

3M™ Trizact™ Pad Conditioners for FEOL Tungsten Plug and Metal Gate Applications

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3M™ Trizact™ Pad Conditioner Marathon Testing

■ W plug process with Trizact™ B5-M990-5S2

- 30 hour marathon (TOX dummy wafers and W monitor wafers measured every hour),
 - Consumable set B (ex-situ conditioning) :
 - Slurry B/Pad B with
 - 3M Trizact B5-M990-5S2 disk (commercial)
 - Sintered abrasive A165 disk (POR)

■ W metal gate process with Trizact™ B6-M990-5S2

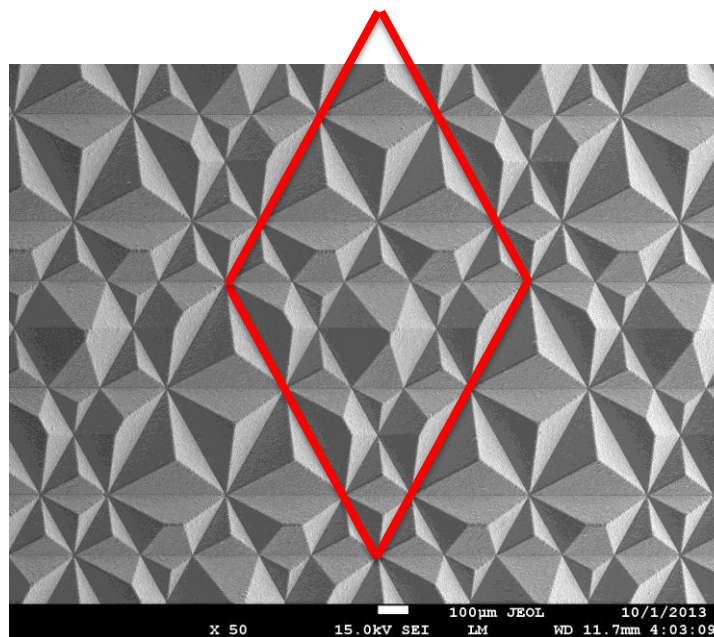
- 20 hour marathon (TEOS and W monitor wafers measured every hour)
 - Consumable set B (ex-situ conditioning):
 - Slurry B/Pad B with
 - 3M Trizact B6-M990-5S2 (experimental)
 - Sintered abrasive A165 disk (POR)



Conditioner Description



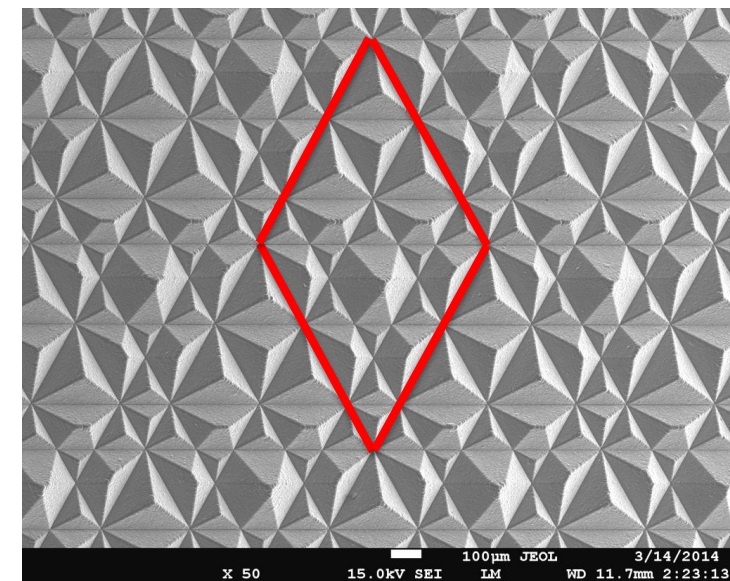
- B5-M990-5S2 (MC3113)
 - Nominal Primary Tip height 160μm
 - ~5% Primary tips
 - Complex Multi-faceted structure
 - Aspect ratio: sharp



Commercial

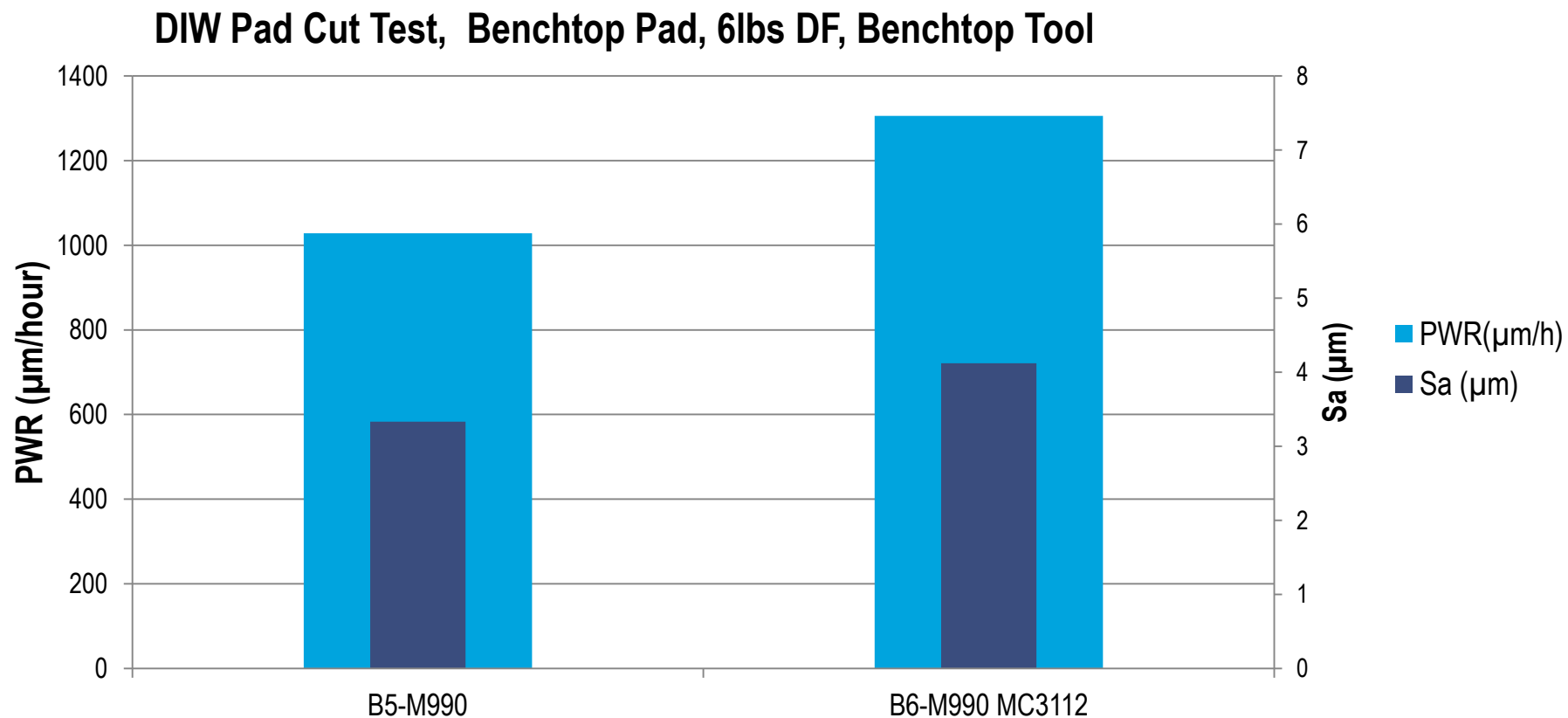


- B6-M990-5S2 (MC3112)
 - Nominal Primary Tip height 160μm
 - ~5% Primary tips
 - Complex Multi-faceted structure
 - Aspect ratio: sharper



Experimental

Trizact™ B5-M990-5S2 and B6-M990-5S2 PWR and SF BenchTop Data



PWR, SF: Trizact B6 > Trizact B5 .

Tool Conditions (Bulk W Test) (P1 and P2) – 300 mm AMAT Reflexion™

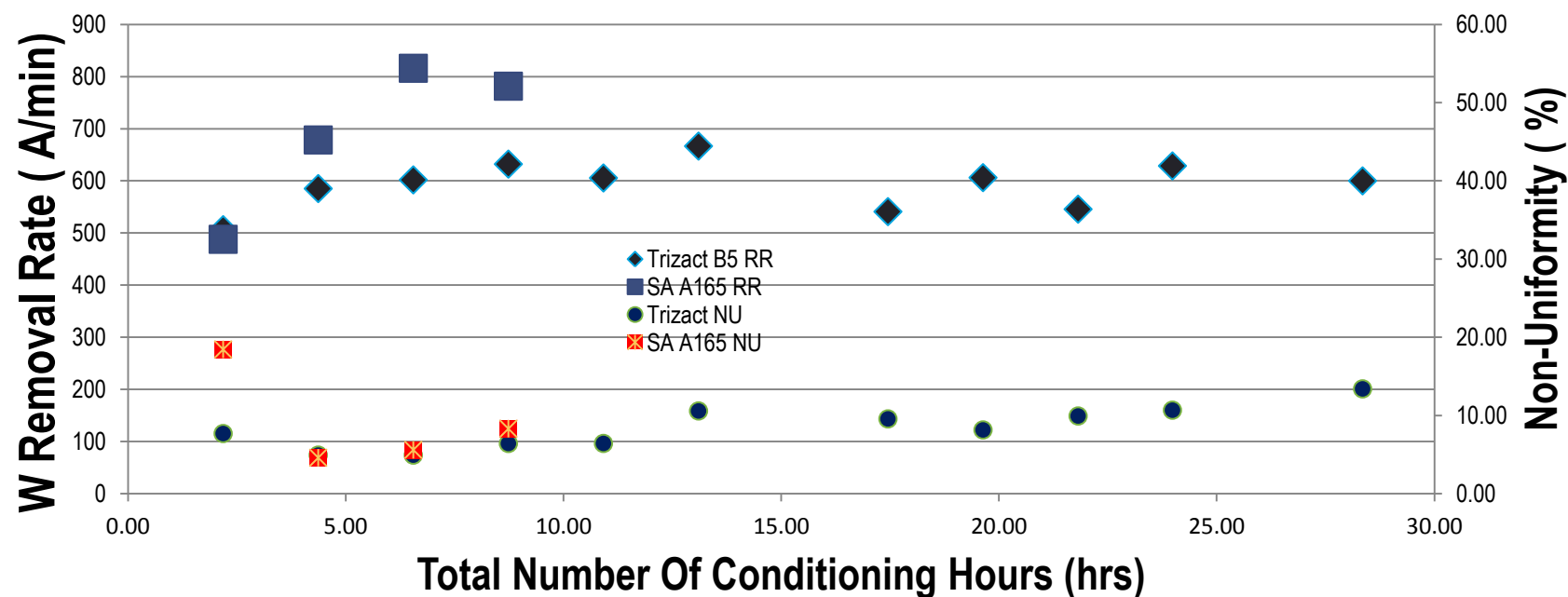
Polish Head and Platen Settings	
Platen Speed	73 rpm
Head Speed	67 rpm
High wafer df	RR=3.8, Z1=3.3, Z2=1.6, Z3=1.4, Z4=1.3, Z5=1.3 psi
Slurry Flow Rate	300 mL/min
Head Sweep	Sinusoidal sweep, 10 zones
Zones	7.00 to 8.02 inches
Slurry	W slurry B
Pad	Pad B
Polish Head	Contour
Dummy Wafers	Thermal Oxide
Rate Monitor	W wafer

Conditioner Settings	
Head Speed	81 rpm
Sweep	Linear sweep, 19 sweeps/min
Zones	2.5" (a) to 12.75" (b)
Conditioning Time	60 secs (100% ex-situ)
Cond downforce	9 lbs
Break-in Cond downforce	9 lbs for 30 mins (in DIW, ex-situ)
Note (a)	may require adjustment to avoid collision with polish head
Note (b)	disk must not travel beyond 12.75"

All consumables and parameters including the downforce on the wafer (1.3 psi vs 2.5 psi) for this test selected based on customer's input

Marathon Test With Slurry B and Pad B Trizact™ B5-M990-5S2 and SA A165 (ex-situ)

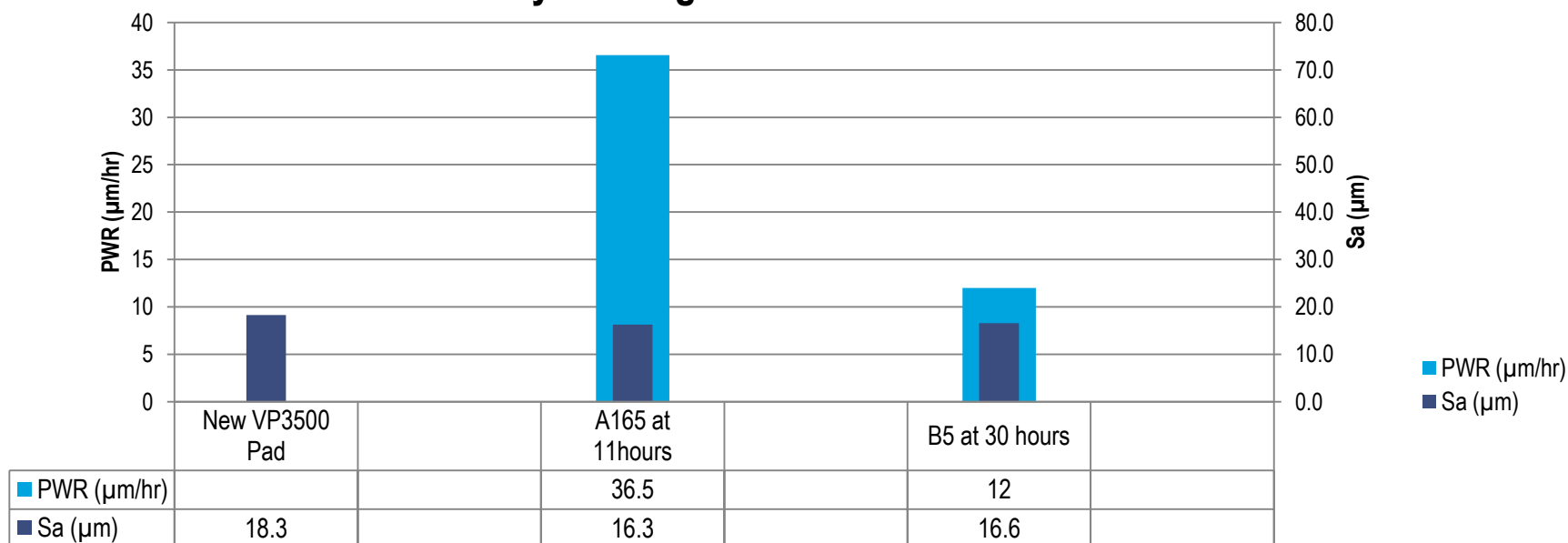
Extended Run Process Results: W RR and NU, 3M Trizact B5, SA A165, 9 lbs
CDF, 1.4 psi Wafer df, W Slurry B, Pad B



W Slurry B and Pad B (ex-situ conditioning) – Longer life and more stable RR/NU with Trizact B5 vs SA A165.

Pad Wear Rate (PWR) and Surface Finish Using Laser Groove Depth Analysis (LGDA) for Trizact™ B5-M990-5S2, and SA A165 with Pad B and Slurry B at 30 hrs

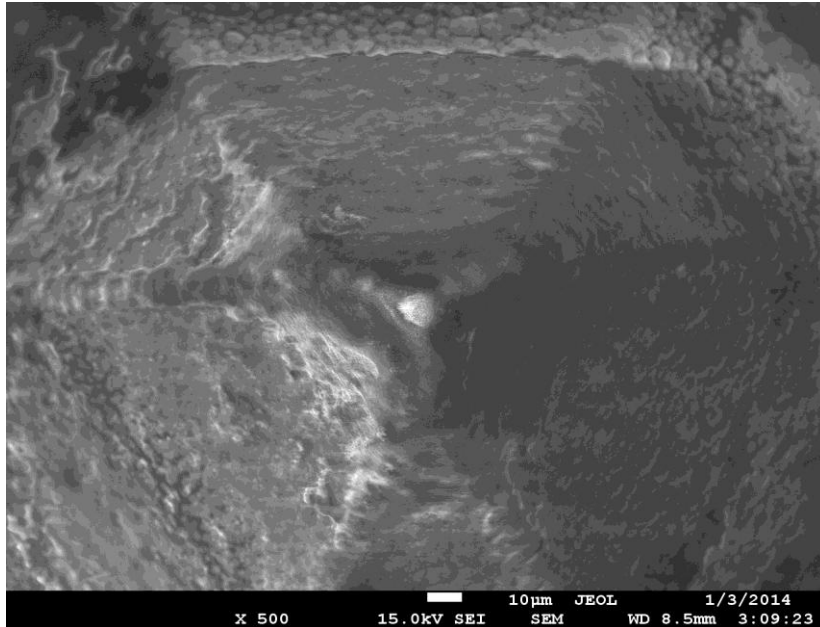
Pad Wear Rate and Surface Finish for Trizact B5-M990-5S2, SA A165, Pad B, Slurry B Using LGDA ex-situ



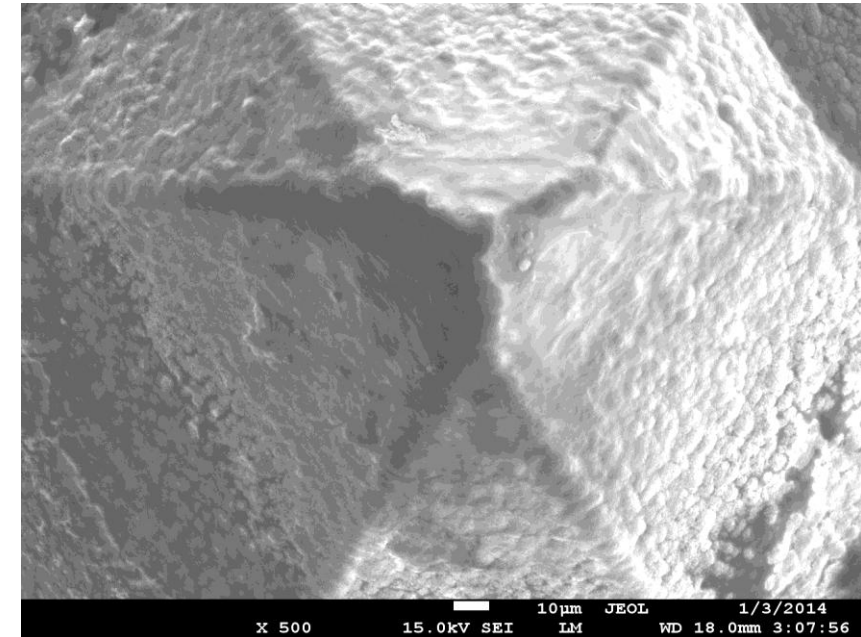
Pad wear rate was at least 3 to 4 times higher with SA A165 vs Trizact B5. Surface finish was the same.

SEM Images – Trizact™ B5 after Marathon Test (Ex-situ Conditioning)

SE imaging

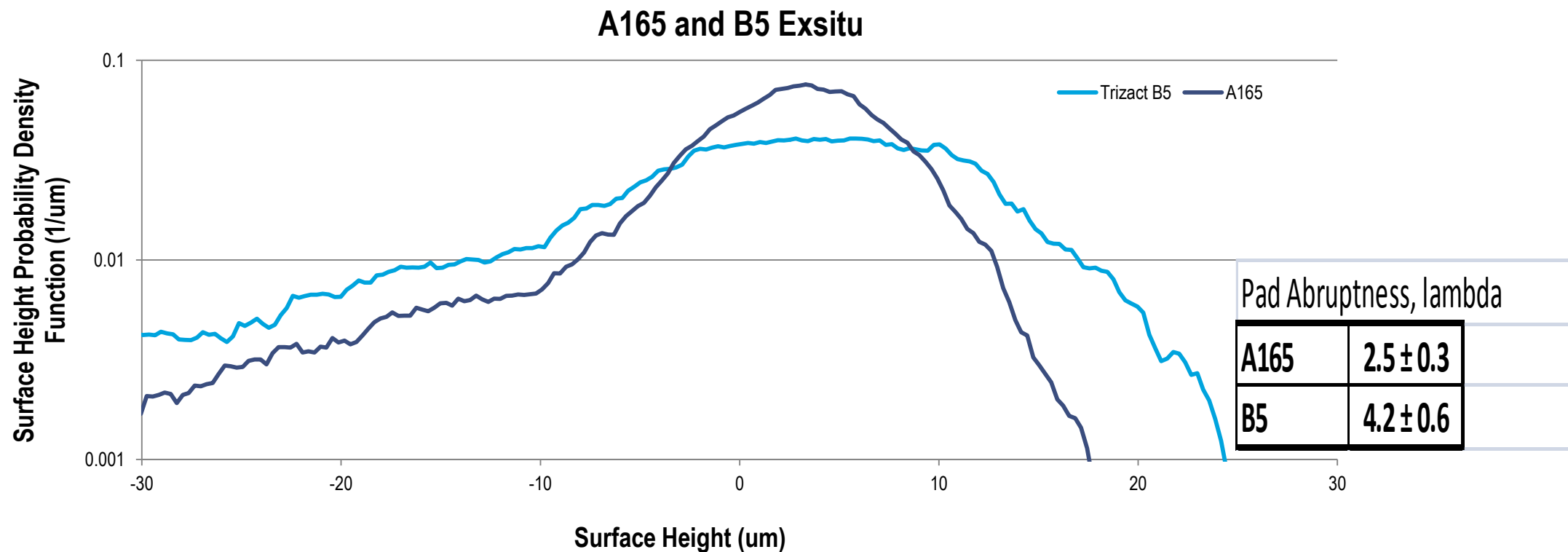


BSE imaging



CVD Coating is intact after 30 hours of ex-situ conditioning (100%) with Trizact B5

Pad Asperity Distribution Analysis (A165, Trizact™ B5 –M990-5S2) , Pad B, Slurry B, Ex-situ at 30 hours

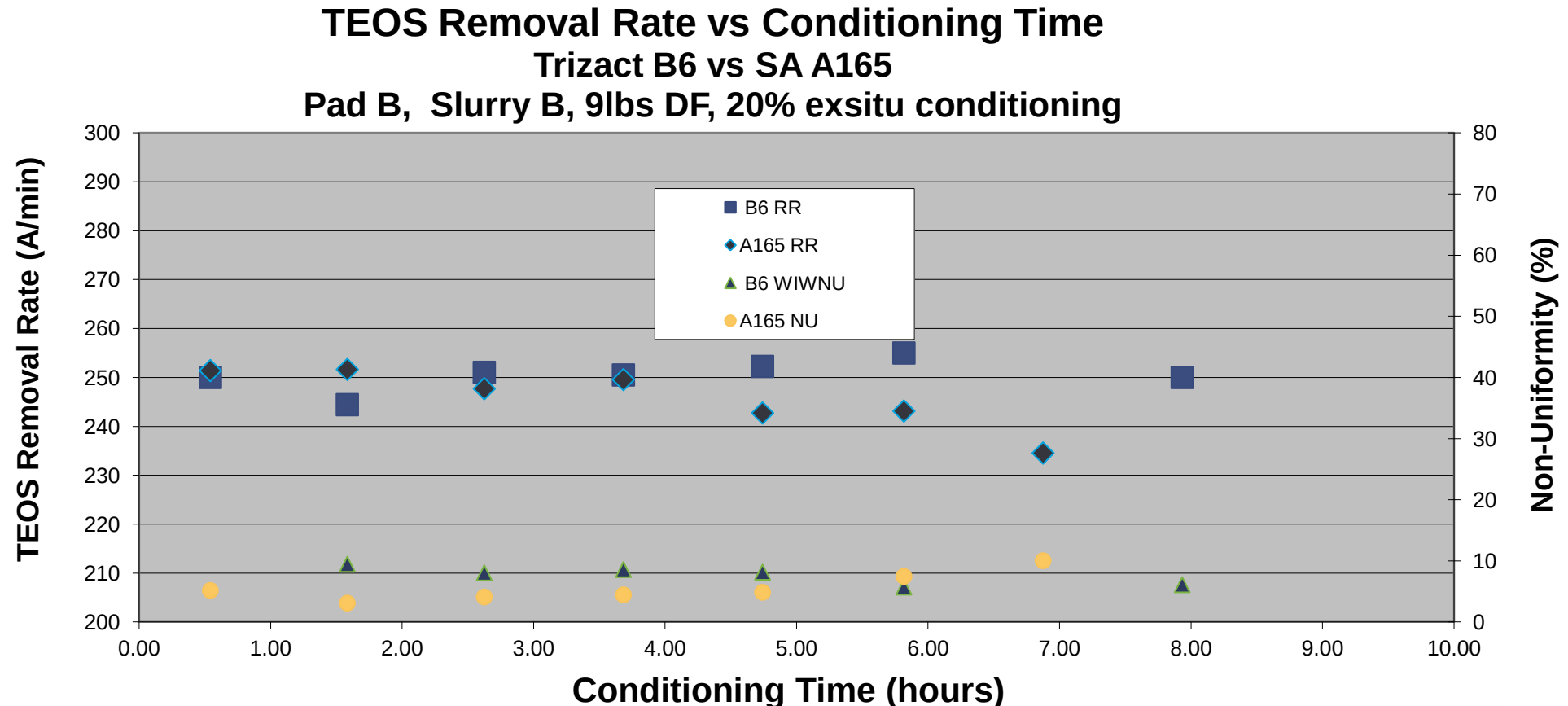


Pad abruptness, lambda is higher and asperity truncation is smaller with pad associated with Trizact B5-M990-5S2 compared to pad conditioned with SA A165 at 30 hours.

Trizact™ Pad Conditioner: Tungsten Gate CMP Process Development

- W Metal Gate or Buff (20% ex-situ conditioning; 9 lbs df, 1.4 psi wafer df)
 - Slurry B/Pad B/ Trizact B6-M990-5S2
 - Benchmark: A165 conditioning disk (POR)
 - Performance Target: Stable TEOS RR (250 A/min)
 - Consumable Life Target: Conditioner: **20 hours; 7000 wafers** (**Current baseline (~3 hours; 1000 wafers)**)

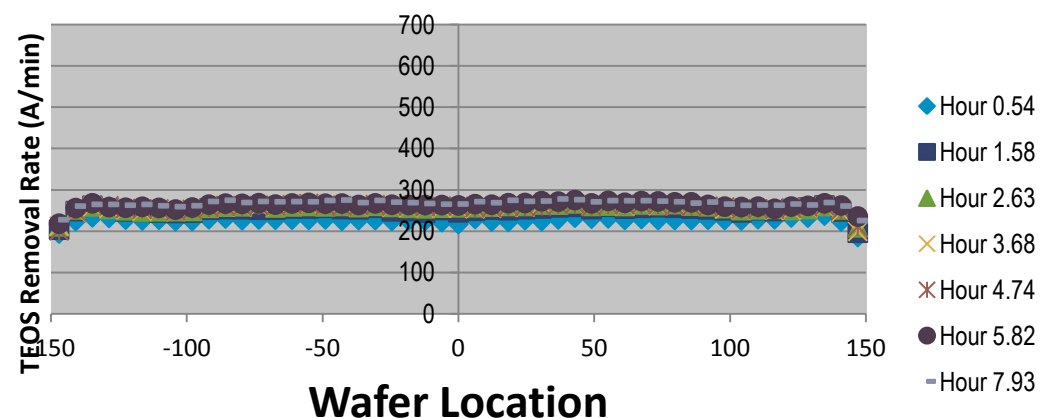
W CMP Gate Buff Process With Trizact™ B6 and SA A165 With Slurry B and Pad B



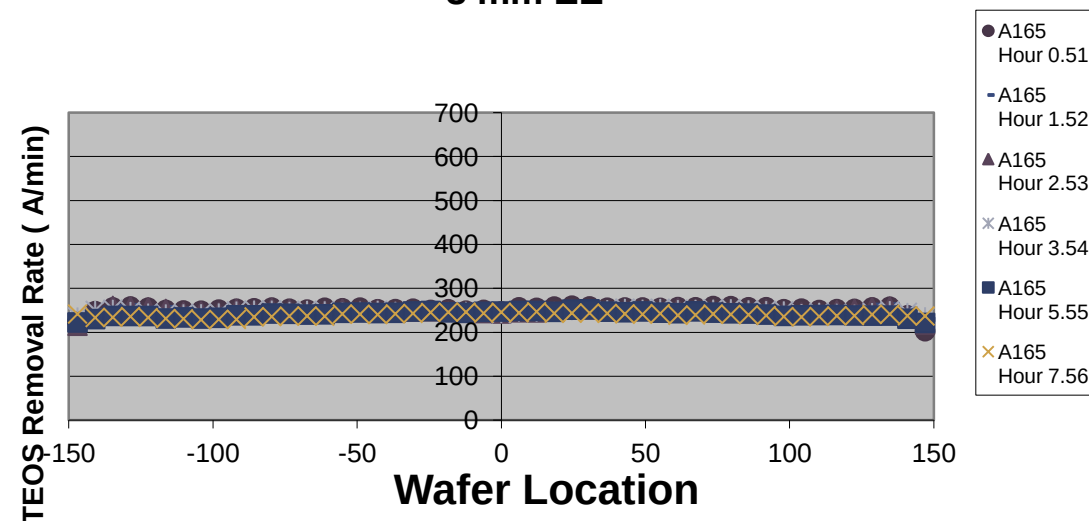
Trizact B6 rate remained stable throughout the test close to the target rate of 250 A/min. The rate drops off with A165 primarily due to pad balding.

W Metal Gate - TEOS Removal Rate Profiles – Pad B, Slurry B,

TEOS Wafer Profiles, 3M Trizact B6
Pad B, Slurry B, 9lbs DF, 1.4 psi, 20% exsitu
conditioning

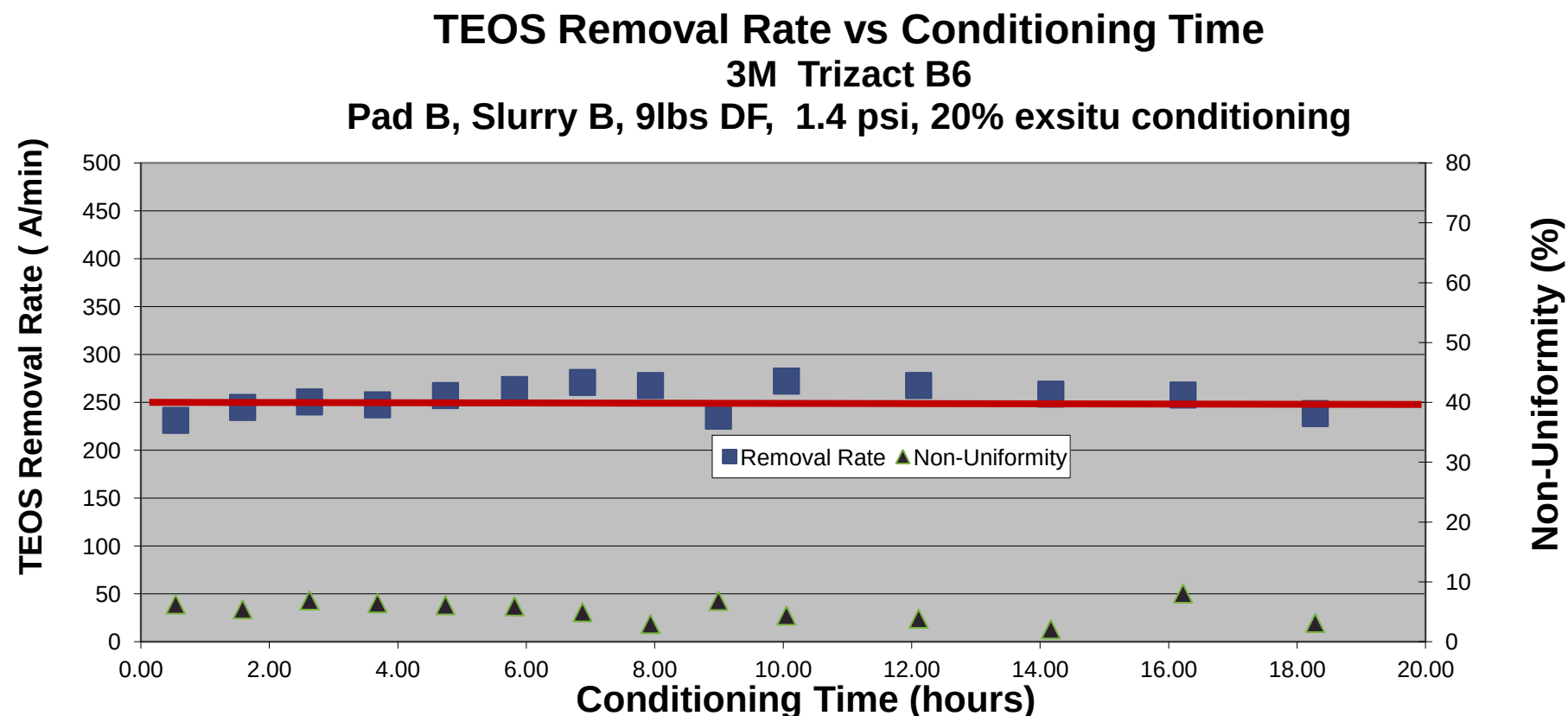


TEOS Wafer Profiles for A165 with Pad B and
Slurry B, 9bs DF, 20% exsitu Conditioning, 1.4 psi,
3 mm EE



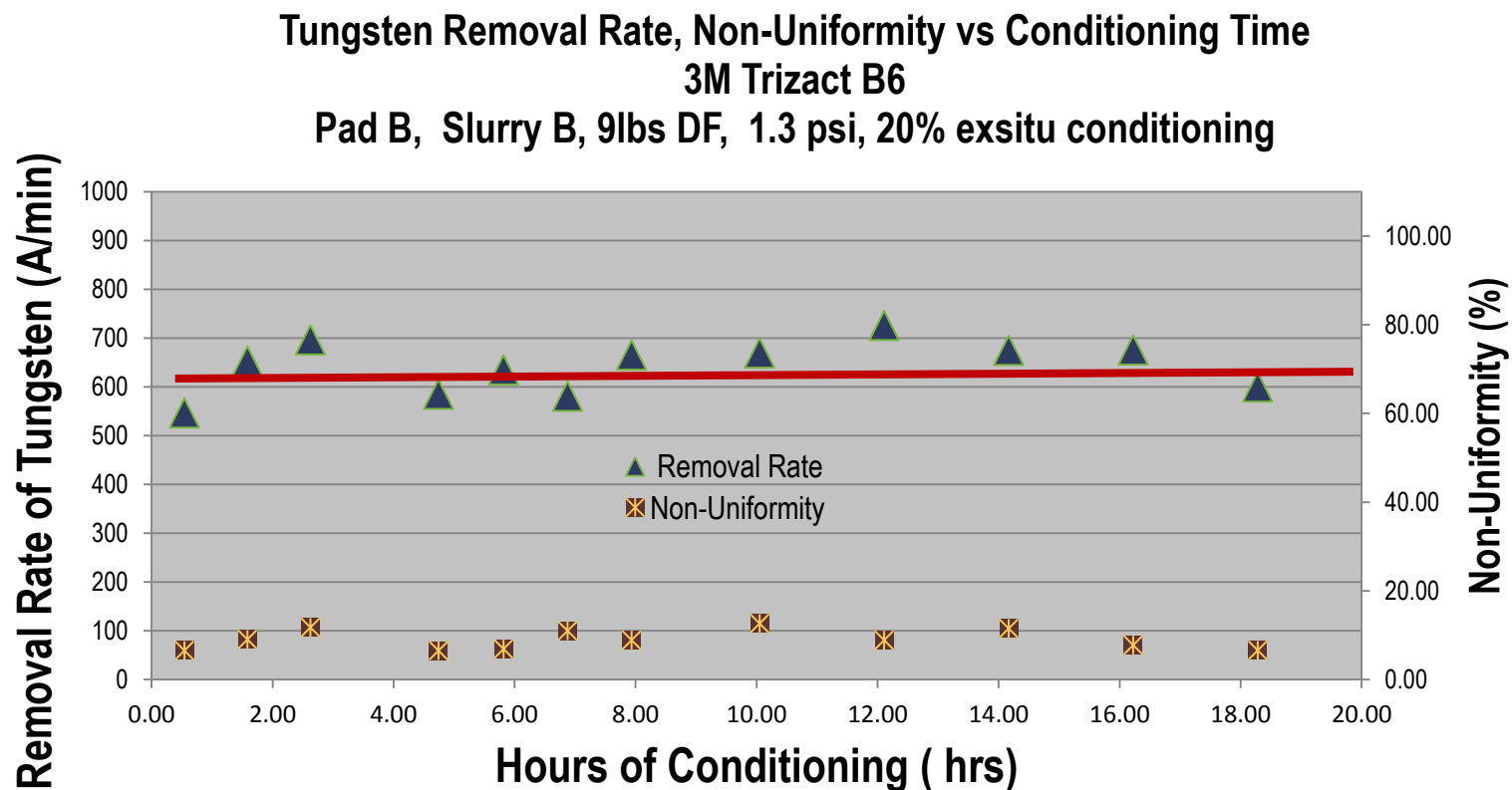
Similar TEOS RR profiles between Trizact B6 and SA A165 (POR)

EOL Marathon Test With W Metal Gate Process With Trizact™ B6-M990-5S2 Disk, Pad B and Slurry B – Oxide RR and NU



Stable Oxide RR and NU with Trizact B6 disk at target rate = 250 A/min

EOL Marathon: Metal Gate Process With Trizact™ B6-M990-5S2 Disk Pad B, Slurry B- W RR and NU

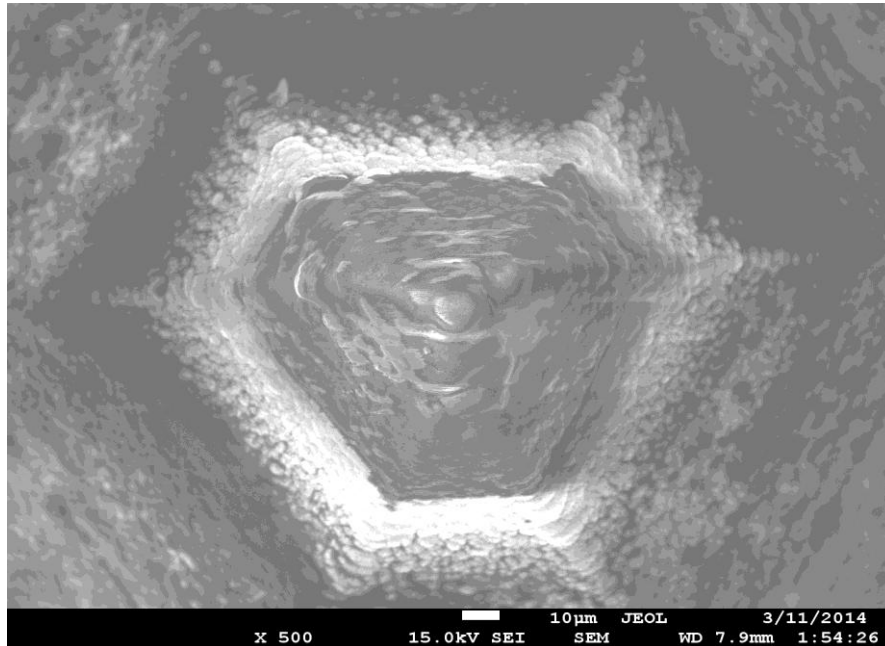


Stable W RR and NU with Trizact B6 disk at target rate ~ 600 A/min

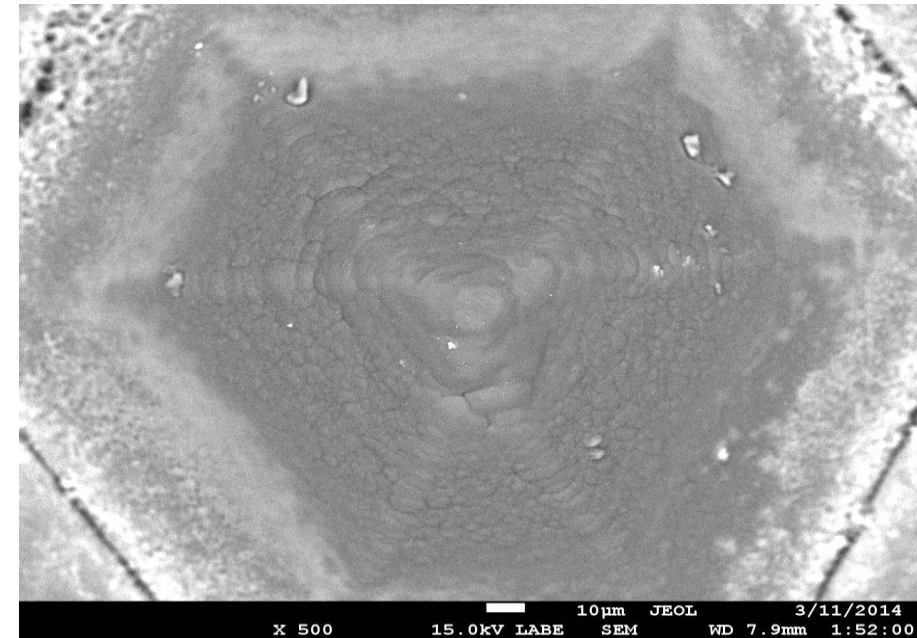


SEM Image of Trizact™ B6-M990-5S2 after EOL Marathon Test

SE imaging



BSE imaging



CVD coating showing minimal wear after 20 hours of ex-situ conditioning with Trizact B6-M990-5S2

SUMMARY

- The utility of 3M™ Trizact Pad Conditioners for W plug and metal gate processes is demonstrated.
- A 3M™ Trizact™ Pad Conditioner reduced the pad wear rate by a factor of 3 or more, compared to a traditional SA conditioner, while maintaining the same W rates and non-uniformities for a W plug process with ex-situ conditioning. A corresponding improvement in pad life is expected.
- For W metal gate process, the more aggressive Trizact™ B6 Pad Conditioner was needed to polish and maintain stable TEOS rate.
- A Trizact™ B6 Pad Conditioner was used for about 18 hours in a W metal gate process, maintaining the same TEOS and W removal rates under typical POR conditions. This is expected to lead to a dramatic increase, > 3X, in the number of wafers processed per pad, compared to a conventional SA conditioner.

