	**40%**
A	4,790	4.9%	5000	4.6	1905	175	700	1100
B	4,023	5.0%	5000	4.2	1723	50	625	750
C	4,449	4.6%	5000	4.4	1985	38	550	750

- The Std Method would have suggested Conditioner A
- The screening method eliminates MRR from a decision making and now the improved conditioner is based on defects, Dishing, erosion or some other important metric.
  - If defect is of greatest concern then Conditioner B would be the best
  - If lowest erosion is of great concern the conditioner C would be best choice.
  - If both erosion and defect are of concern then Conditioner B is best compromise.
  - The criteria for conditioner selection will be based on the process and the critical metrics of that process.

Modifying Conditioner Parameters

- In the first example conditioner parameters; down force, conditioner rotation speed, and sweep were held constant. What if the desired MRR can not be achieved by platen speed and wafer down force alone.
- In these cases the investigator can optimize conditioner down force and or conditioner speed to increase the MRR.
- The conditioner sweep schedule can be optimize to improve uniformity.

Conclusion

- This method allows the investigator to compare conditions on the critical metrics rather than purely on productivity by eliminating the variation of MRR & uniformity.
- As a result a conditioner more suited for the process can be selected based on; defects, dishing & erosion, pad cut rate & pad texture.

Thank You