

Tuning Wear Rate and Surface Roughness of CMP Pads via Precise Control of Pad Conditioner Features

Electronics Materials Solutions Division

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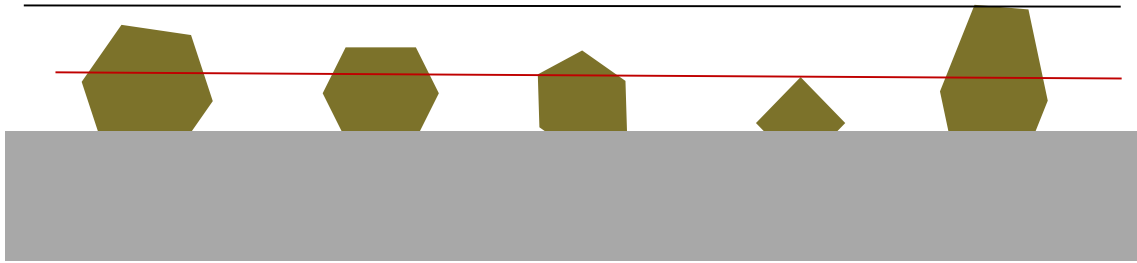
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Introduction

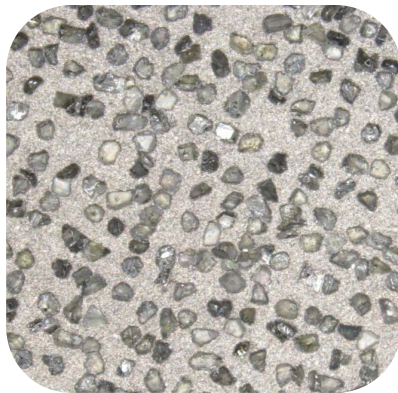
1. Microreplicated Technology for Pad Conditioners
2. Decoupling Pad Roughness from Pad Wear Rate
3. Test Plan, Input Variables, Response Outputs, Equipment, Materials, & Methods
4. Results
 - Pad Wear Rate (PWR) and Average Surface Roughness (Ra)
 - PWR and Ra from Disk Types
 - Effluent Particle Concentrations with Disk Types
5. Summary, Conclusions, and Future Work

Why Microreplicated technology for Pad Conditioners?

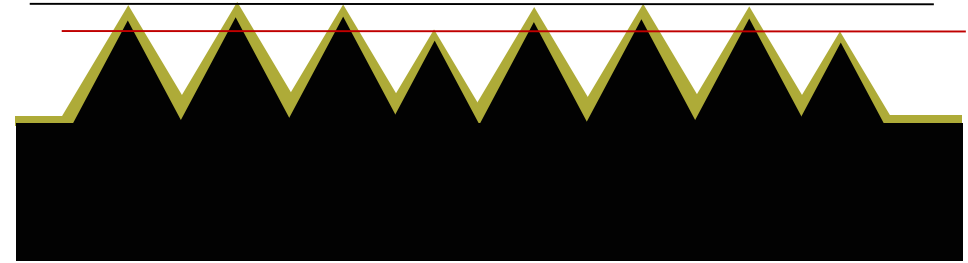
Shape of contact features: varies randomly
Height dispersion of contact features: varies randomly
Type of contact features: varies, depends on grit type



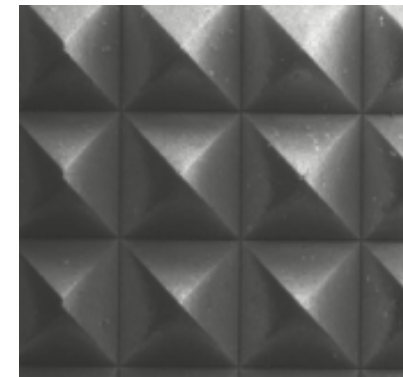
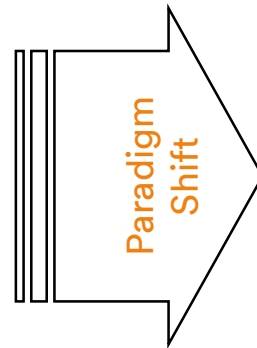
Grit Type Pad Conditioner



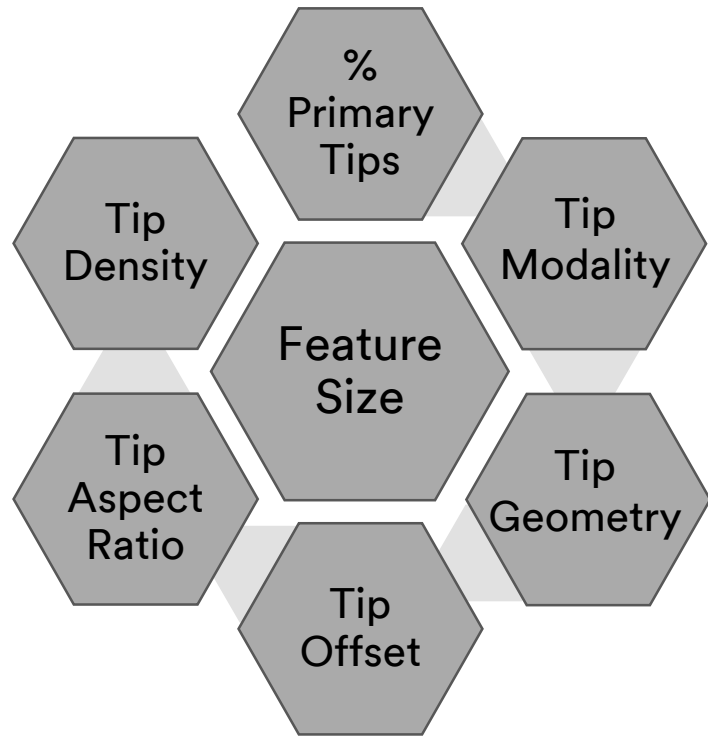
Shape of contact features: Designed-in and replicated
Height dispersion of contact features: Designed-in
Type of contact features: Designed-in



Trizact™ Pad Conditioner

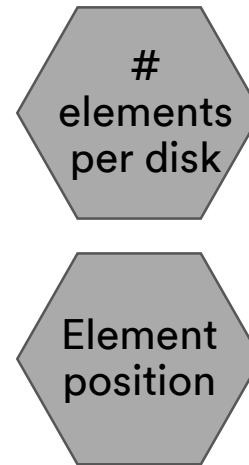


Trizact™ Pad Conditioner Configuration



Engineered Microreplicated Elements

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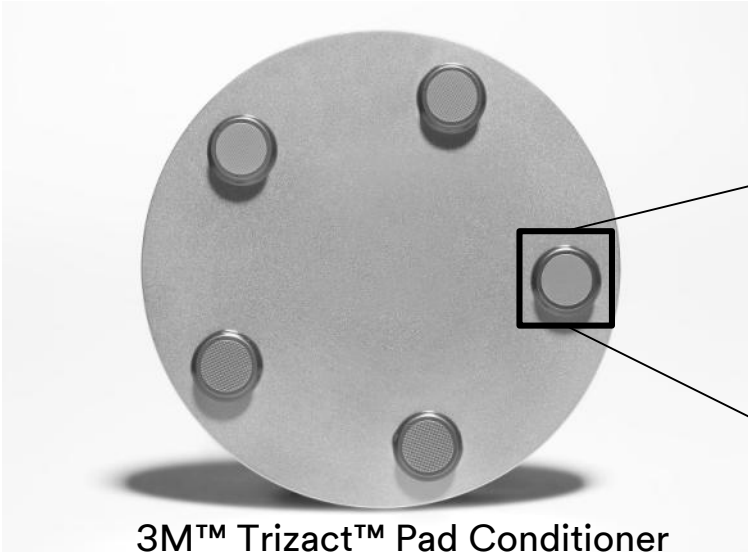
Disk Construction

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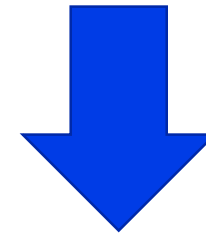
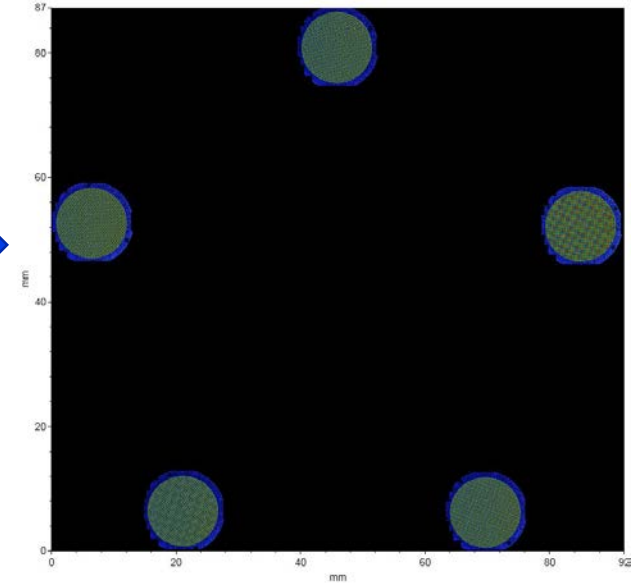
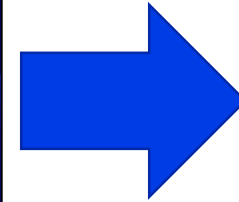
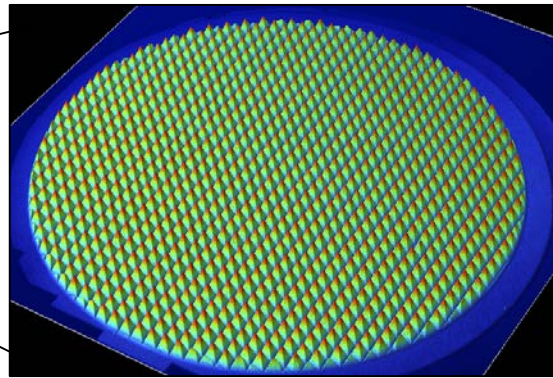
3M™ Trizact™ Pad Conditioner

Microreplication Consistency Enables Advanced Metrology

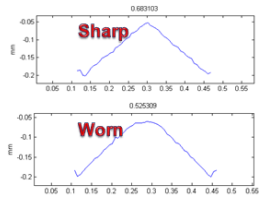


3M™ Trizact™ Pad Conditioner
B75-2990-5S2

Topography of Each Element



100% Inspection



Each Tip
Characterized



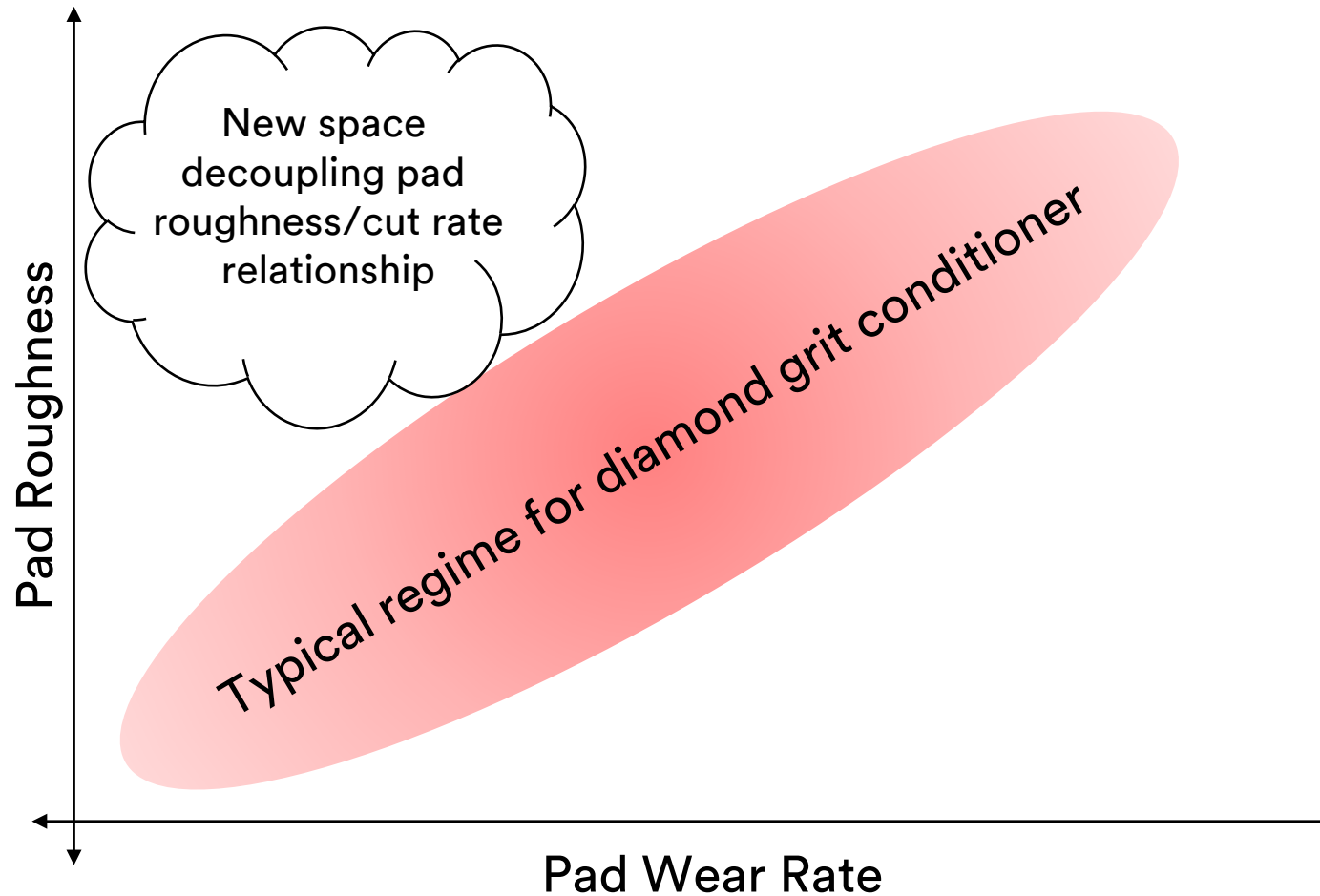
Sharpness of Every
Abrasive Feature/Tip

Flatness of Every Element

Coplanarity of All Elements



Decoupling Pad Roughness and Pad Wear Rate



Test Plan, Input Variables, Response Outputs

Test Plan: Measure pad wear, pad roughness and effluent after 1 hour conditioning in DI water.

Input variables

Pad conditioner types A & B.

A= commercially available Trizact pad conditioners

B= new experimental Trizact pad conditioners

Pad conditioner designs: 1, 2, 3, 4 for incrementally higher pad wear “aggressiveness”

Pad X, industry standard pad

Response outputs

Pad Wear Rate, PWR (um/hr)

Pad roughness, Ra (um)

Pad debris concentration (#/ml), debris size > 0.56 um .

Equipment, Materials & Methods

Equipment

AMAT Reflexion™

LASER & Mechanical Profilometer

Optical Particle Counter for pad debris concentration

Materials

30” diameter pad

3M Trizact Pad Conditioners (A1 - A4, B1 - B4)

DI Water

Methods

Pad Wear Measurement: groove depth before / after 1 hr of conditioning

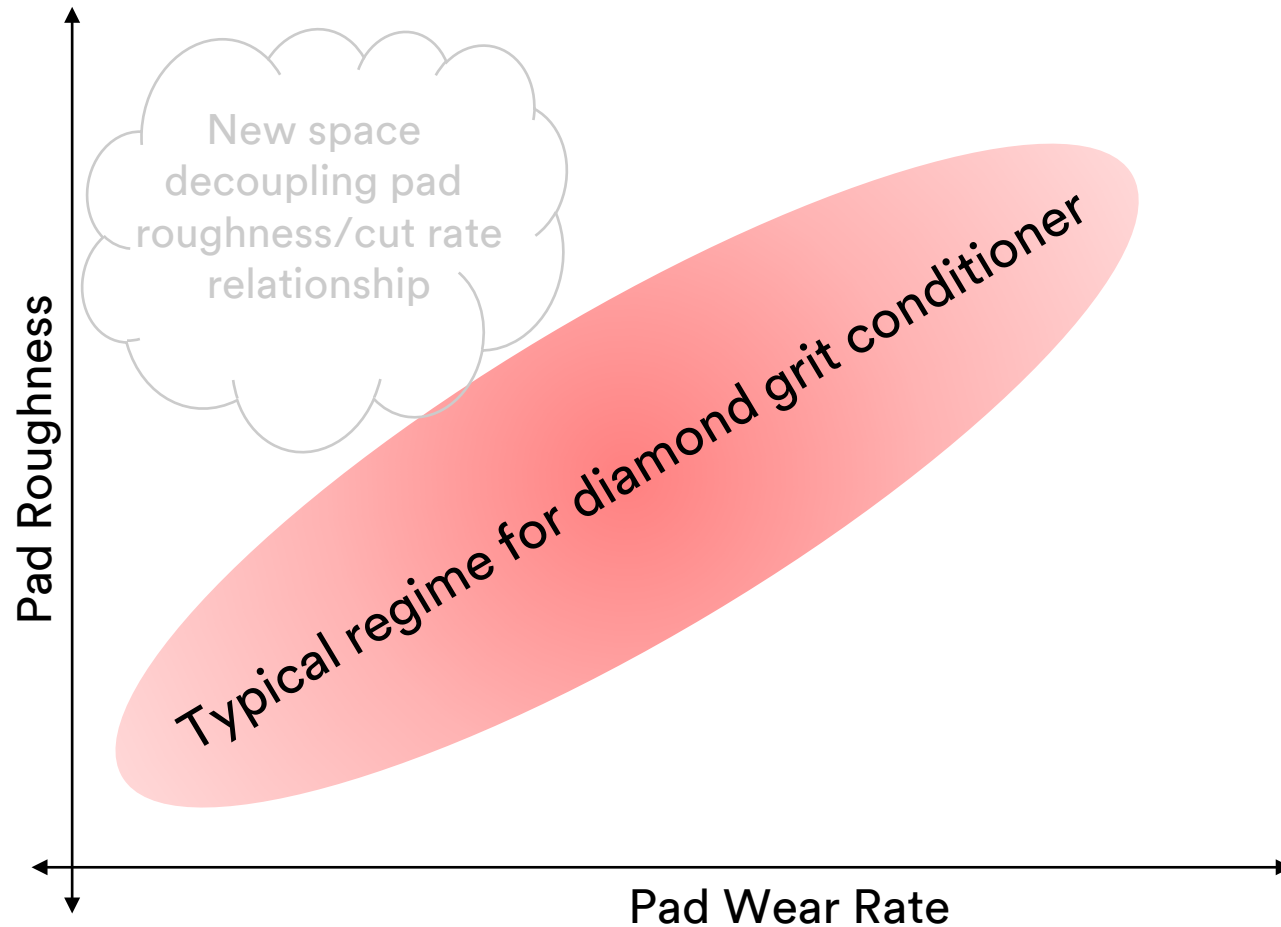
Pad Roughness Measurement: surface roughness before / after 1 hr conditioning

Particle Concentration: Effluent collected during last 5 minutes of 1 hr conditioning process

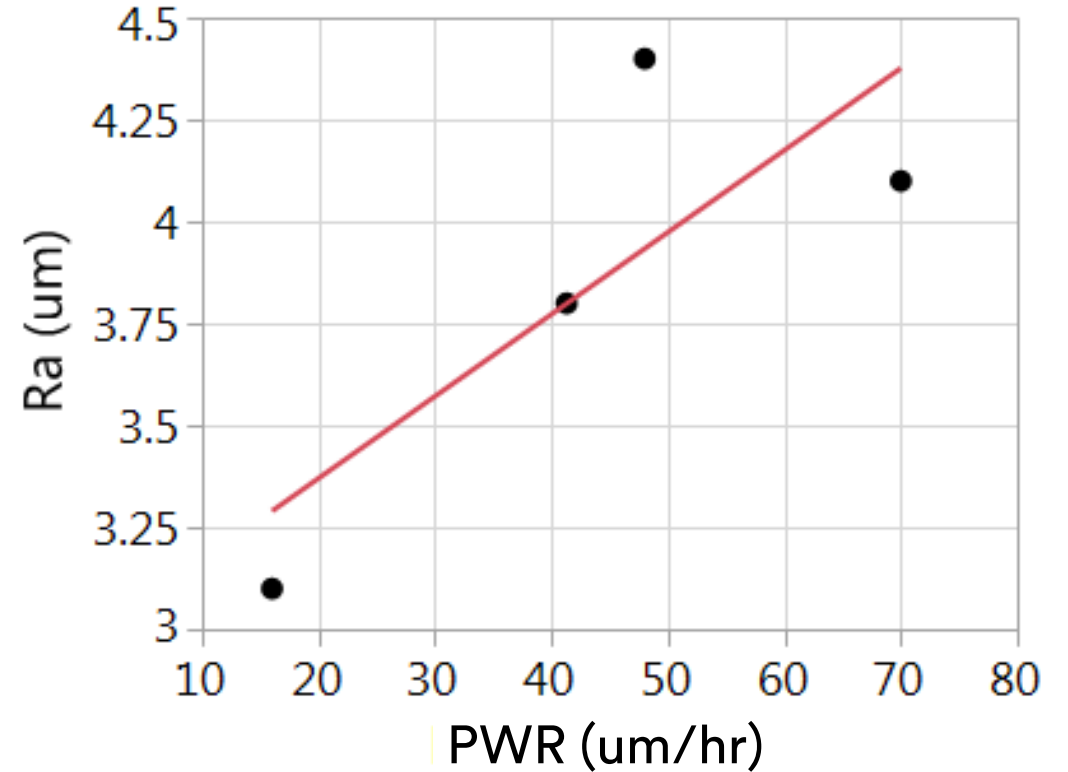
Pad Conditioner Recipe Settings	
Platen Speed	93 rpm
Head Speed	81 rpm
Sweep	Linear 13 swp/min
DI water flow rate	200mL/min
Down Force	6lbs

Typical Regime for Type A Pad Conditioners

Type A pad conditioners, Pad Surface Roughness vs. Pad Wear Rate



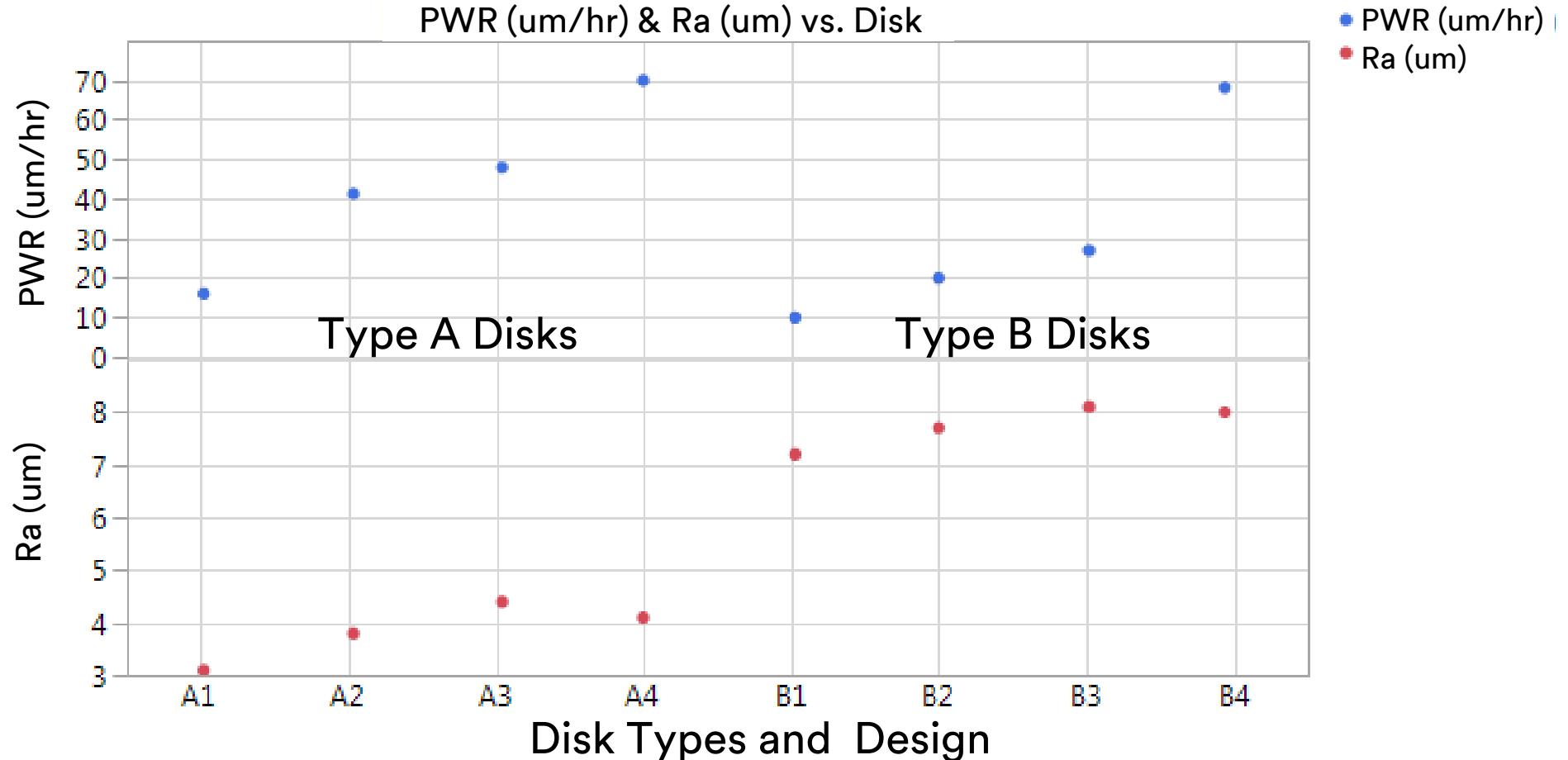
Bivariate Fit of Ra (um) By PWR (um/hr) Disk Type=A, Pad=X



Type A pad conditioner designs show typical relationship between pad roughness and pad wear rate

Comparison of Type A and B Pad Conditioners

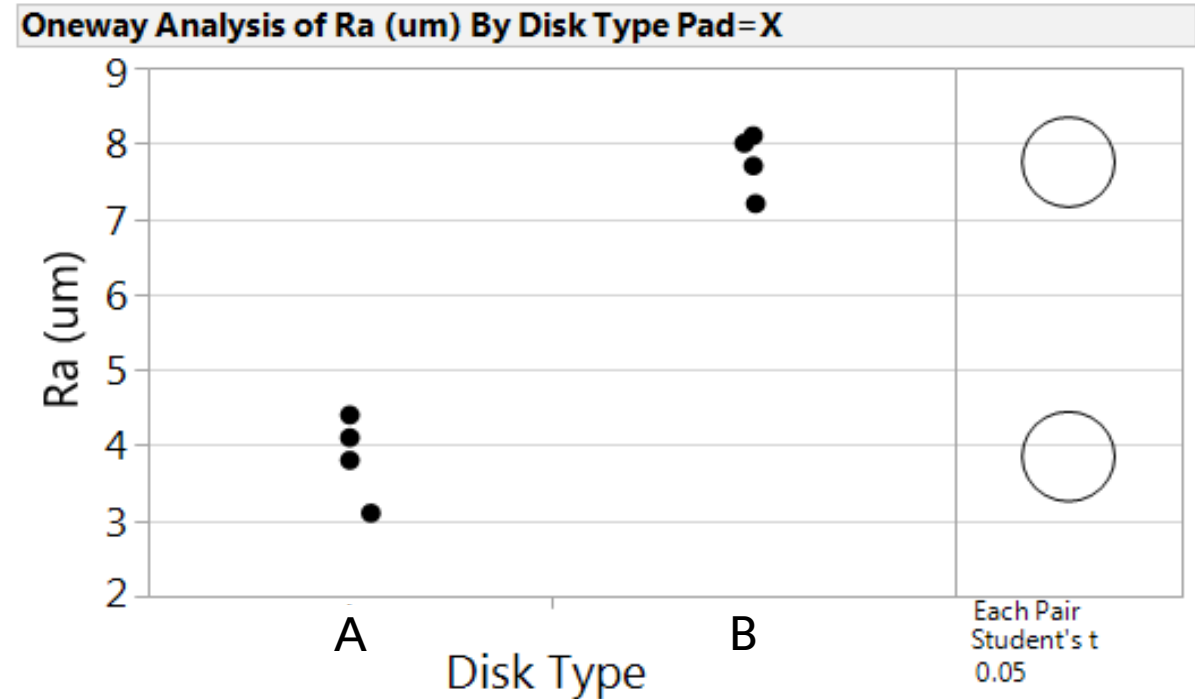
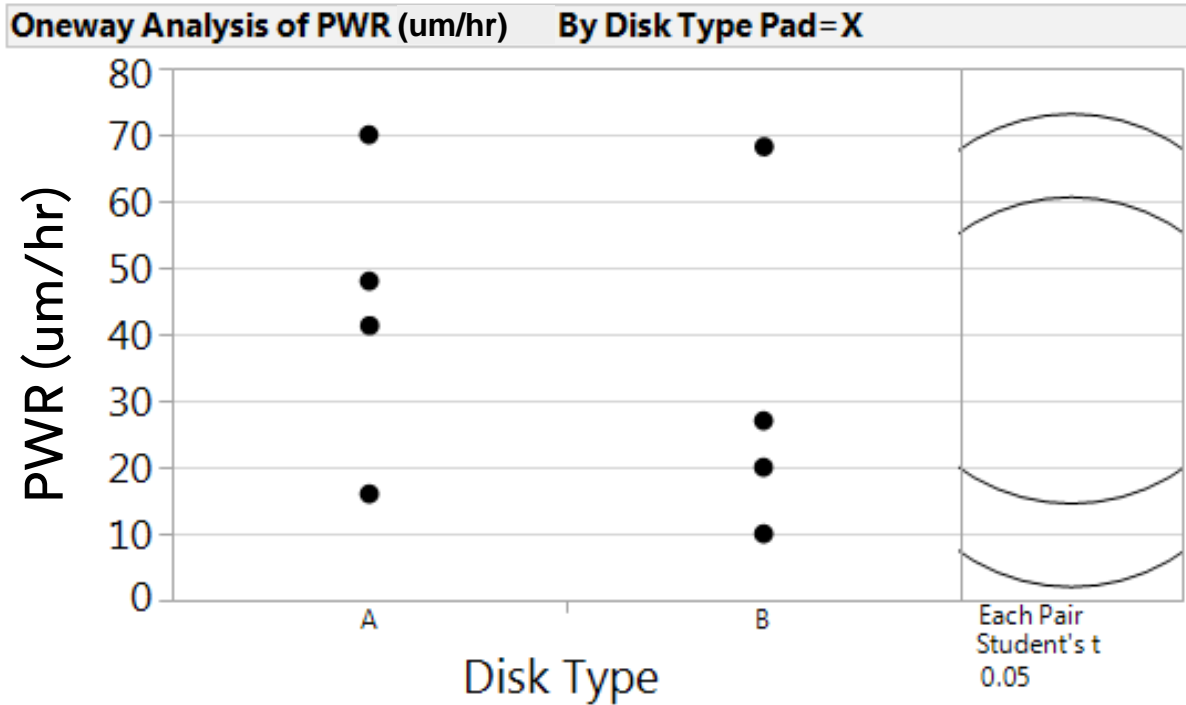
Pad Surface Roughness vs. Pad Wear Rate



Different pad conditioner designs can modulate pad surface roughness significantly and independently of pad roughness

Comparison of Type A and B Pad Conditioners

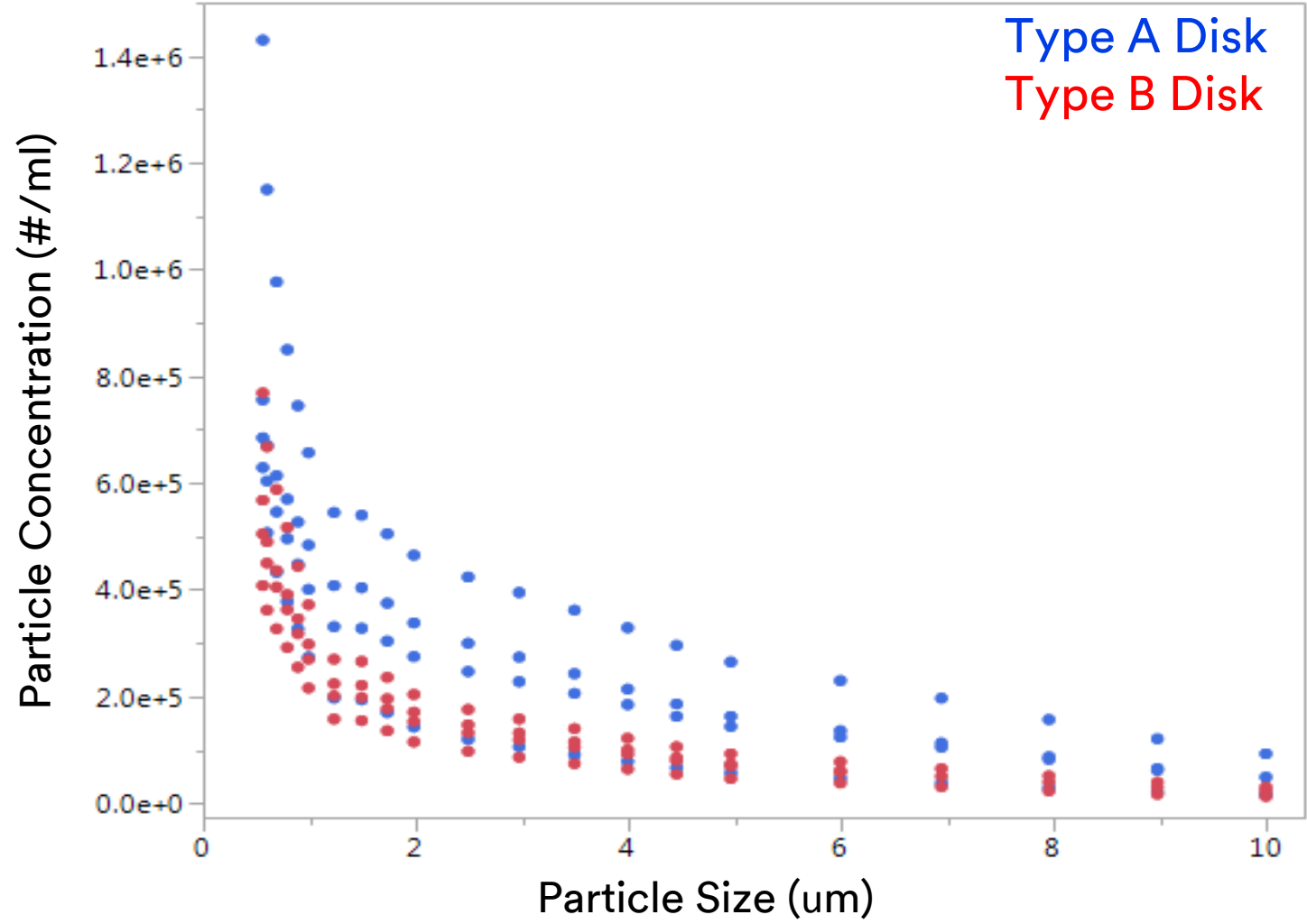
Pad Surface Roughness vs. Pad Wear Rate



Both pad conditioner disk types give similar pad wear rate (PWR, um/hr) range; however, the average surface roughness (Ra, um) from Type B > Type A disks

Comparison of Type A and B Pad Conditioners

Particle Concentrations vs. Size



Type B pad conditioner disk seems to generate less pad debris compared to type A disk



Summary

- This work measured and compared the effect of 8 precisely controlled pad conditioner designs on a typical bulk material removal pad
- Pad wear rate, pad average surface roughness, and particle data from effluent were compared for a range of different pad conditioner designs

Conclusions

- One pad conditioner type modulated pad roughness significantly and independently of pad wear, so high surface roughness was imparted to pads with relatively low pad wear
- These results demonstrate the ability to decouple pad roughness from pad wear rate, and show potential to enable low pad wear in high wafer removal rate applications

Future Work

- Wafer level data from chemical mechanical polishing with disk types A and B
- Pad conditioner life comparison between disk types A and B
- Pad wear, pad roughness, and LPC counts on different pad types