



Advanced Tungsten CMP with No Pad Conditioning

**Presentation to the NCCAVS CMP Users Group
May 5, 2004**

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Background Information

Process Data Using ASP-W3525 Pads

(Peroxide concentration, downforce, table speed, etc.)

Process Qualification and Production Results

- Extended run
- Contamination data
- Lot-to-lot consistency

Contact info



Background Information

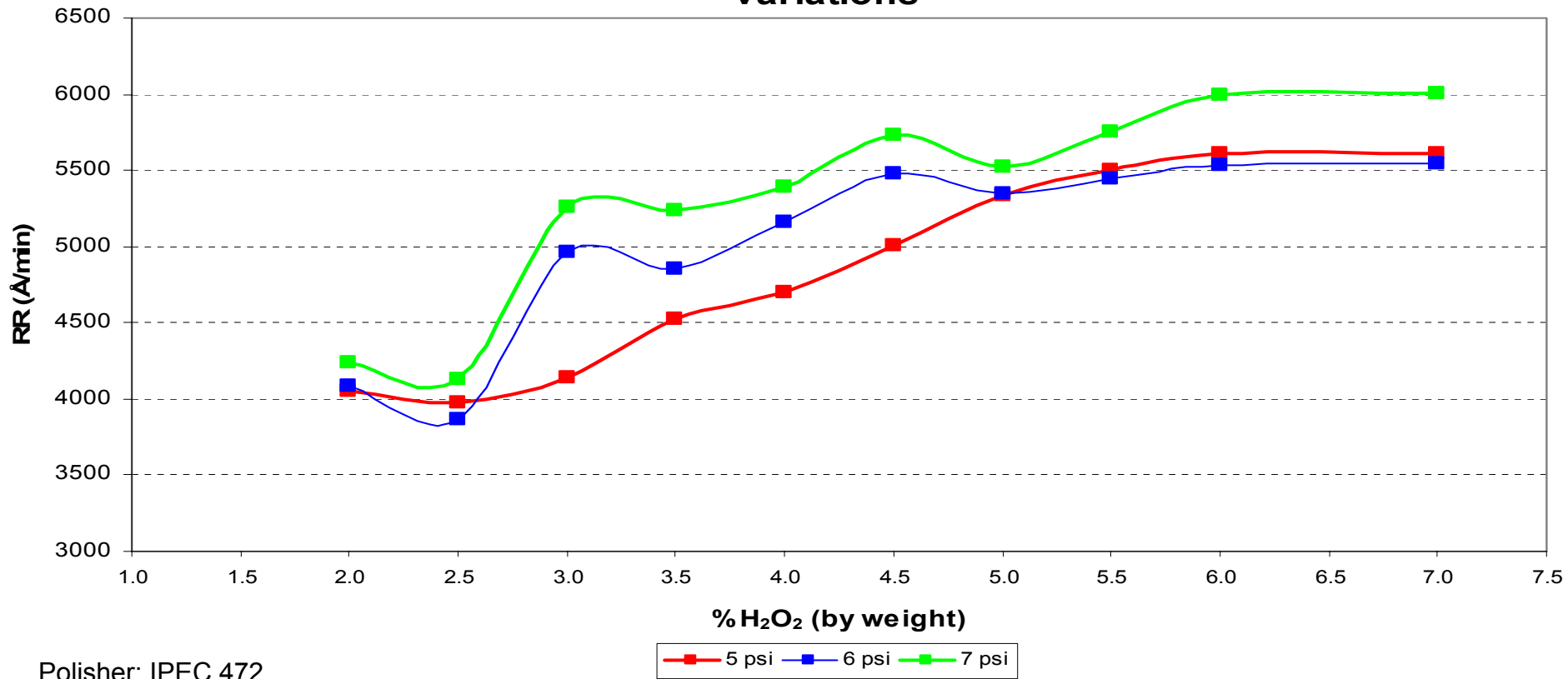


- PSI provides professional outsource CMP for everything from prototypes and development work through volume outsource production.
- Desired properties for a tungsten CMP production process:
 - Excellent pad-to-pad and lot-to-lot consistency
 - Reasonable removal rate and very low uniformity
 - Low defectivity
 - Minimal conditioning (zero if possible)
 - Long pad life
- Multiple pads screened and best performance achieved with the psiloQuest ASP-W3525 pad.



Peroxide Concentration Study

RR Study comparing Down-Force @ % H₂O₂ concentration variations



Polisher: IPEC 472
Slurry: Cabot SSW-2000

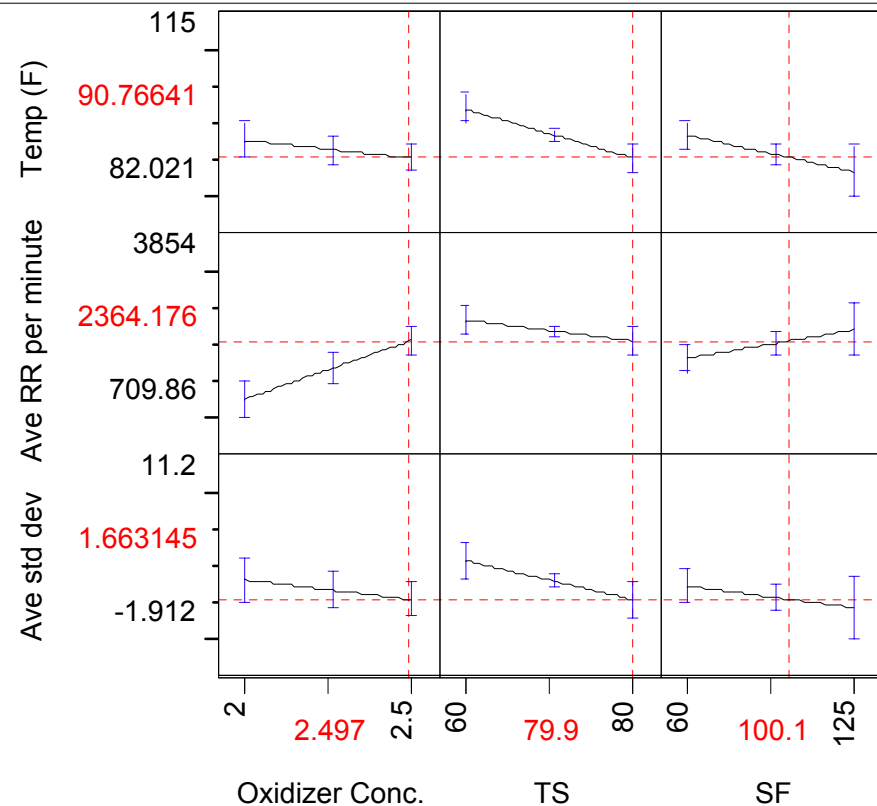


IPEC 472 Process DOE Results

- Simplified DOE shows strongest response to oxidizer concentration
- Negative slope for removal rate vs table speed is likely an artifact of simplified design

Least Squares Fit

Prediction Profiler



AMAT Mirra Process DOE Results

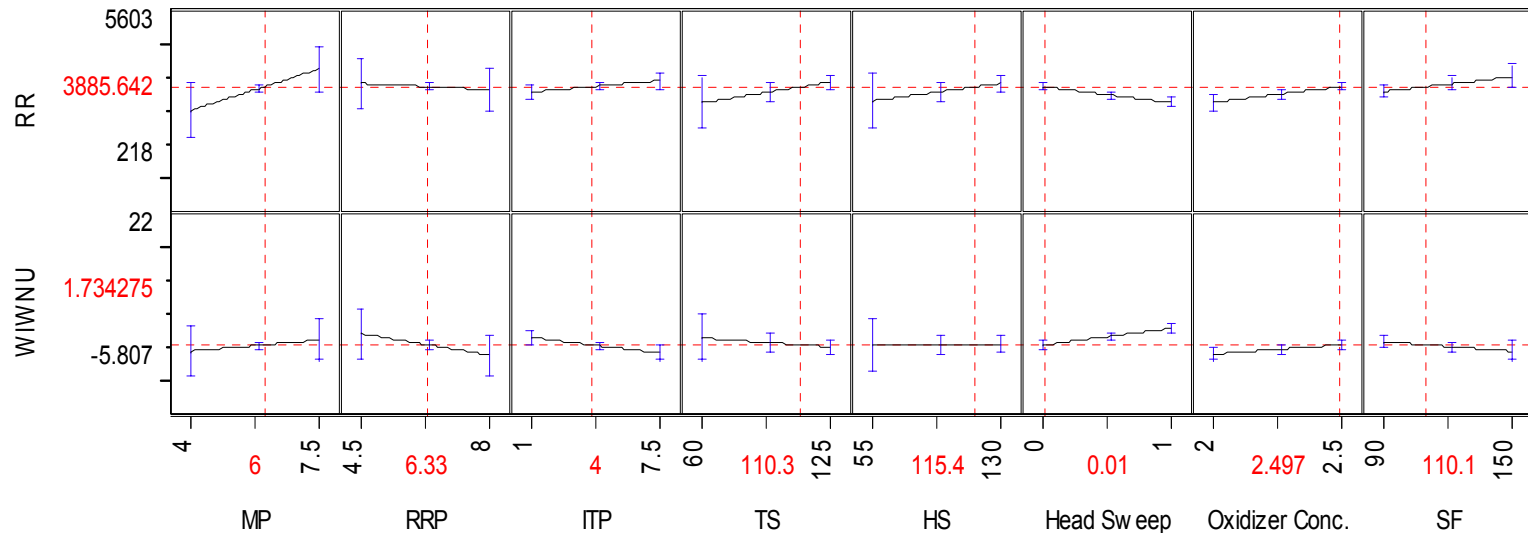
- Membrane pressure (downforce) is largest predictor coefficient
- Wide process margin on all other variables tested
- Consistent with trends observed in IPEC 472 data

Least Squares Fit

Response RR

Response WIWNU

Response Surface Effects on AMAT MIRRA MESA using 1:1 SSW2000:DIW



Ebara EPO222 Process DOE Results

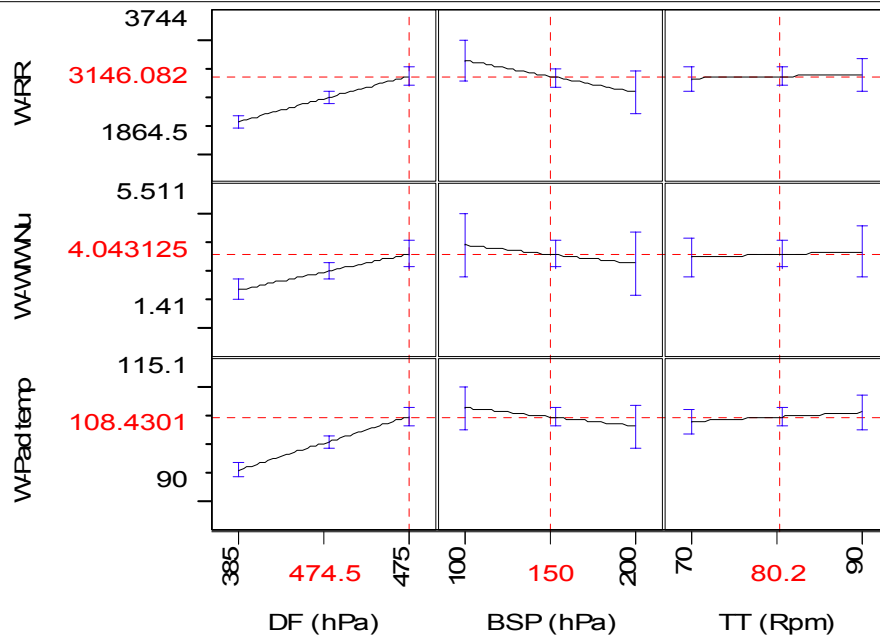
Least Squares Fit

Response W-RR

Response W-WIWNu

Response W-Pad temp

ASP-W3525 Response Surface Effect on Ebara F-Rex200 using 1:1 SSW2000:DIW at 2%H2O2



Recent data taken on Ebara EPO222 polisher

- Downforce (DF) has the biggest effect on measured response parameters
- TurnTable (Table Speed) has very minimal effect on the response parameters
- As expected, tungsten RR (W-RR) increases as Downforce (DF) increases.
- BSP has mild inverse effect on W_RR, W-WIWNu and W- Pad Temperature



Pad Variability Study



Polishing data taken across multiple pads

- Total of 20 ASP-W3525 pads
- Includes 5 different raw material lots

Rate and uniformity data taken on 3 monitor wafers per pad

- All polishing performed on IPEC 472 polisher at psiloQuest apps lab
- Data compiled into single dataset for comparison

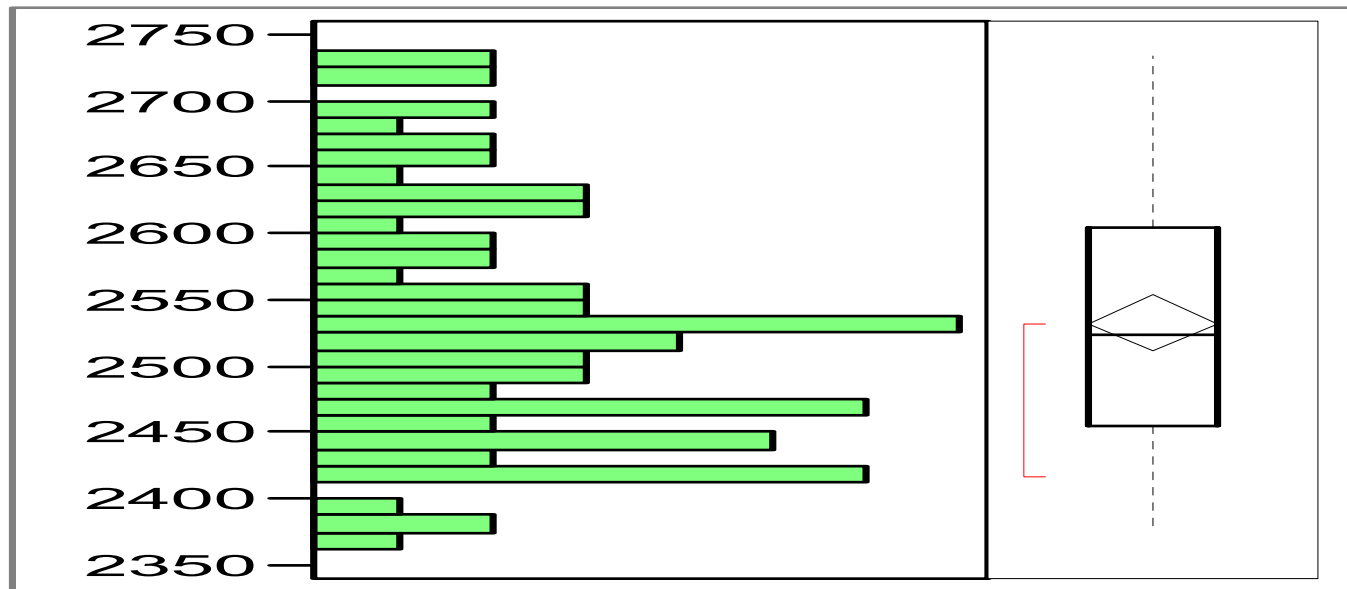
Demonstrates excellent pad-to-pad consistency across multiple lots



Multi-Lot Removal Rate Variation

Distributions

P-RR (A/ MIN)



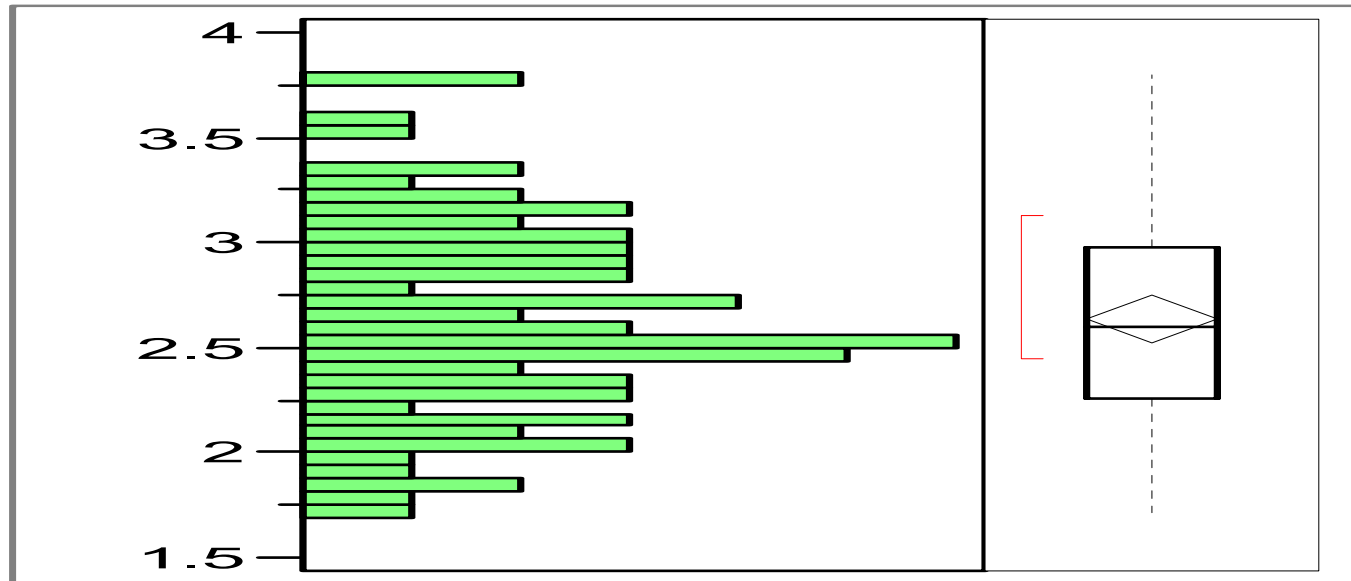
Moments

Mean	2532.7365
Std Dev	94.865909
Std Err Mean	11.027938
upper 95% Mean	2554.7151
lower 95% Mean	2510.7578
N	74

Multi-Lot WIWNU Variation

Distributions

P-Stdev



Moments

Mean	2.638
Std Dev	0.4834226
Std Err Mean	0.05778
upper 95% Mean	2.753268
lower 95% Mean	2.522732
N	70

Production Qualification



Elements of Rapid Qual Plan

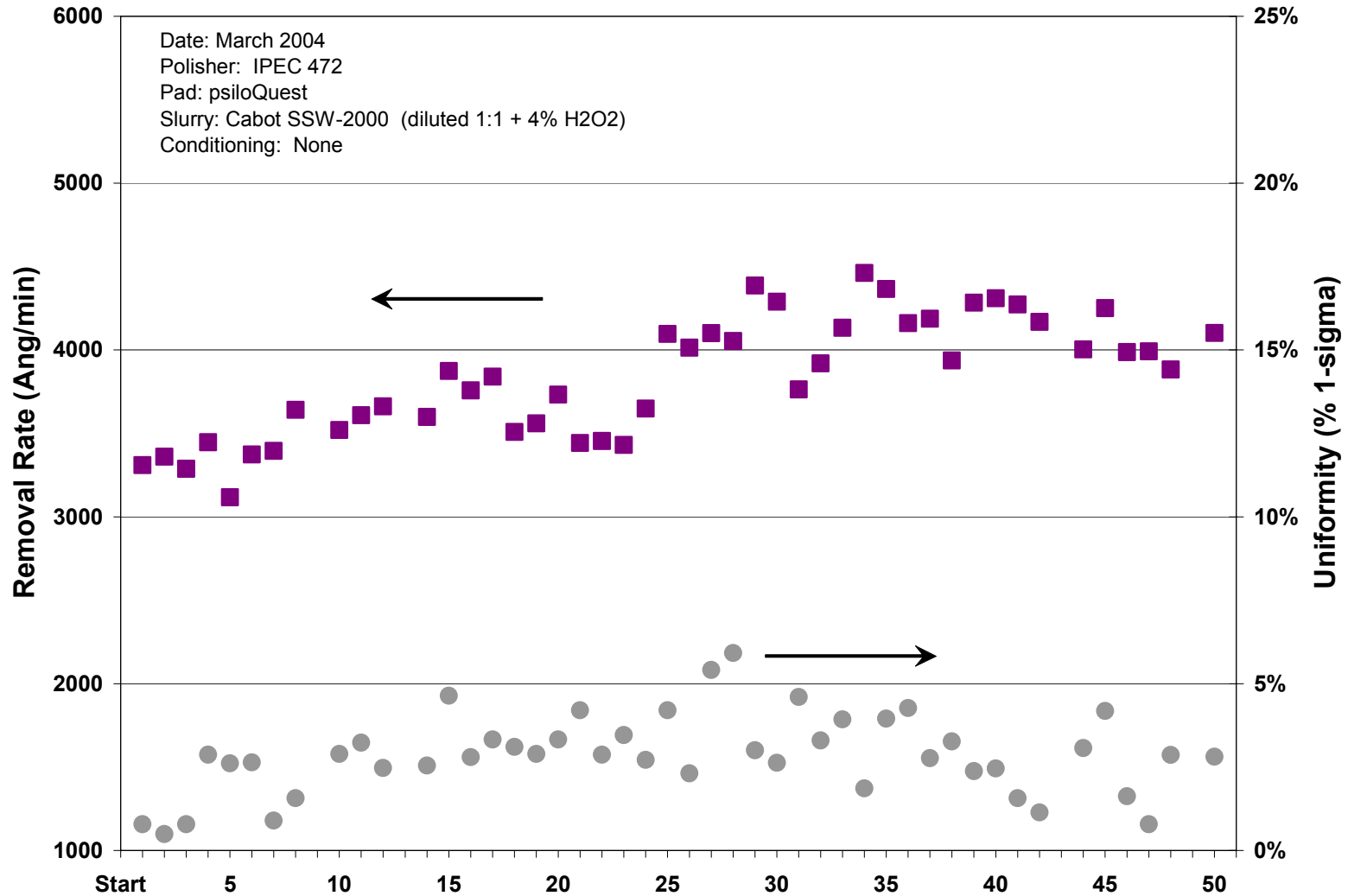
- 50-wafer baseline run for blanket film rate and uniformity
- SIMS/TXRF data showing residual contamination levels
- Defectivity
- Device yield on multiple split lots

Results

- All qualification runs completed in very short timeframe
- Comparison to in-fab process showed equal or better performance on all critical metrics



First attempt 50-wafer baseline run



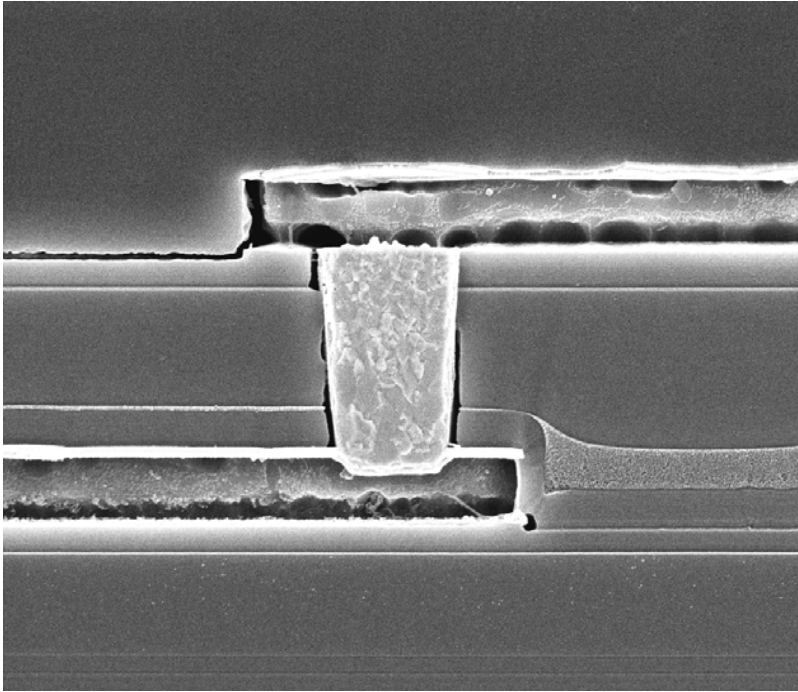
SIMS / TXRF contamination data

Key Points

- Comparison to IC1000 shows equal or better performance
- All values from PSI lab are less than or equal to fab reference

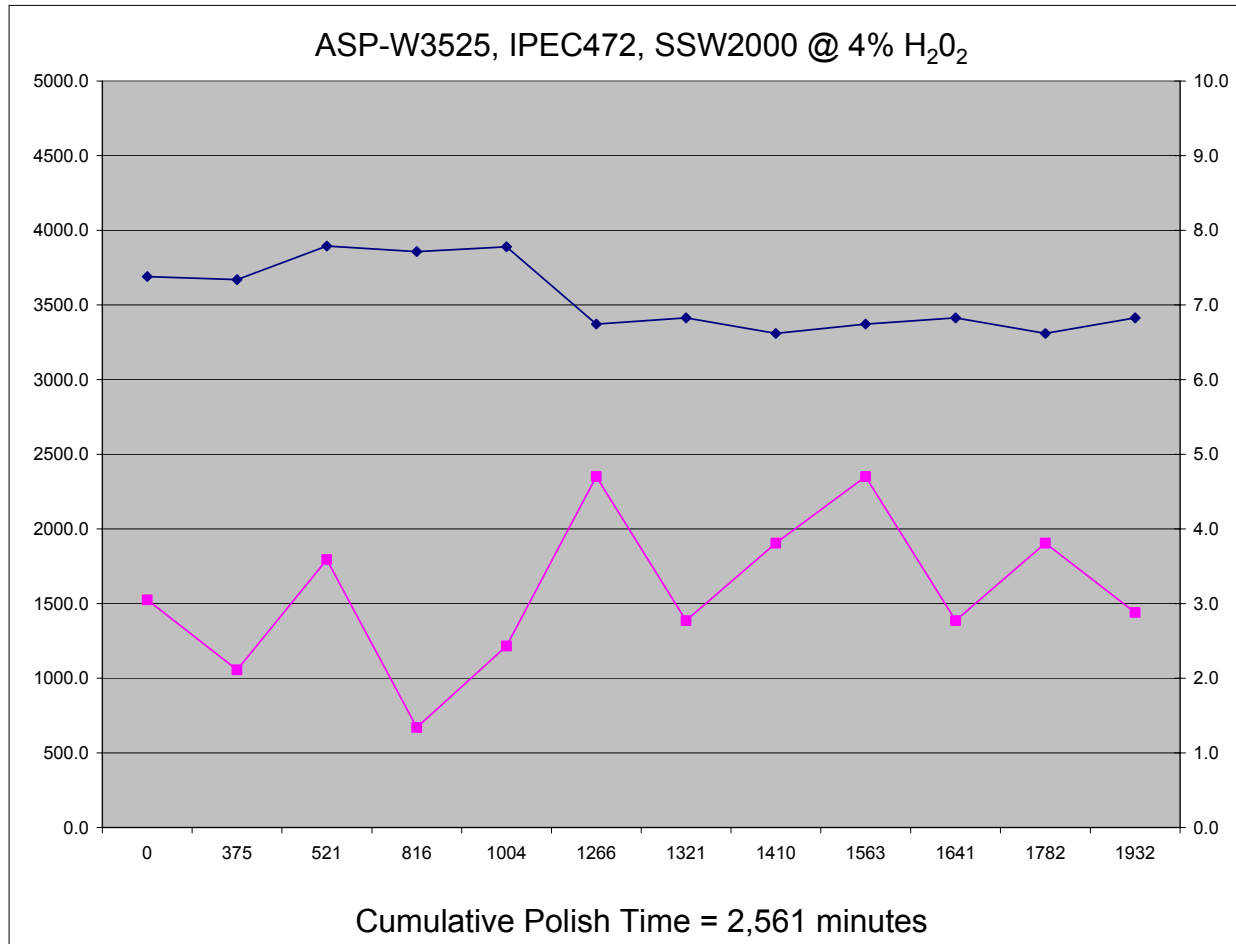
#	Element	PF1 Reference	IC1000 Process on 472's at PSI	pQ Pad on 472 at PSI	pQ Pad on 372M at PSI	Scrubber Qual	Second Scrubber Qual
1	P	108.07	81.91	96.28	76.24	80.32	84.78
2	S	478.7	402.44	368.09	389.6	383.63	384.49
3	Cl	79.84	80.31	80.98	66.78	77.42	72.85
4	K	0	0	0	0	0	0
5	Ca	5.18	14.97	7.74	39.96	5.75	3.62
6	Sc	0	0	0	0	0	0
7	Ti	0.65	1	0	0	0	0
8	V	0	0	0	0	0	0
9	Cr	0	0	0	0	0	0
10	Mn	0	0.09	0	0.13	0	0
11	Fe	179.11	114.37	95.44	95.03	0.94	0.45
12	Co	0	0	0	0	0	0
13	Ni	0	1.11	0.21	0.08	0.25	0
14	Cu	0.1	2.53	0.74	3.93	0	0
15	Zn	0.05	11.37	3.38	15.39	0.85	0
16	W	0	0	0	0	0	0

Cross section of completed via



- Excellent plug planarity and controlled recess.
- End-of-line device yield equivalent between outsourced CMP and existing qualified fab process.

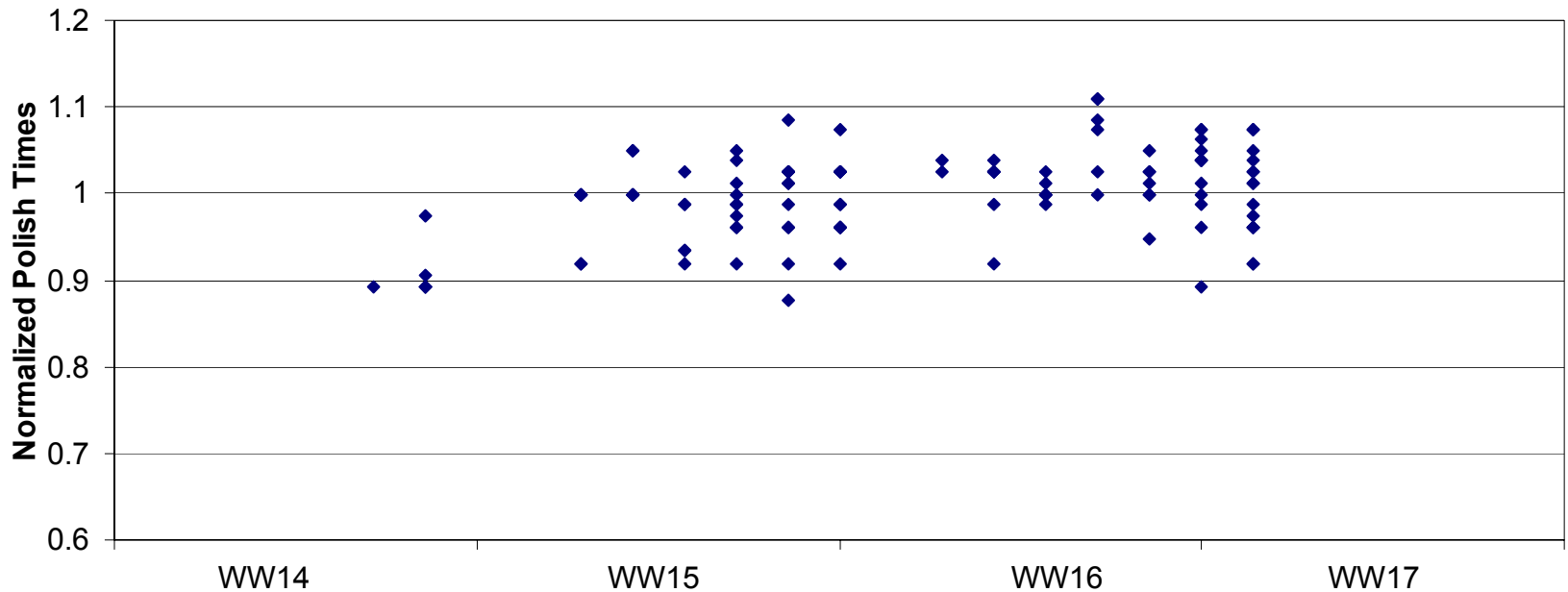
Blanket Film Qual Data through Typical Pad Life



Normalized Production Lot Polish Time

Daily Production Data

(103 wafer lots - Random mix of contact, via1 & via2)



Over 100 production lots across multiple pads showing very repeatable polishing performance



Conclusions



The psiloQuest ASP-W3525 tungsten CMP pad provides:

- Excellent pad-to-pad and lot-to-lot consistency
- Reasonable removal rate and very low uniformity
- Zero conditioning required
- Low defectivity
- Long pad life

Through PSI, the end customer has achieved:

- Immediate capacity with no capital outlay
- Product yield equivalent to current fab in-house production



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