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Epic®

Achieving Process Stability on Soft Pads

Gregory T. Gaudet – Cabot Microelectronics

May 15,2013

Process Stability on Soft Pads

- Well known problem
  - Rate increase in early pad life
- To fix it …
  - …either we (pad manufacturer) need to do something…
    - Roughness, flatness
    - Grooving
  - … or you (pad user) need to do something…
    - Extended break-in
    - Balancing conditioner effectiveness and conditioning time
    - Process tweaks
- This presentation
  - Three recent, internal CMC experiments
  - Some interesting (surprising?) results

D2XX Flavor "Secret Decoder Ring"

Porosity	25D	42D	50D	60D	72D
Very High (>60%)		F17			
High (40-50%)	F12	F9	F8	F6	F3
Medium (20%-40%)			F7	*F5*	*F2*
Low (<20%)	F11	F10		F4	F1

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D2XX F9/42D Groove Pitch Skew

Pad13-020

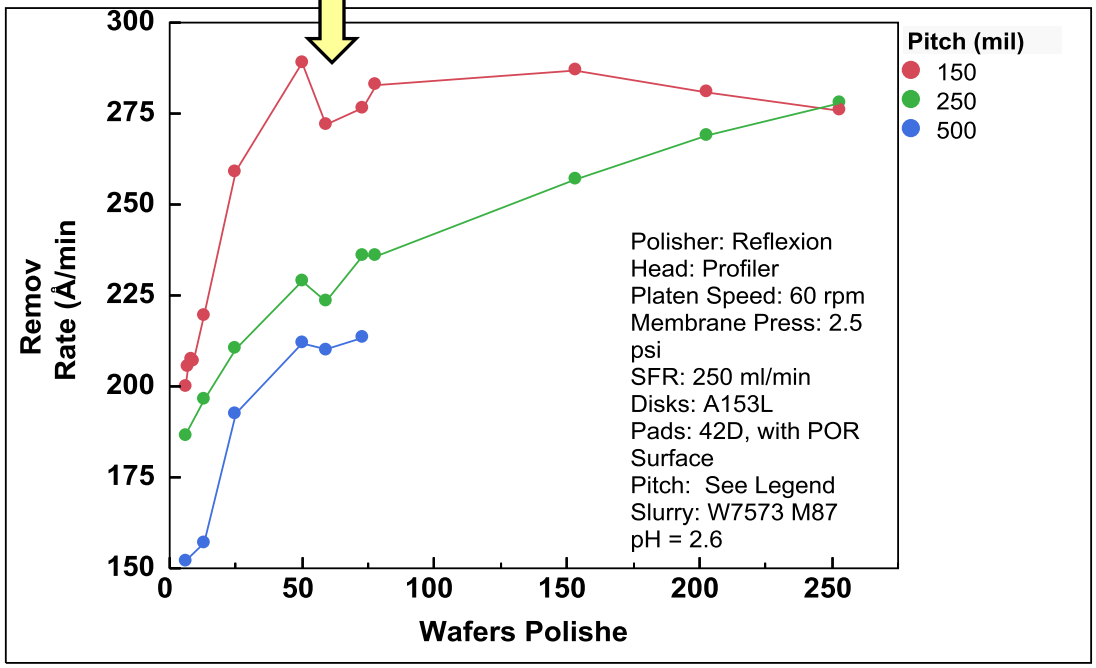
Nathan Speer

Pad Application Team

3/22/2013

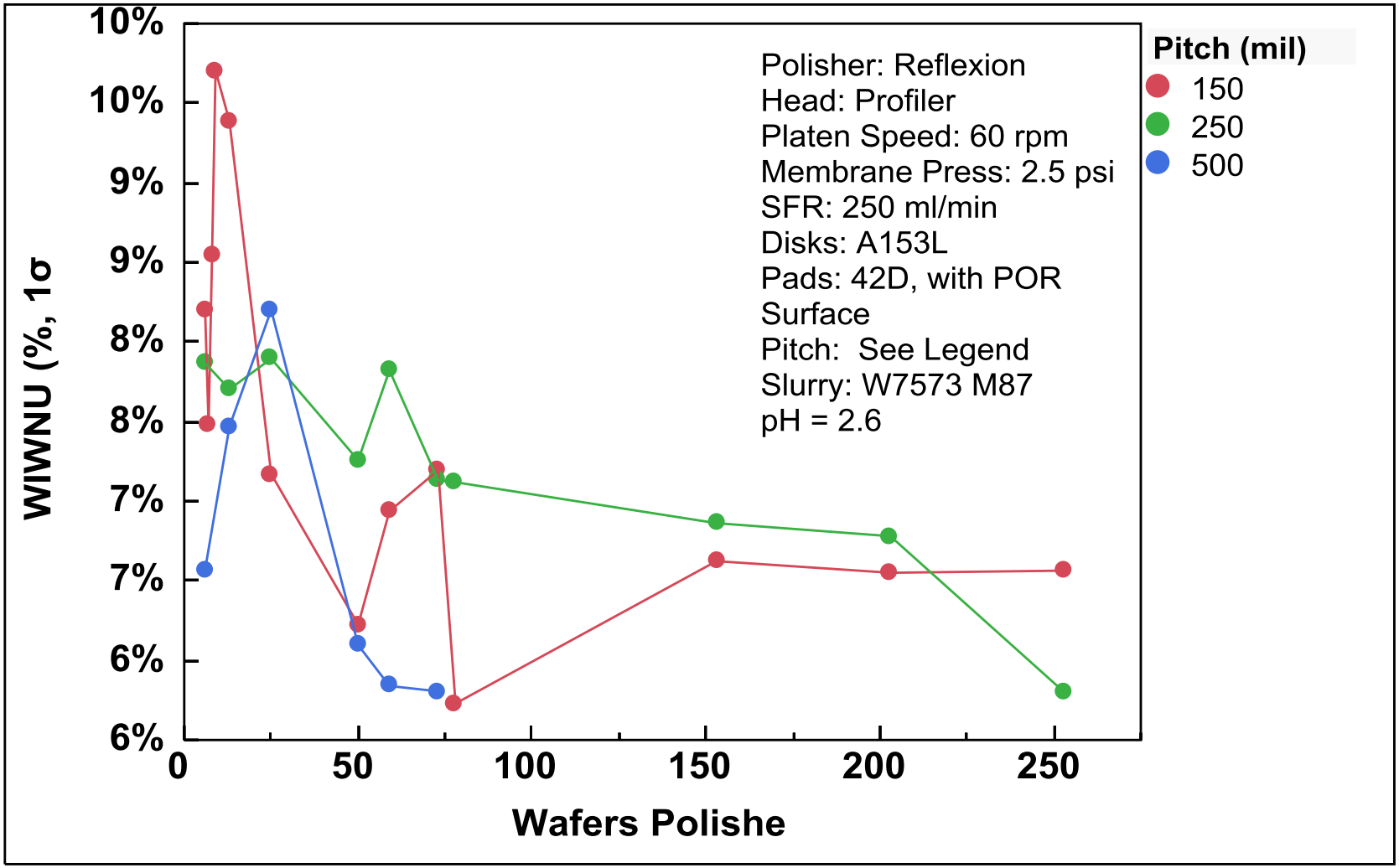
Removal Rate Trends

RPM skew performed between wafer 51 and 78 somehow had an effect on our BKM wafers, which are plotted below. Each monitor wafer was cascaded behind dummy wafers to reduce this kind of a 'memory' effect.



- **Removal Rate trend plot (for our BKM recipe only) are plotted above**
- **In addition to our BKM recipe, we performed an RPM skew between wafers 50 and 78. Even though we cascaded two dummy wafers before each monitor wafer, the effects of the RPM skew can be seen in the trend plot (yellow arrow)**
- **The 150 mil Pitch pad appears to stabilize more quickly.**

Within-Wafer Uniformity Trend



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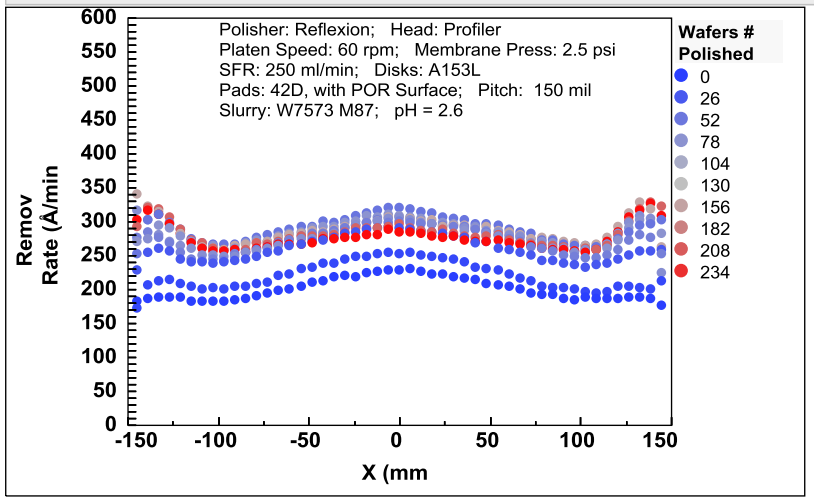
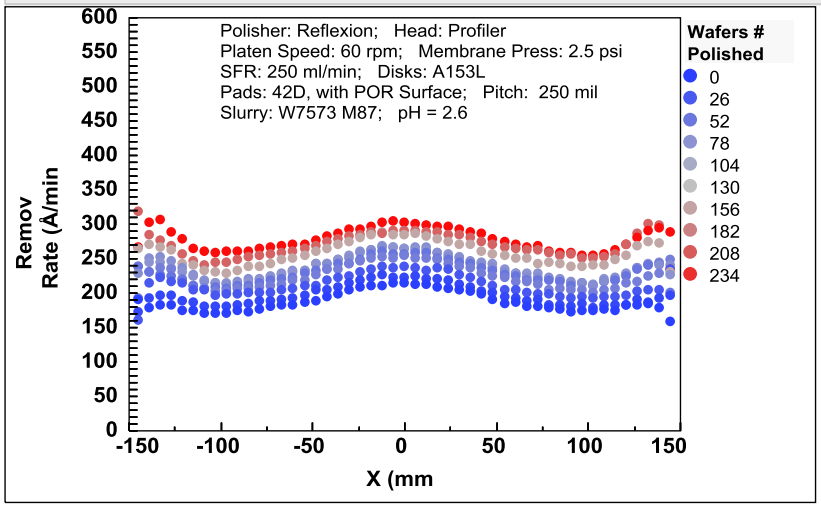
Removal Rate Profiles

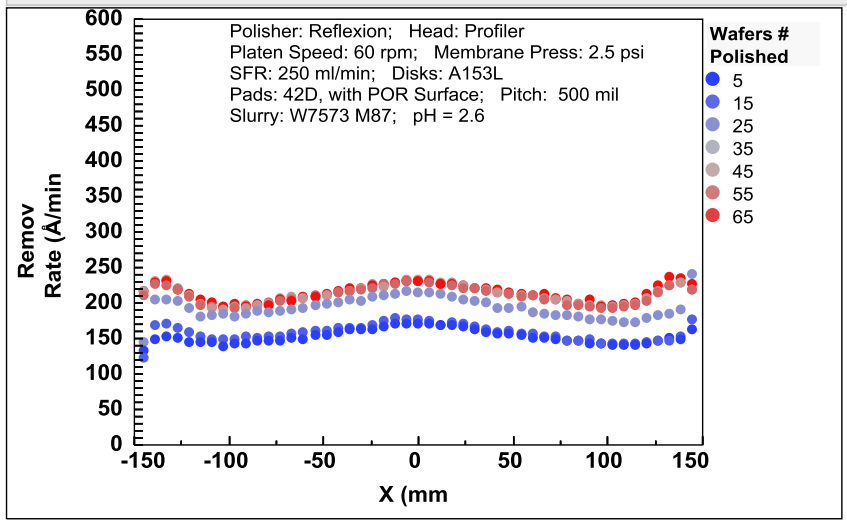
Bivariate Fit of Removal Rate (Å/min) By X (mm) Pitch=150, Wafer Type=TEOS, PS=60



Bivariate Fit of Removal Rate (Å/min) By X (mm) Pitch=250, Wafer Type=TEOS, PS=60



Bivariate Fit of Removal Rate (Å/min) By X (mm) Pitch=500, Wafer Type=TEOS, PS=60



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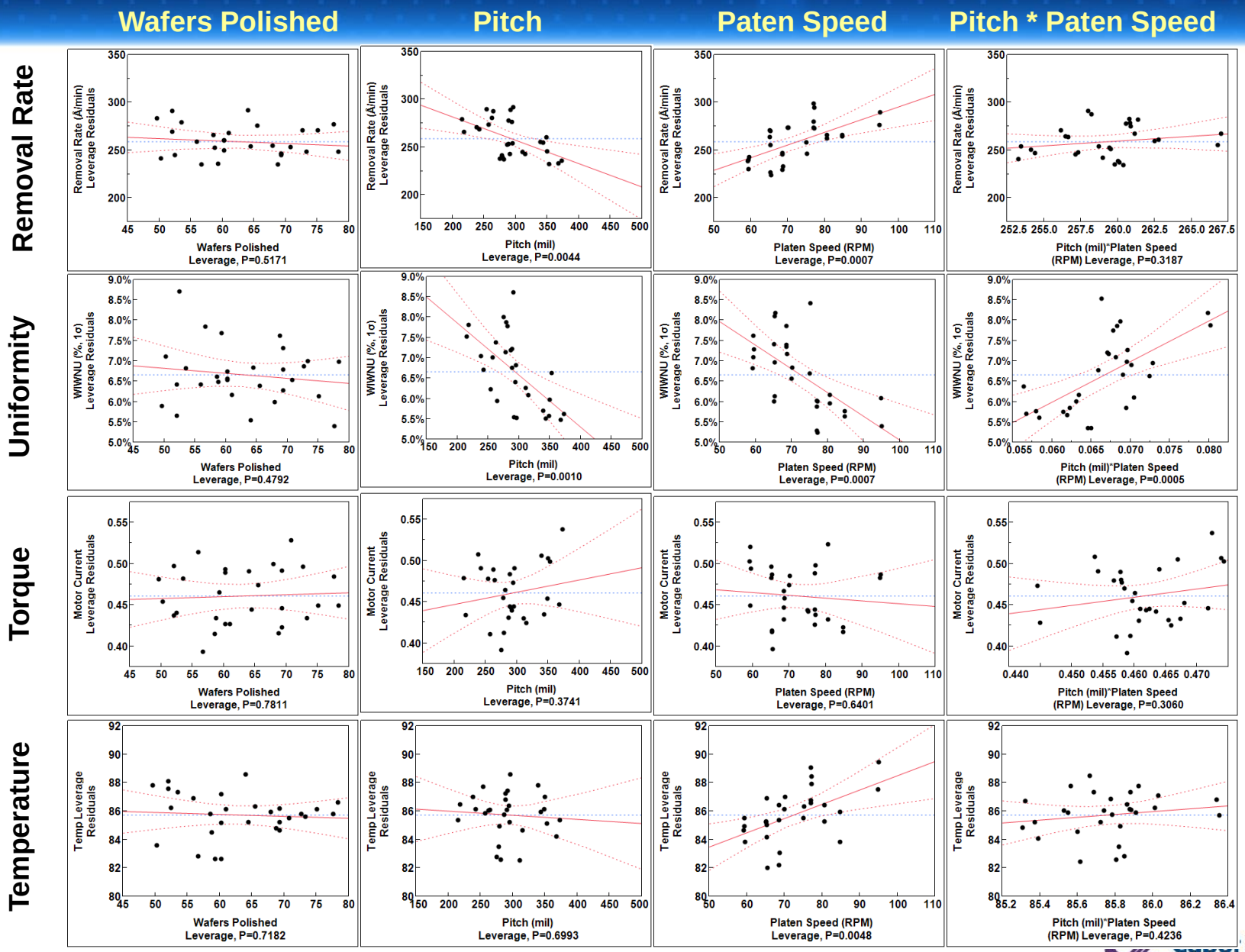
Platen Speed DOE Part Only (wafers 50-78)



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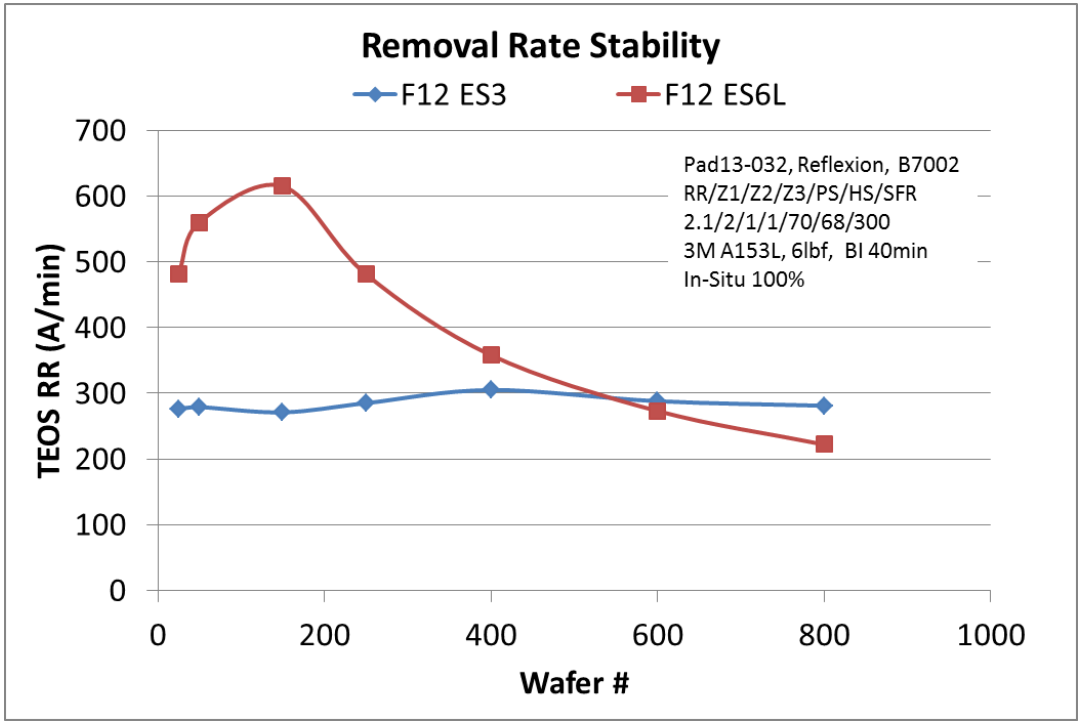
Pad13-032: Soft Pad RR Stability Test

Wei Fan

Pad Application Team

4/4/2013

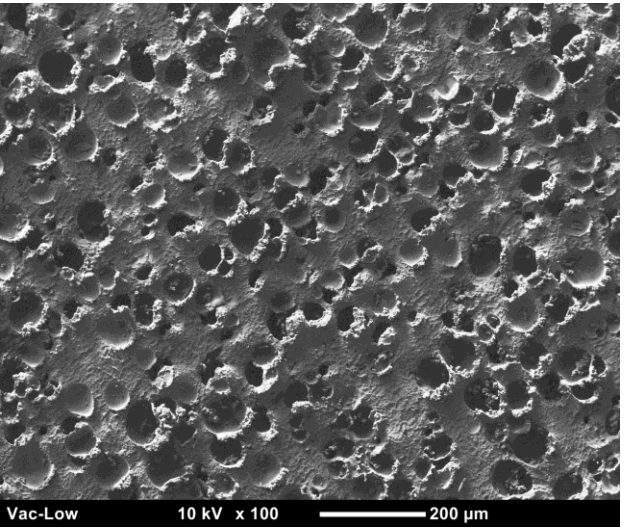
F12 RR Stability



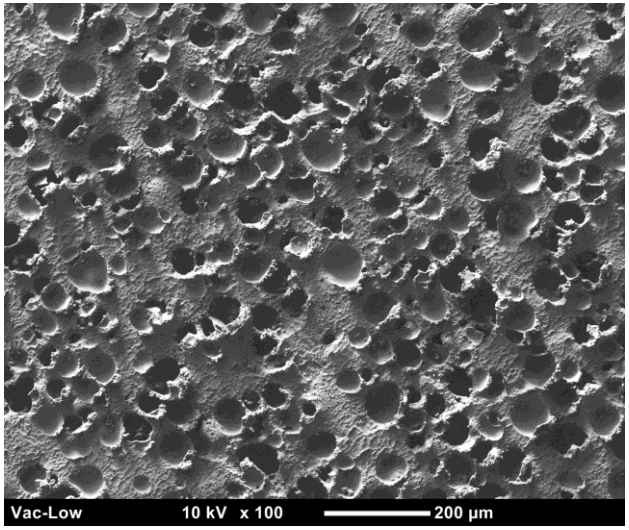
- ES6 achieves high removal rate, but not stable.
- ES3 has good RR stability.

F12-ES3 Pad Surface

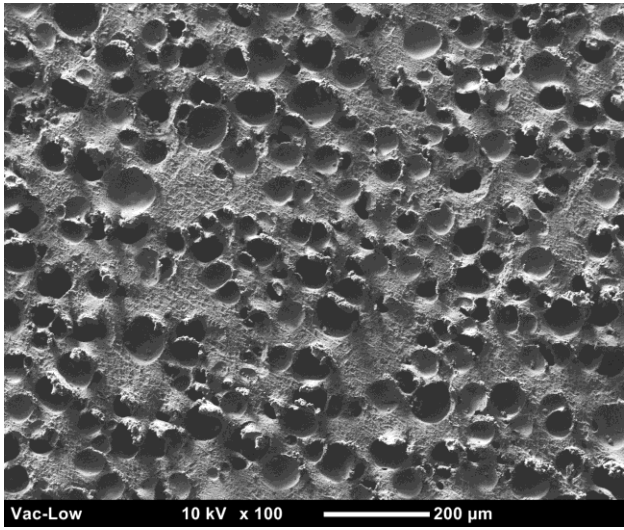
Pre



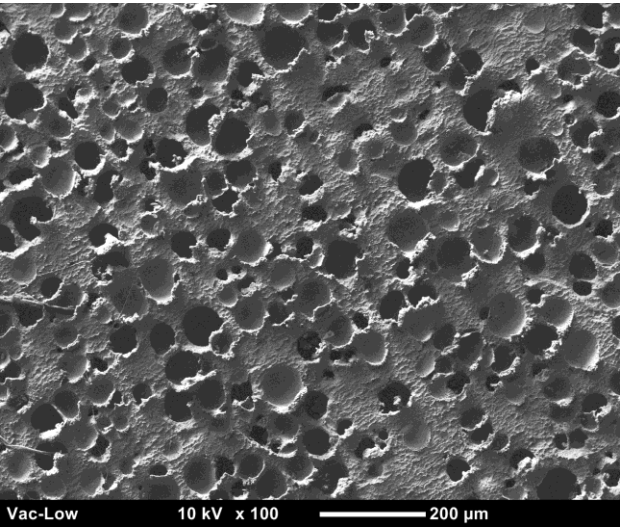
10min break-in



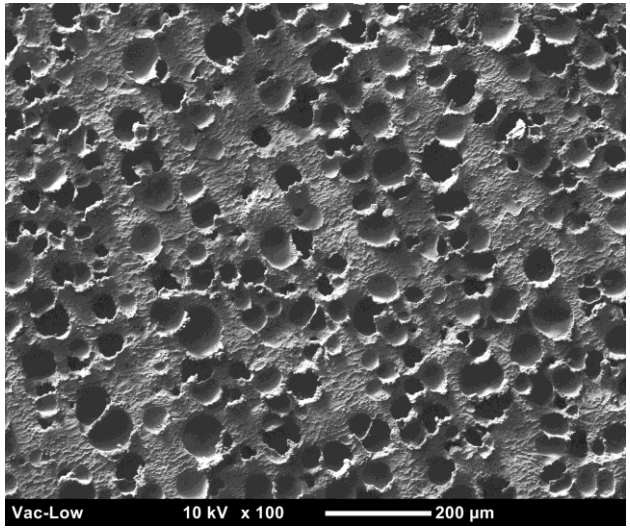
14 wafers polished



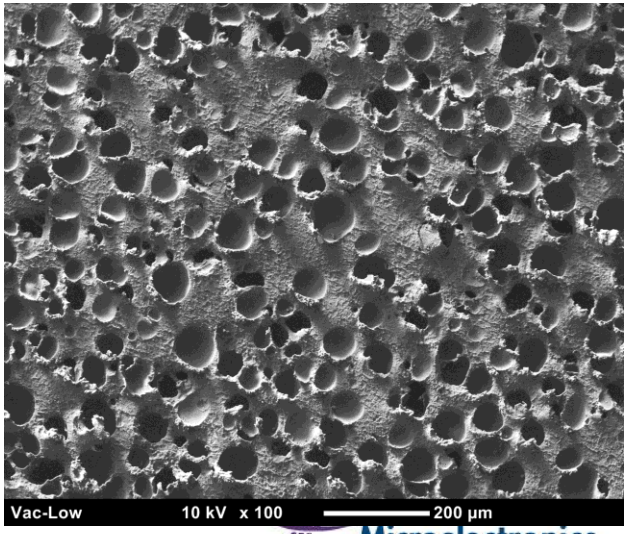
30min re-break-in



51 wafers polished

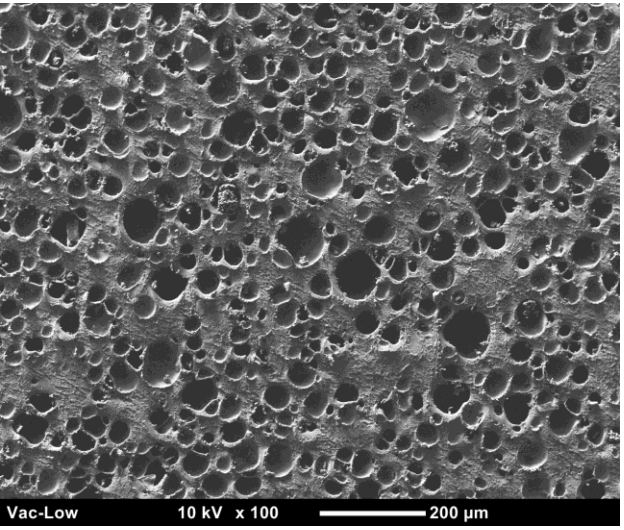


600 wafers polished

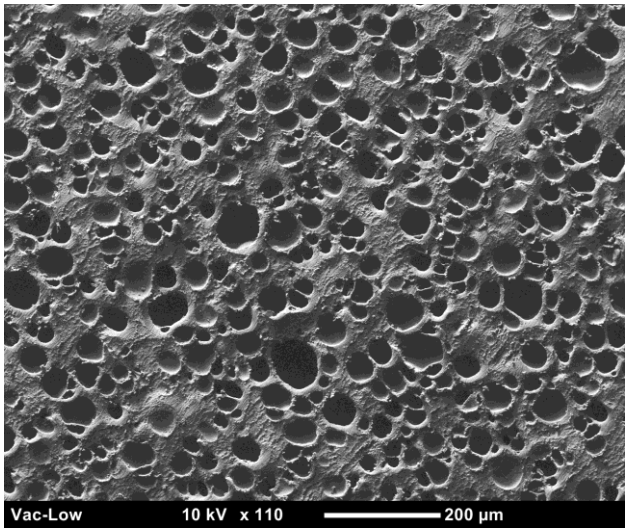


F12-ES6L Pad Surface

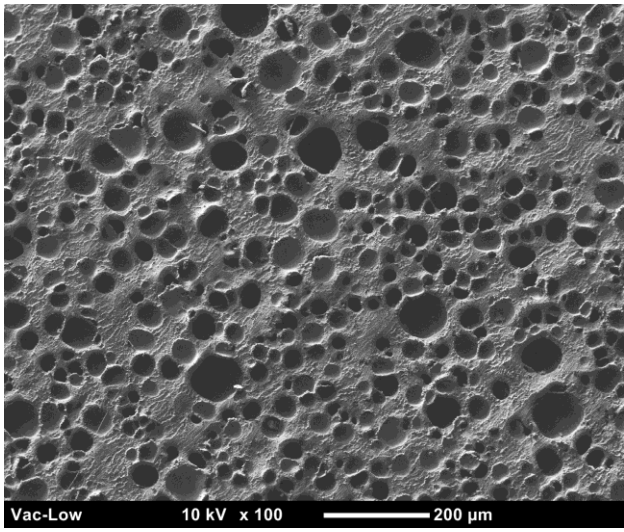
Pre



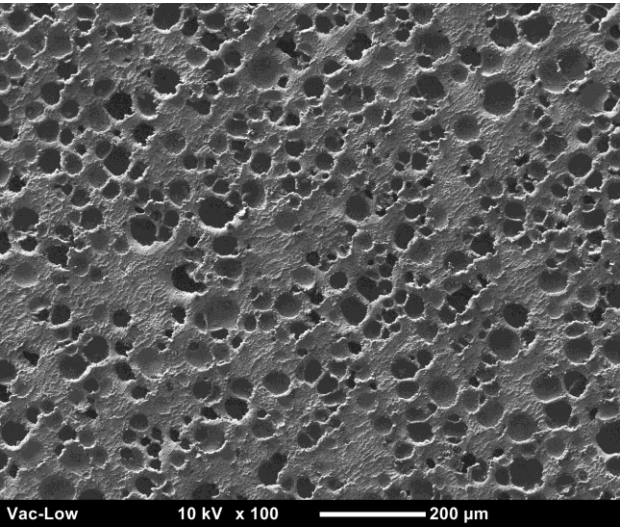
10min break-in



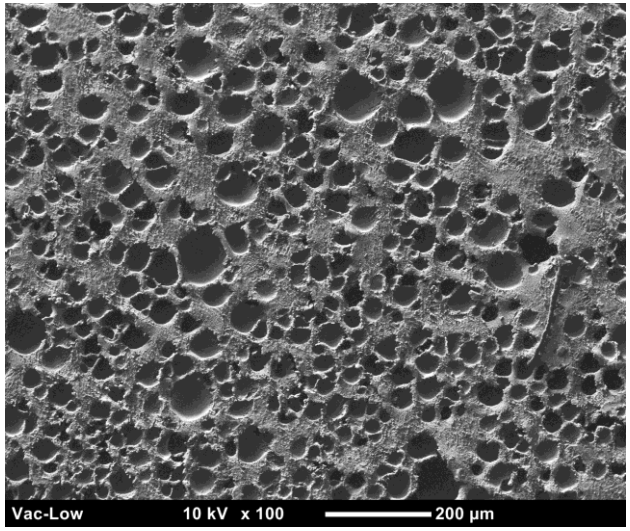
14 wafers polished



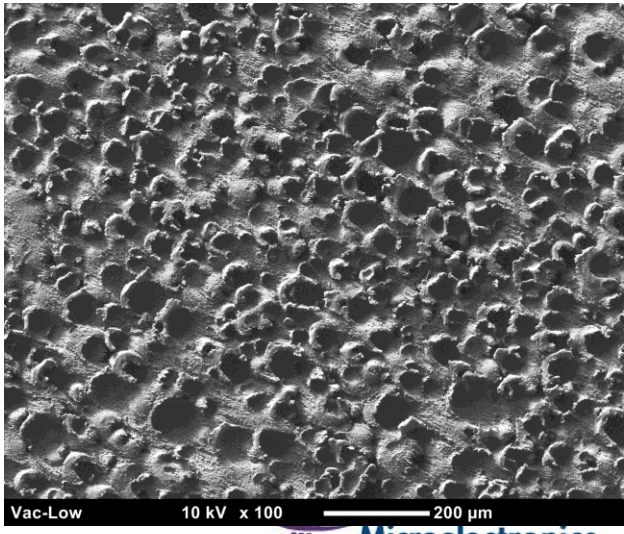
30min re-break-in



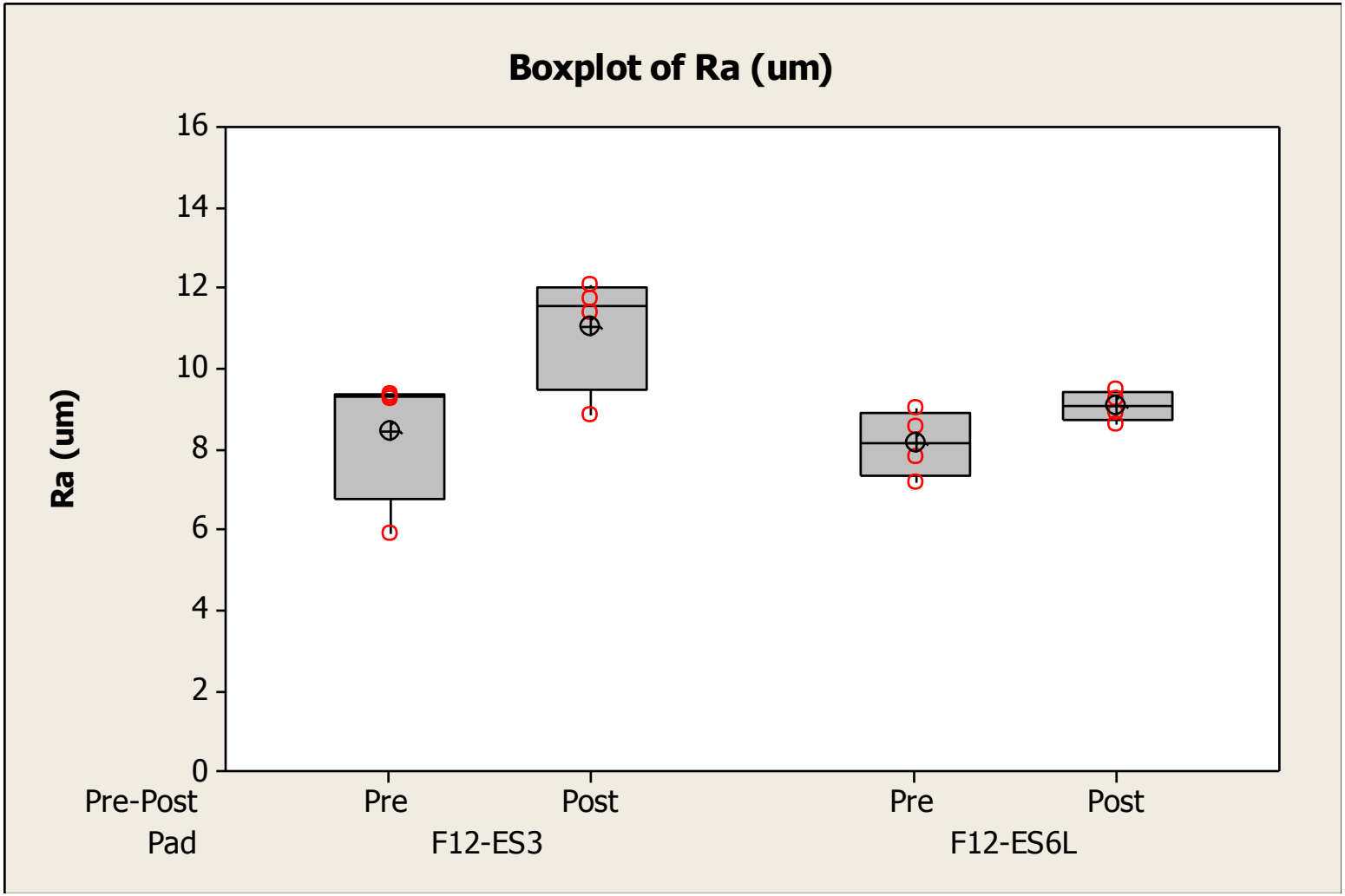
51 wafers polished



600 wafers polished



F12 Roughness Change After Polishing



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Ultrahigh Porosity Barrier Experiment X-Y vs. Concentric vs. Hexagonal

Pad13-039

Nathan Speer

Pad Application Team

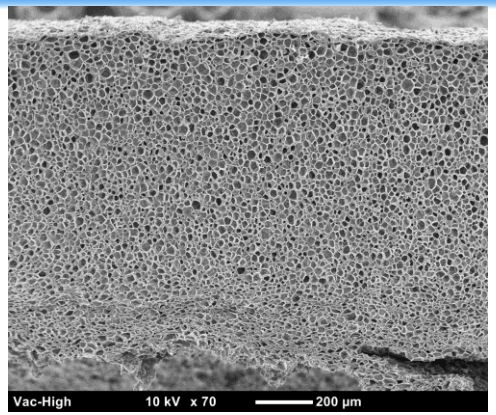
4/11/2013

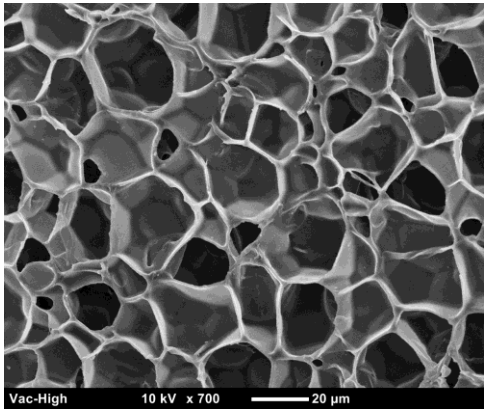
Experiment Details (Pad13-039)

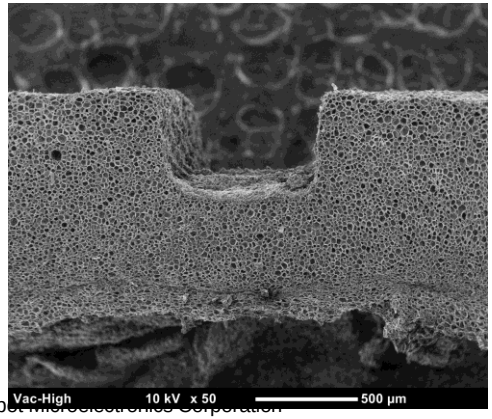
	Pad D200	Disk	Slurry	Polishing pressure (psi)	CDF (lbf)	Condition type	Total wafers run
Pad13-039	F9/42D UHP X-Y	A153L	B7002	1.5 psi	7	in-situ 100%	•1000 Wafers Total: •TEOS Monitor Wafers at 1, 5, 11, 18, 25, 32, 76, 111, 150, 300, 500, 700, 900, and 1000: •Performed down force ladder after wafer 500 •Changed P1 Slurry to B9631 after wafer 700, Monitor Wafers at 715 and 725. Then converted back to B7002
	F9/42D UHP Conc	A153L	B7002	1.5 psi	7	in-situ 100%	
	F9/42D UHP Hex	A153L	B7002 B9631 Wafers 701-725	1.5 psi	7	in-situ 100%	

SEM Cross Sections

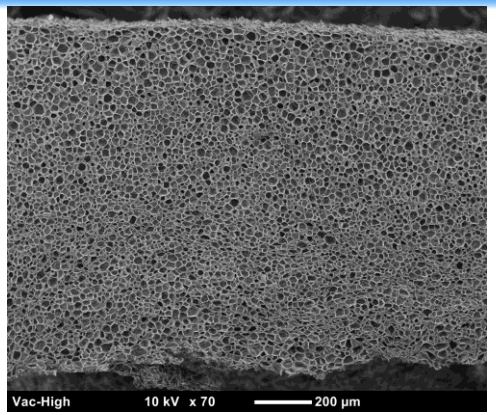
XY

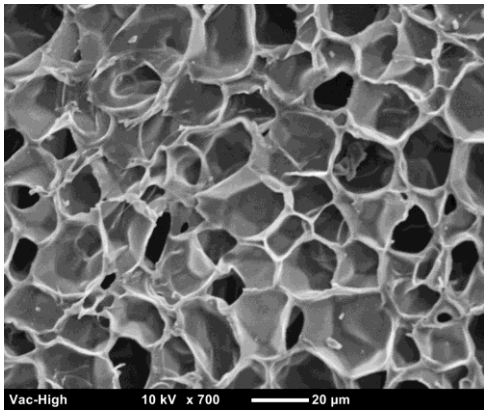


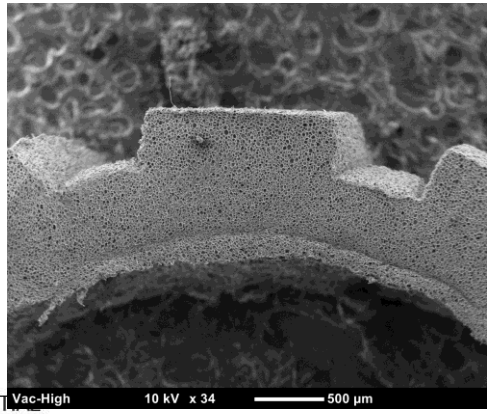




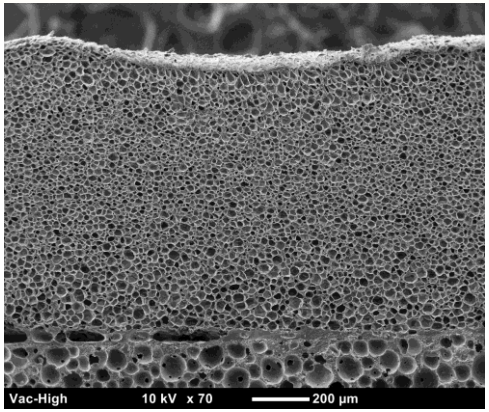
Concentric

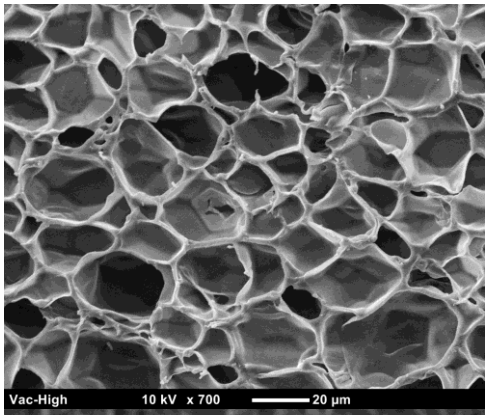


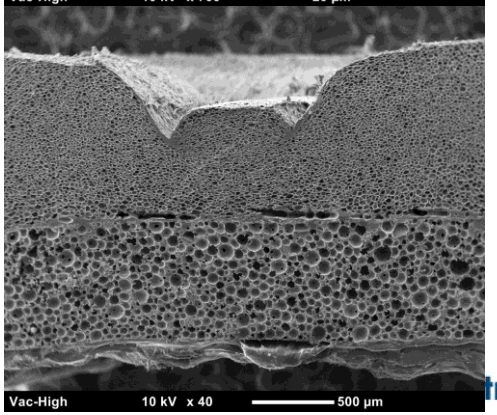




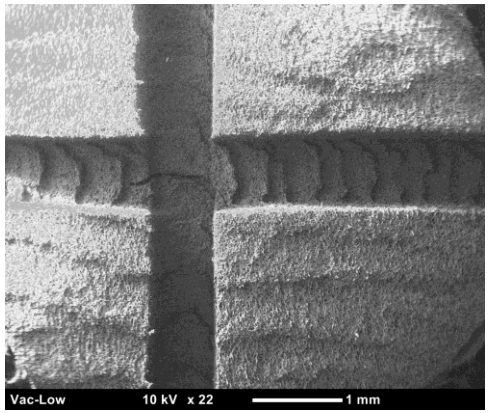
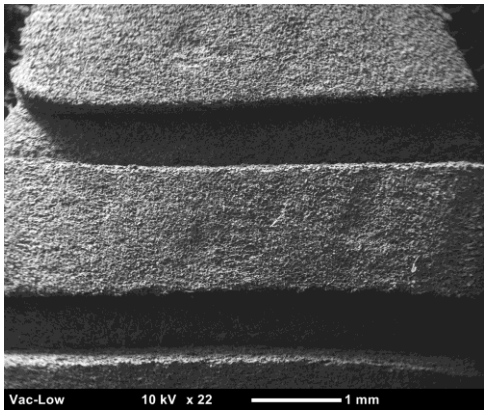
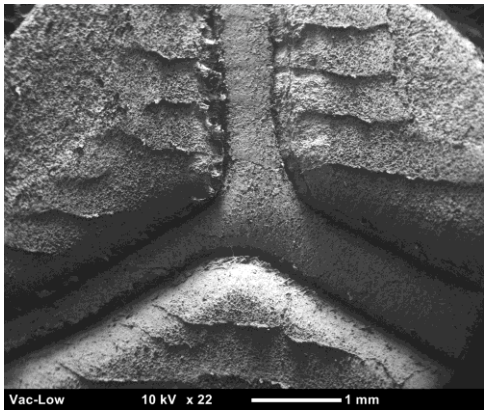
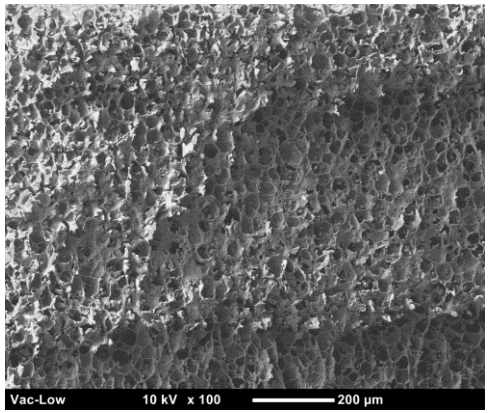
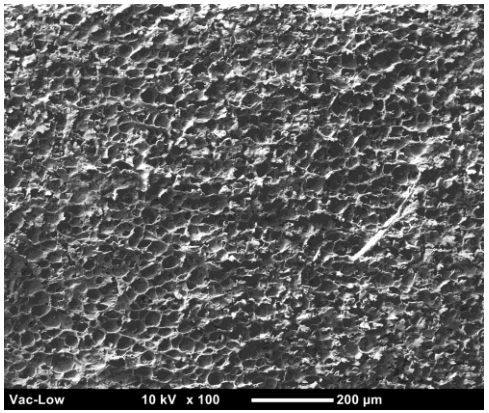
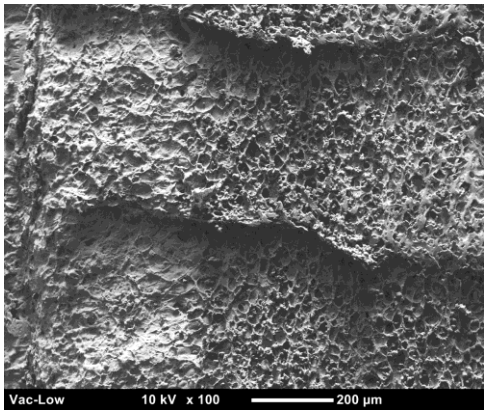
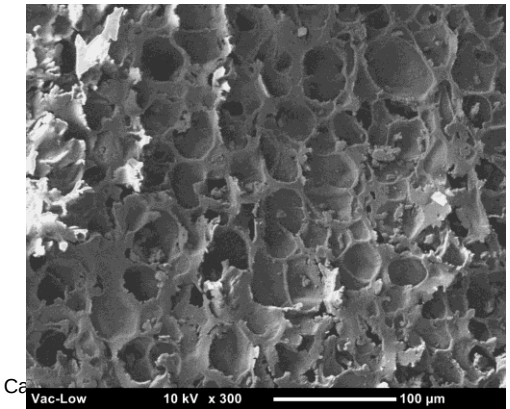
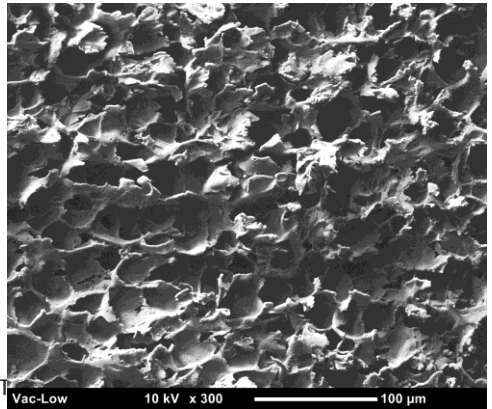
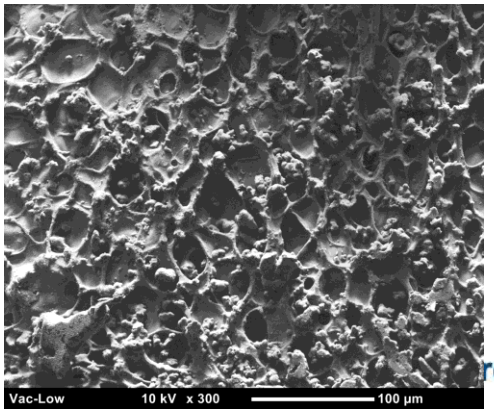
Hex



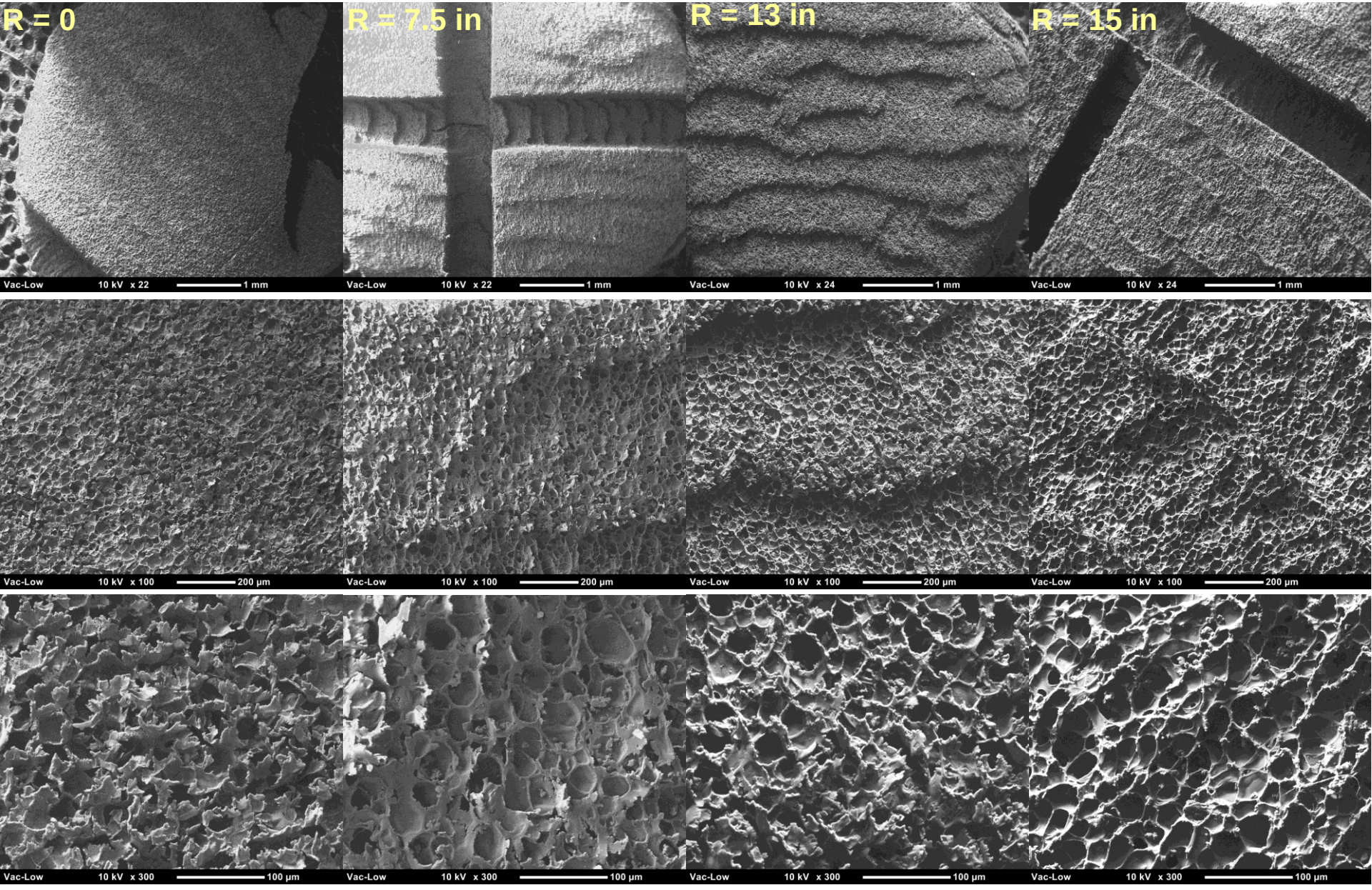




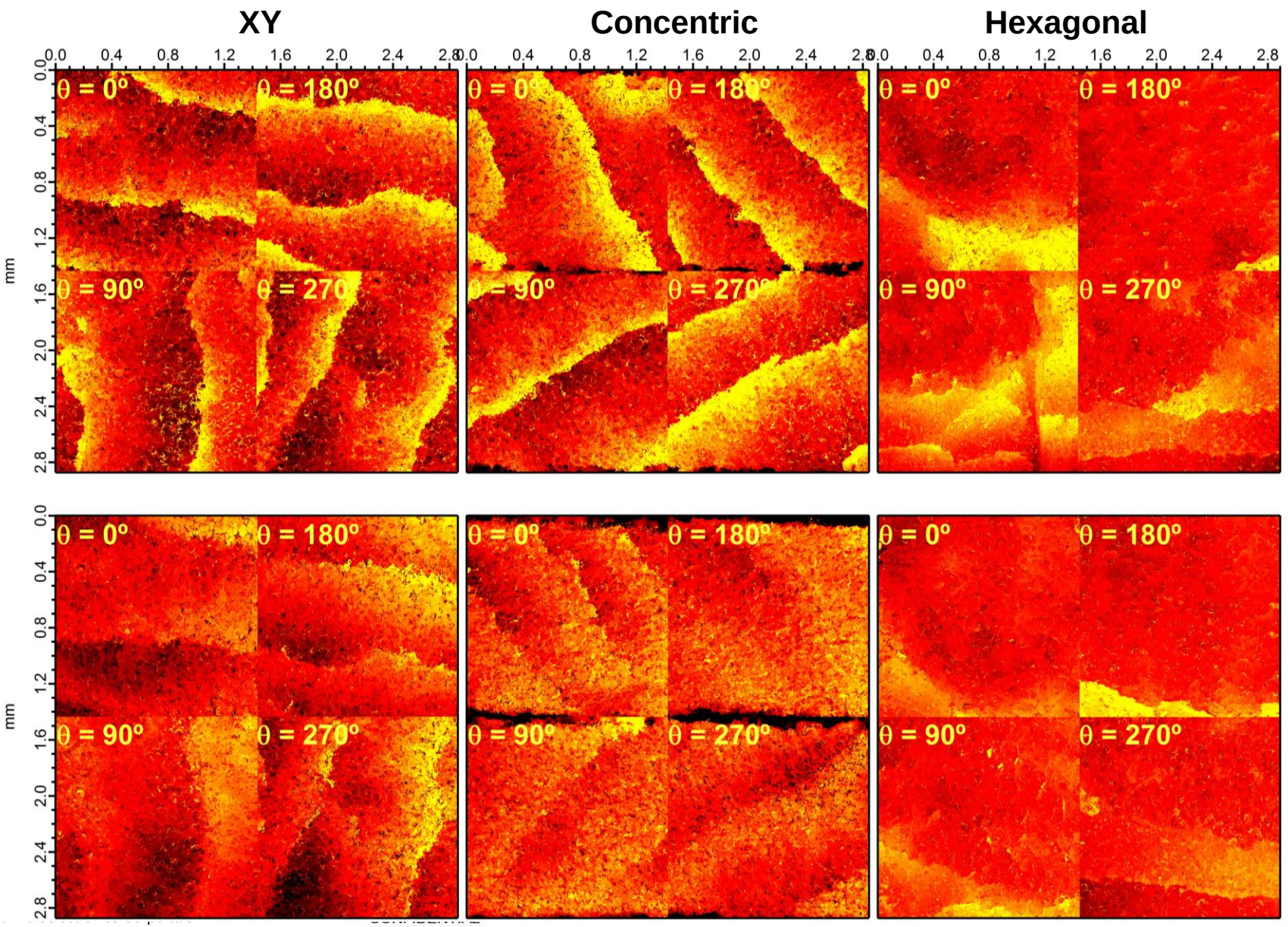
SEM Top-Down Images of Grooves

XY	Concentric	Hex
		
		
		

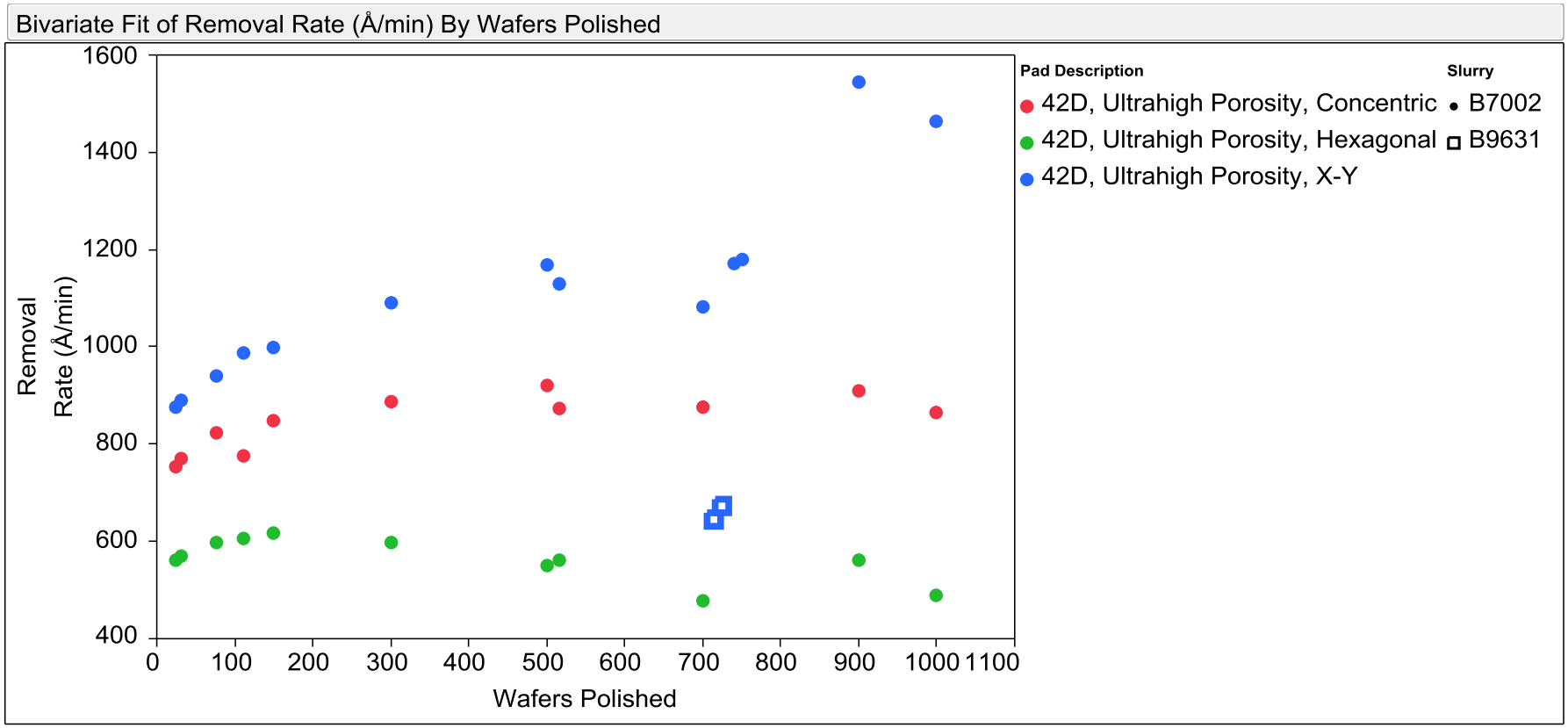
XY-Post-SEM Images (center vs. Edge)



Confocal Microscopy Images

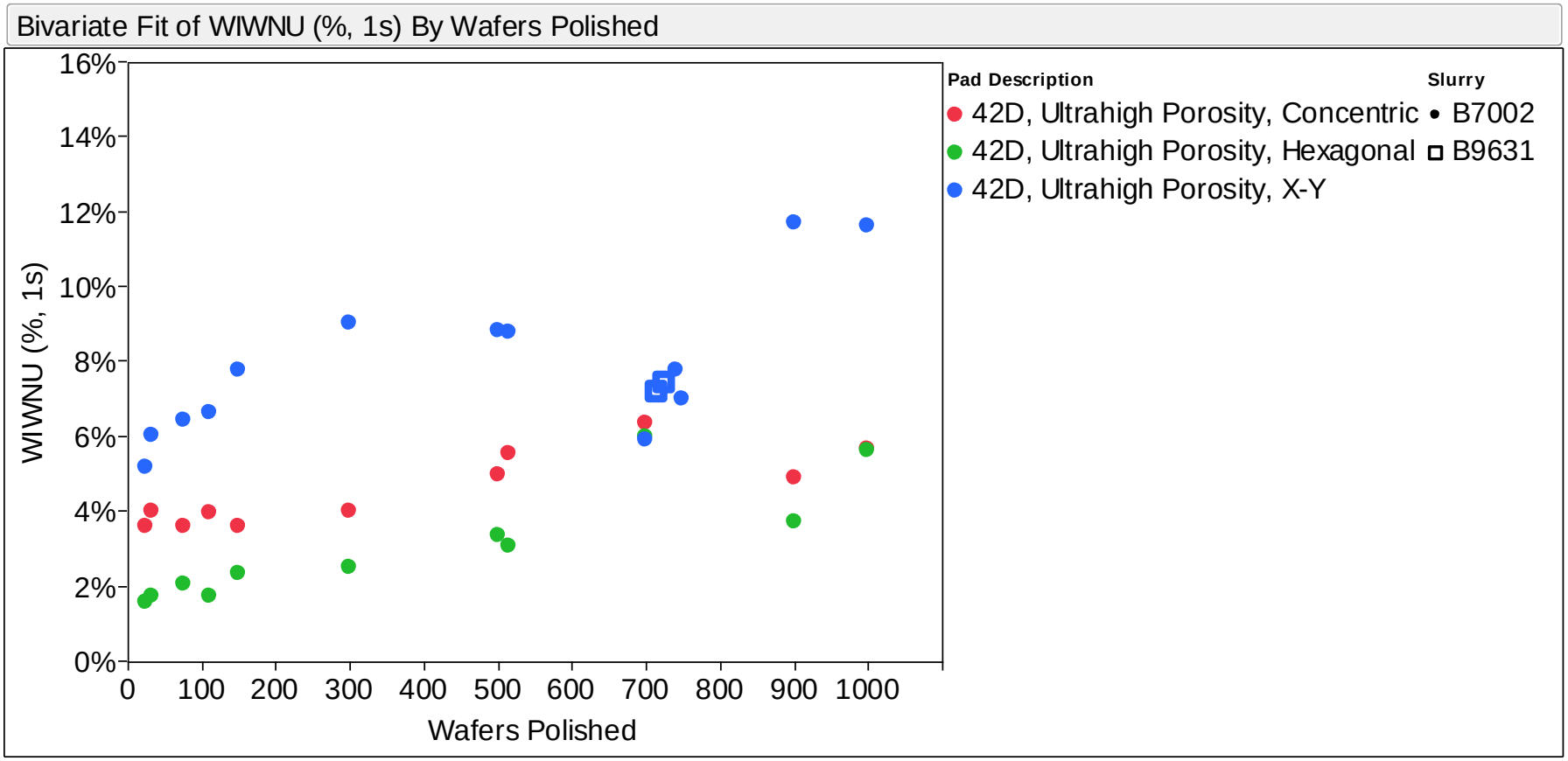


Removal Rate Trend

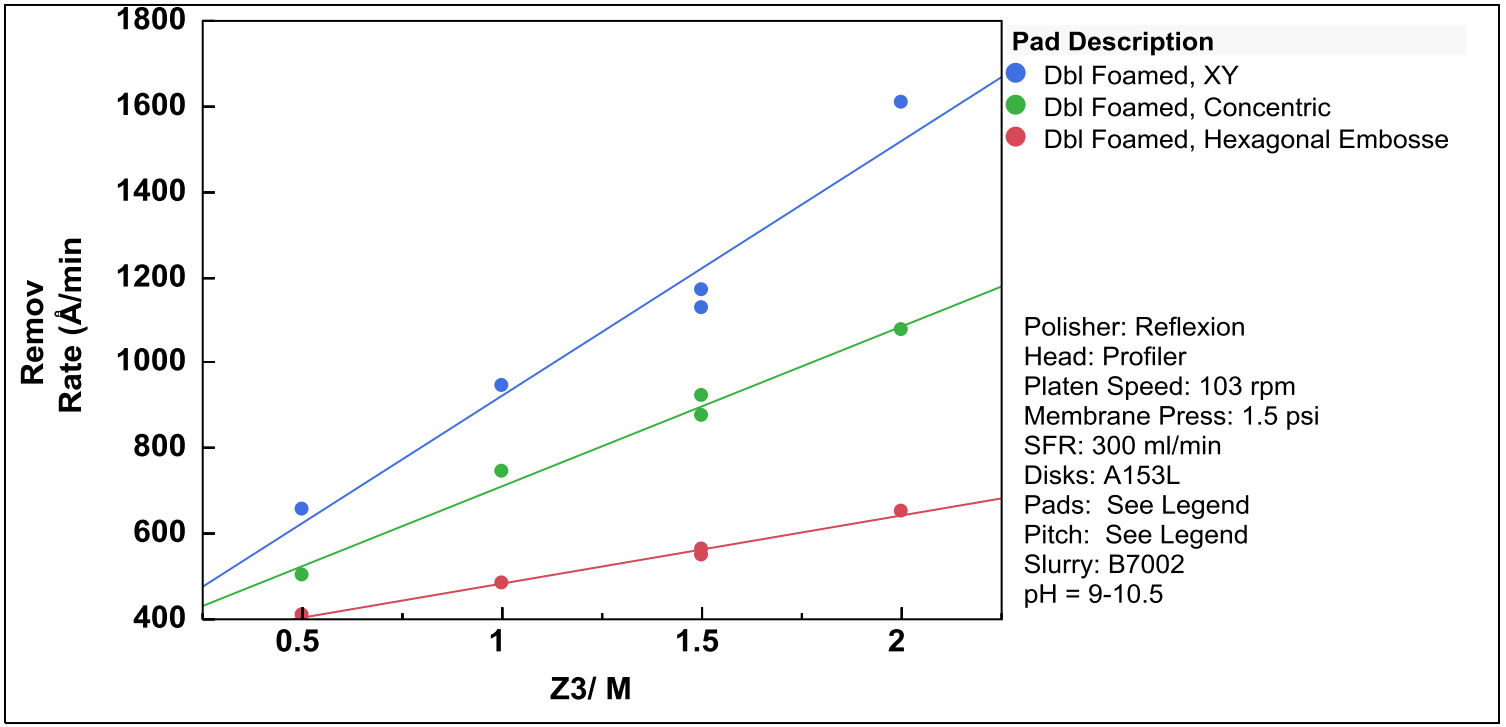


- **All Pads were relatively stable to 700 wafers. After 700 wafers, we spot checked B9631 slurry on the X-Y Pad (blue squares), removal rate recovered after spot check and then climbed sharply**

Uniformity Rate Trend



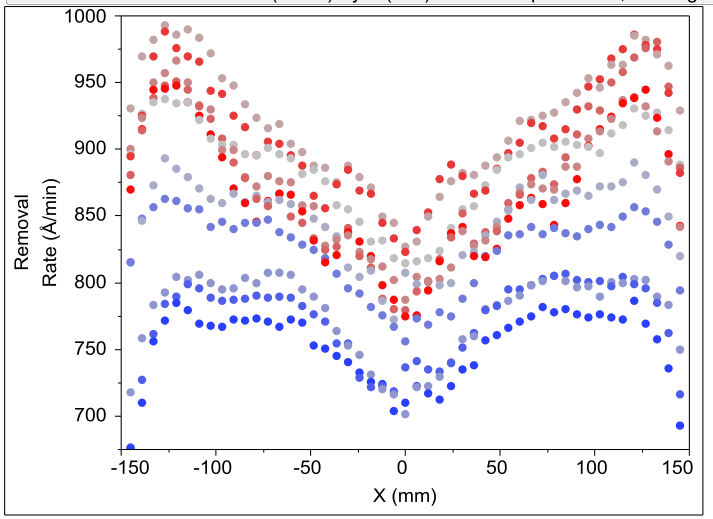
Removal Rate vs. Z3 Membrane Pressure (wafers 500 – 516)



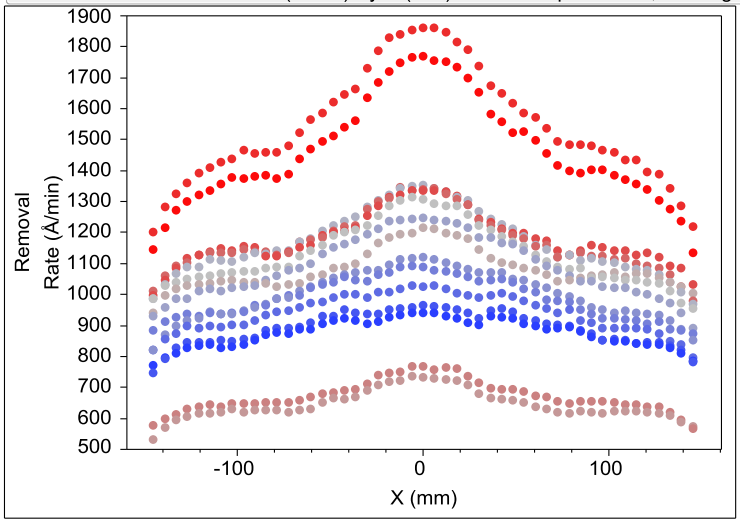
- **The removal rate response (slope) was different for each pad.**

Removal Rate Profiles

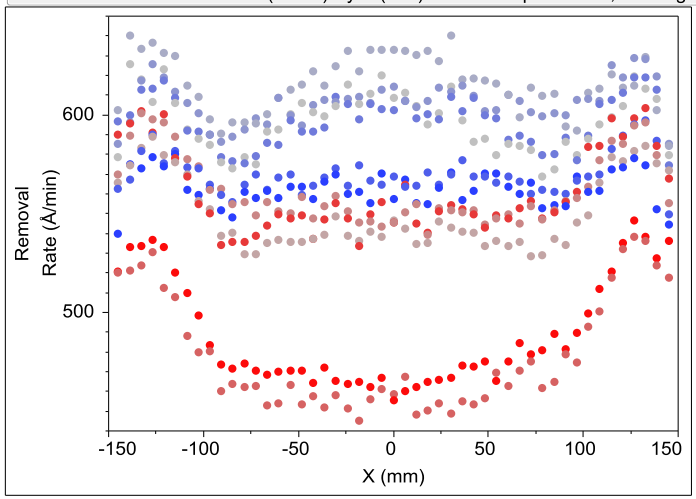
Bivariate Fit of Removal Rate (Å/min) By X (mm) Pad Description=42D, Ultrahigh Porosity, Concentric



Bivariate Fit of Removal Rate (Å/min) By X (mm) Pad Description=42D, Ultrahigh Porosity, X-Y



Bivariate Fit of Removal Rate (Å/min) By X (mm) Pad Description=42D, Ultrahigh Porosity, Hexagonal



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Conclusions

- Soft pad process stability most likely caused by slow changes in pad surface (global flatness, local roughness)
- Surface changes in soft pads are usually slower than in hard pads
  - Pad/conditioner interaction
- Subtle changes in groove pitch affected process stability
- It is possible to make the surface “too smooth”
- Ultrahigh porosity looks interesting
  - More effective conditioner interaction?