

# Daimler Surveillance Panel Meeting Minutes

March 1, 2018

11:00 A.M. CST

## **Call Participants:**

Lubrizol - Patrick Joyce

Southwest Research Institute – Jose Starling, James McCord

Intertek - Jacob Goodale, Jim Moritz, Josh Ward

Daimler - Suzanne Neal, Greg Braziunas

Infineum - Jim Gutzwiller, Elisa Santos, David Brass, Bob Salgueiro, Jun Cui

Chevron Oronite – Mark Cooper

TEI – Derek Grosch, Mark Sutherland

Afton – Bob Campbell

TMC – Sean Moyer

Volvo/Mack – Greg Shank

## **Reports:**

Parts Update – Liners were received and TEI has begun distributing kits to the labs. TEI mentioned that they have not received the additional components that the panel wanted to be included in the DD13 rebuild kit. Jose will gather part numbers for components to be included in cooperation with other labs and forward this information to TEI.

## **Unfinished Business**

**(None)**

## **New Business**

**Batch “B” Liner Update** – Suzanne presented a hone spec comparison of the FM vs Mahle liners along with metals content which was also shared previously (See slide 6 of attached Daimler presentation).

**Liner Surface Measurements and Analysis**– Patrick Joyce presented a statistical analysis on liner surface conducted by Kevin O’Malley for measurements completed by TEI. Also Lubrizol conducted a series of materials analysis to compare the old PNB batch liners to the new batch C liners including SEM, EDS and metals concentration.

SEM and EDS analysis outlined some visual differences in hone depth along with possible porosity differences. Metals analysis showed minor differences between PNB and C. Hardness measurements were also conducted and batch C liners were slightly harder than PNB liners, but nothing major. White light interferometry (zygote) showed decent differences in hone between Batch C and PNB. Analysis showed the PNB hone is consistently rougher with deeper valleys but batch C still falls within expected limits.

It was asked if further analysis would be needed to include more liners. Lubrizol and the panel agreed that a few more liners would be analyzed in the same manner to verify the various items noted in the initial comparison of one each liner.

Patrick (Lubrizol) presented further analysis of liner surface comparisons. The analysis compared stylus radius and roughness data for both PNB and Batch C liners. Discussion took place on which limits should be applied.

**Motion:** *Jacob Goodale made the motion that for Batch C liners specifications be set using the 0.0001" tip stylus on the average of all four traces with the following limits shown below effective immediately.*

**Rvk Limits:** 0.7 to 2.0

**Rk Limit:** 0.2 to 0.8

**Rpk Limit:** 0.27

Greg Braziunas seconded the motion. No other discussion took place. All members on the call approved the motion and motion was passed.

**Coordinated Reference Runs:** It was agreed that the analysis presented shows differences however there is no path forward at the moment other than this current set of liners. It was agreed that coordinated references need to be run and that all three labs (Lubrizol, Southwest and Intertek) would run on the current reference oil (864-1) utilizing all current test hardware. Each of the labs will conduct the reference test on their matrix stands with an expected start date of approximately 2 weeks from this meeting.

It was also agreed that the same material analysis presented by Lubrizol in the meeting would be conducted on additional liners to gather a representative sample, but that it would not hold up starting references.

**Next Meeting:** An invitation will be sent for the next SP meeting, but is tentatively scheduled for 3/28/18.

The meeting was adjourned at 1 PM CST.

# DAIMLER

Daimler Surveillance Panel  
DD 13 Scuffing Test ASTM D8074  
March 1st, 2018

Daimler Trucks



# Agenda:

1. Review DD13 Scuffing Test Liner Update from August 8<sup>th</sup>, 2017
2. Liner Surface Measurement (0.0001” vs 0.0002”) Styles – Kevin O’Malley
3. Review Material Analysis for PNB vs. Batch C liners
4. Discuss Next Steps for Referencing

# DAIMLER

DD 13 Scuffing Test Liner Update  
Suzanne Neal & Gregory Braziunas  
August 8th, 2017

## Daimler Trucks



# Overview

- Liners were originally ordered from Daimler internal manufacturing
  - Semi Finished liner from FM
  - Machined on Detroit honing line
- Daimler manufacturing strategy has shifted:
  - Detroit location will no longer be making DD 13 liners
- Long term supply of DD 13 liners for NAFTA will be supplied through Mahle Brazil

# Comparison

Company	Casting	Honed	Pros	Cons	
Mahle	Semi Finished Casting Created by Mahle	At Mahle Facility	<ul style="list-style-type: none"><li>• High Quality</li><li>• Long Term Supplier</li></ul>	<ul style="list-style-type: none"><li>• New supplier for scuffing test liner supply</li></ul>	Recommended Option by Daimler
FM / Detroit Diesel	Semi Finished Casting Created by FM	At Detroit Diesel	<ul style="list-style-type: none"><li>• Maintain current supplier for scuffing test liner supply</li></ul>	<ul style="list-style-type: none"><li>• Supply not guaranteed</li></ul>	

# Proposal/Timing

Company	Time to Make from PO	Shipping
Mahle	7 weeks	~2 weeks

## Referencing

- Reference tests
  - Already planned to reference many parts at once
    - Batch B - Top Ring
    - Batch A - Second and Third Ring
    - Batch A - Pistons
    - Batch C - Liners
  - Liner Batches:
    - PNB FM Liners - Parts not batched from service
    - Batch A Liners - FM 1080 from Detroit (returned for scratches)
    - Batch B Liners - Order for FM/Detroit 2000 Liners - Canceled
    - PNB Mahle Liners - Parts not batched from service
    - Batch C Liners - Full order of 2000 liners from Mahle

# Hone Spec Comparison – FM vs. Mahle

Part Number	Supplier	Hone Spec			Notes
		Rpk	Rk	Rvk	
A 471 011 2910	FM / Detroit	0.2 a/2 20-30°	0.2 – 0.8	0.5 – 1.8	
A 471 011 3310	Mahle	0.2 a/2 20-30°	0.2 – 0.8	0.8 – 2.0	PPAP falls within range of FM and Mahle specifications.

# Casting Comparison – FM vs. Mahle

Part Number	Supplier	Content %								Casting Type
		Fe	C	P	Si	S	Cu	Mn	Cr	
A 471 011 2910	FM	Remainder	2.5-3.5	Max 0.15	1.5- 2.4	Max 0.12	Max 0.8	0.5- 0.9	Max 0.5	Gravity
A 471 011 3310	Mahle	Remainder	2.7-3.5	0.1- 0.35	1.8- 2.3	Max 0.8	0.4- 0.9	0.3- 0.7	0.2- 0.6	Spun

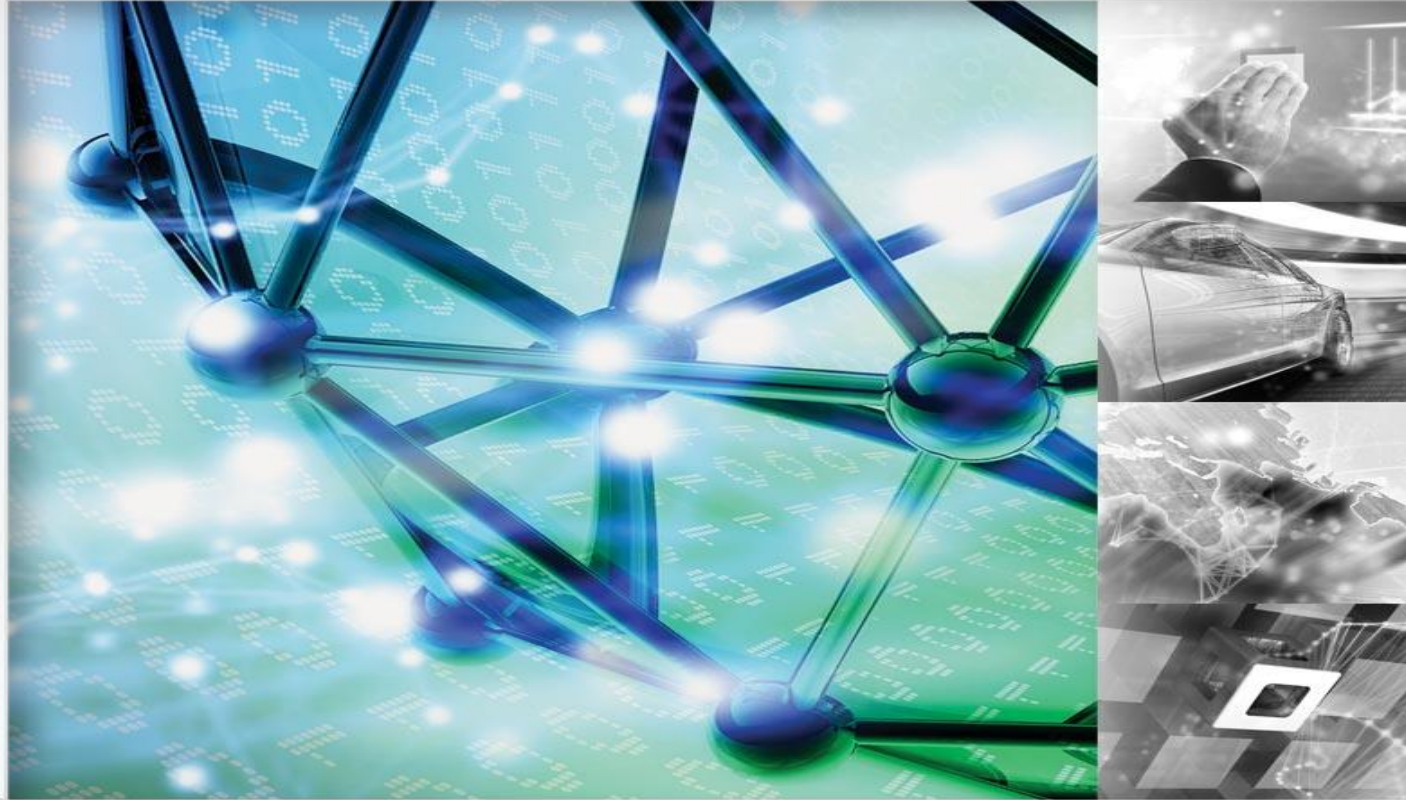


# Next Steps from August 8<sup>th</sup>, 2017 Meeting

- Suzanne/Greg
  - Find out if liners are available in service
  - Find out timeline for small order (~60 liners) or alternative options
  - Once information is available, another SP meeting will be held
- SP would like to do a material comparison between the parts (Lubrizol offered to complete the comparison)

# Current Status/Update

- Mahle Liners have been received at TEI
- TEI completed stylus comparison
- Liners were sent to Lubrizol for Material analysis
- SP Discussion:
  - Next Steps for referencing



## DD13 Liners – Batch C vs PNB

**Chad Hoersten, Patrick Joyce, Kevin O'Malley, and Jeanne Petko**

February 28<sup>th</sup> 2018

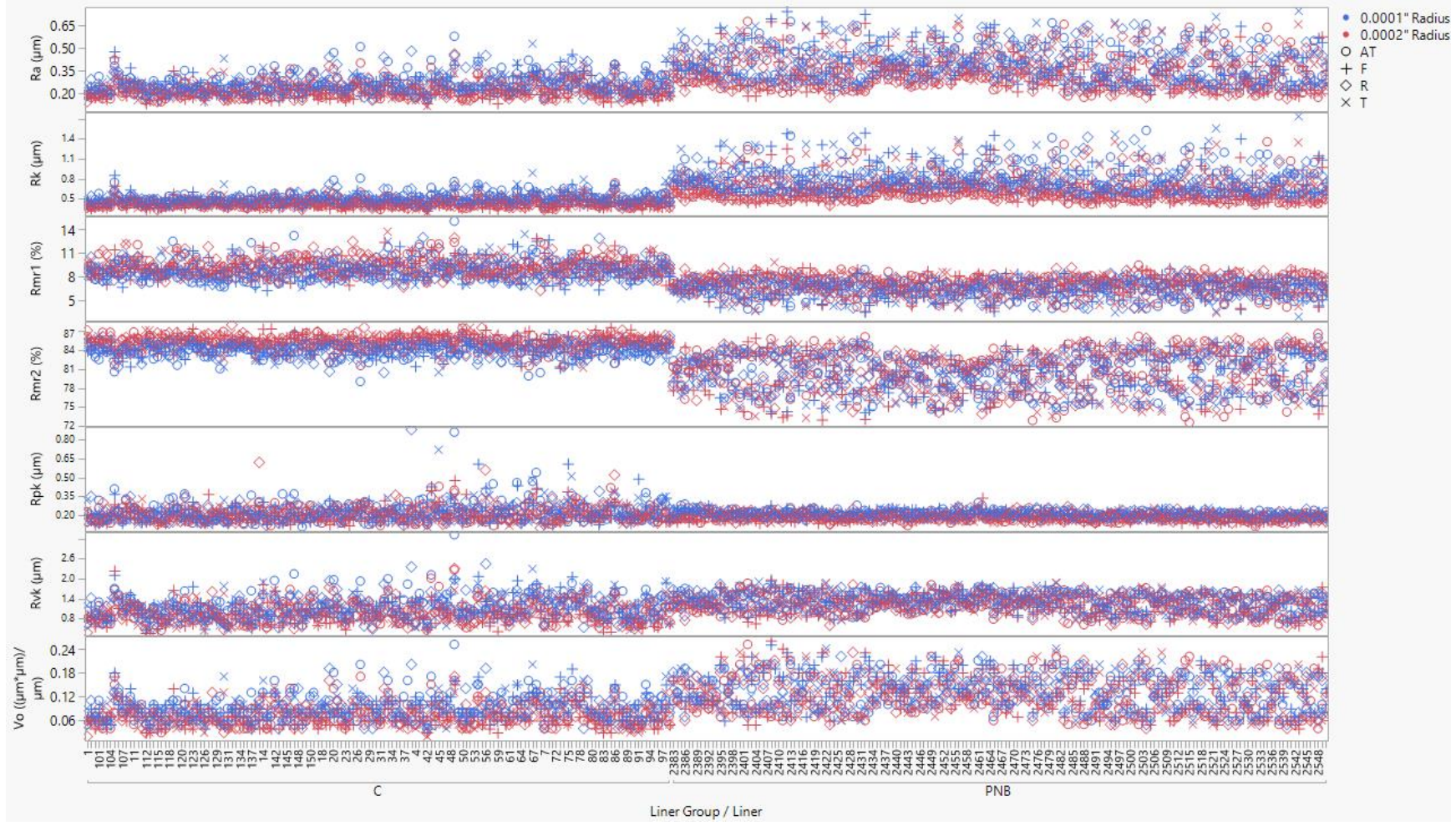


# Statistical Comparison

# Liner Measurements



Batch C liners differ from PNB liners

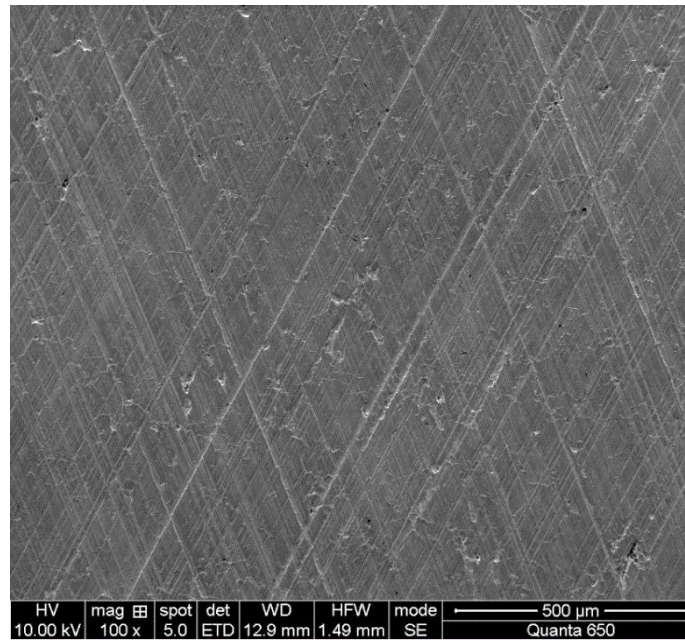


A grayscale, high-magnification photograph of an engine oil cap. The cap is the central focus, with the words "ENGINE OIL" and a small logo embossed on its top surface. To the left of the cap is a circular, ring-like component, possibly a dipstick seal or a part of the oil filler neck. The background is dark and out of focus, showing various mechanical parts of an engine. The text "SEM/EDS" is overlaid in white, bold, sans-serif font in the center of the image.

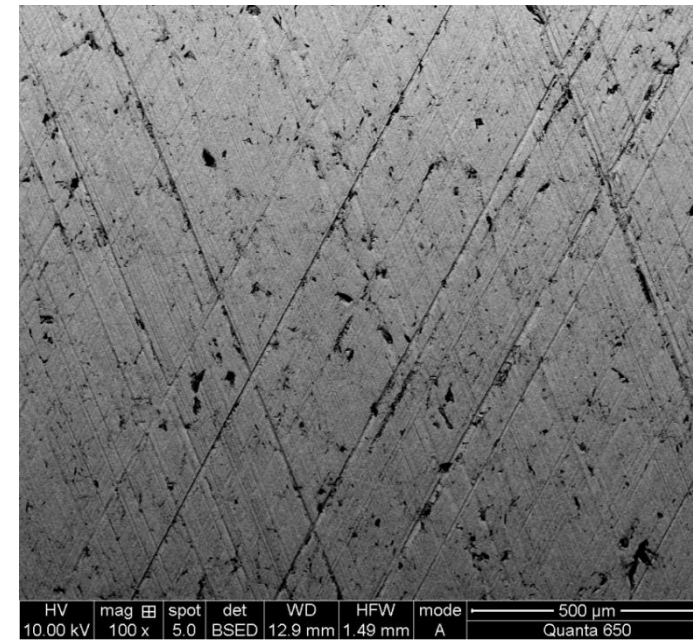
SEM/EDS



BATCH C

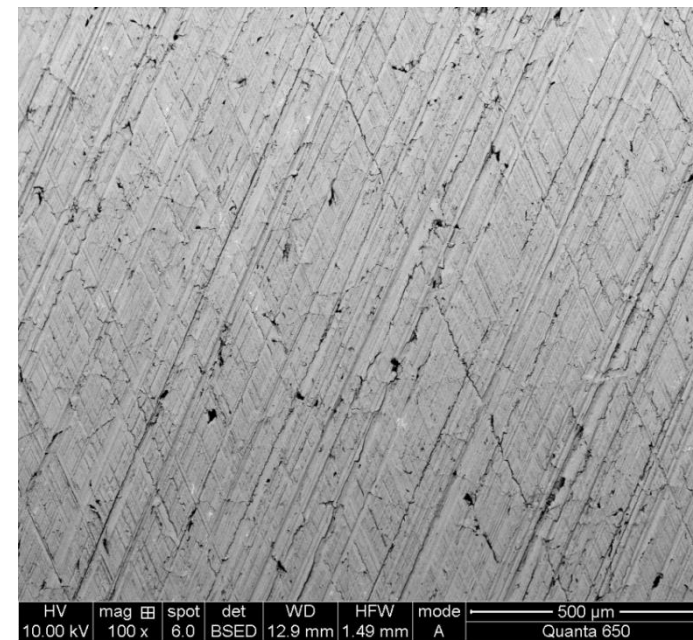
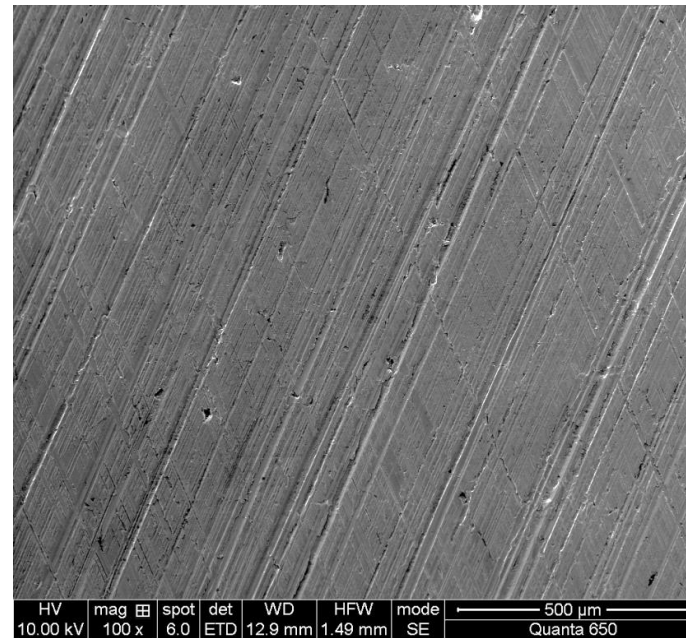


SE detector



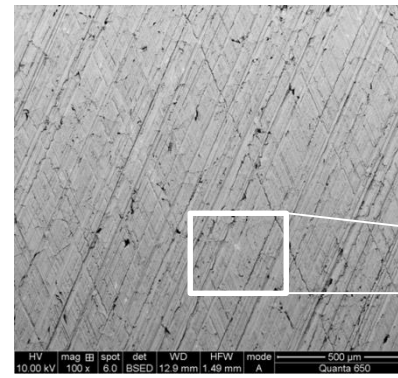
BSED detector

PNB

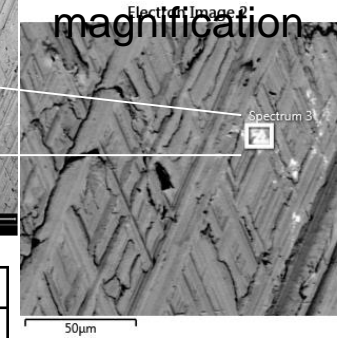


PNB

Element	Wt%	Atomic %
C	9.73	32.22
O	1.18	2.94
Al	0.06	0.09
Si	1.95	2.76
P	0.05	0.07
S	0.11	0.13
V	0.03	0.03
Cr	0.20	0.15
Mn	0.73	0.53
Fe	84.89	60.46
Ni	0.10	0.07
Cu	0.69	0.43
Mo	0.27	0.11
Total:	100.00	100.00



Analysis of lighter area at higher magnification



Element	Wt%	Atomic %
C	8.95	34.57
Si	0.29	0.48
P	1.03	1.55
S	0.51	0.74
V	2.12	1.93
Cr	7.35	6.56
Mn	0.00	0.00
Fe	44.87	37.27
Cu	0.14	0.10
Mo	34.73	16.80
Total:	100.00	100.00

Production liner had areas of higher Mo, Cr, and V that appear lighter in the BSED image.

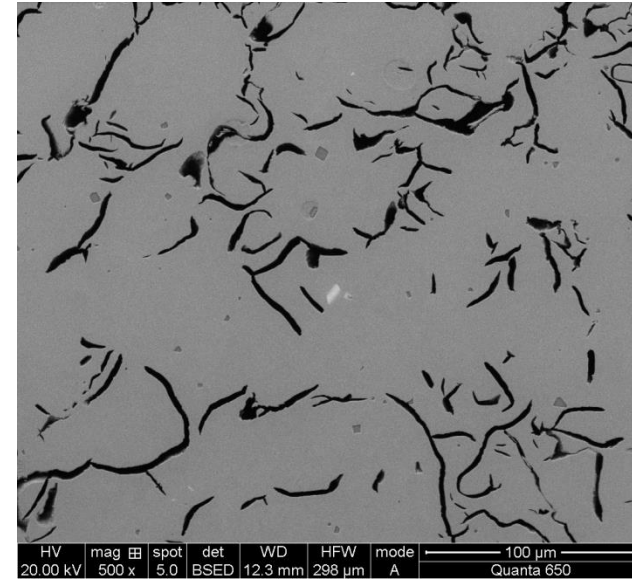
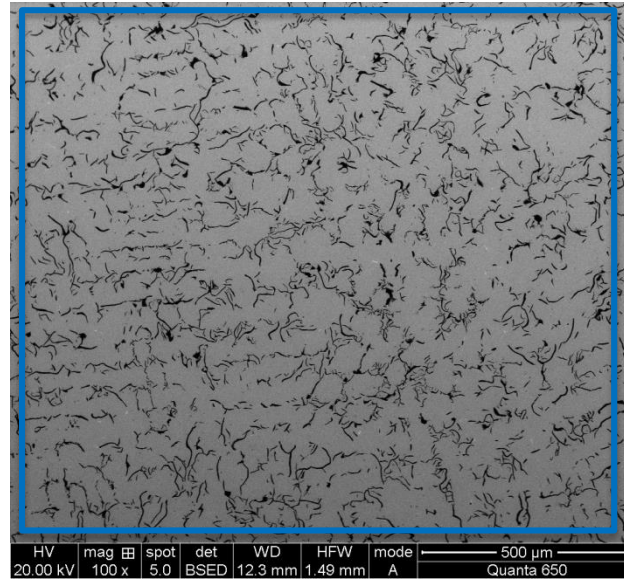
BATCH C

Element	Wt%	Atomic %
C	10.06	32.99
O	1.11	2.74
Al	0.05	0.08
Si	1.92	2.69
P	0.40	0.51
S	0.09	0.12
V	0.03	0.02
Cr	0.49	0.37
Mn	0.67	0.48
Fe	84.56	59.62
Ni	0.07	0.05
Cu	0.55	0.34
Mo	0.00	0.00
Total:	100.00	100.00

The batched liner did not have any lighter areas of Mo, but does have some V, Cr, and Ni.

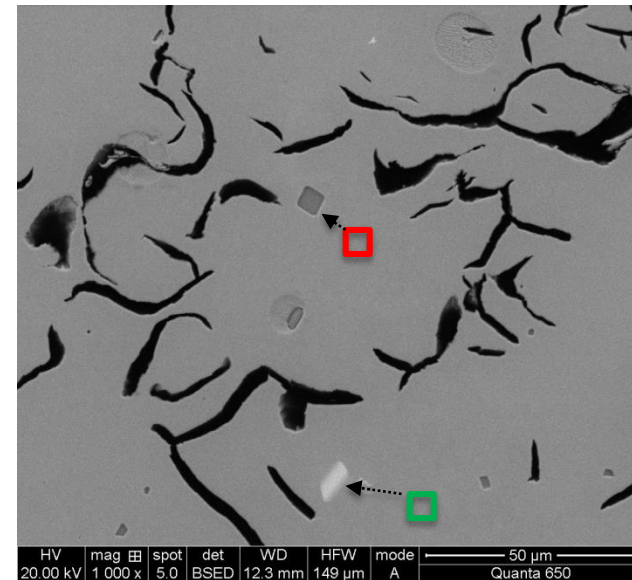


PNB  
CROSS  
SECTION  
Unetched

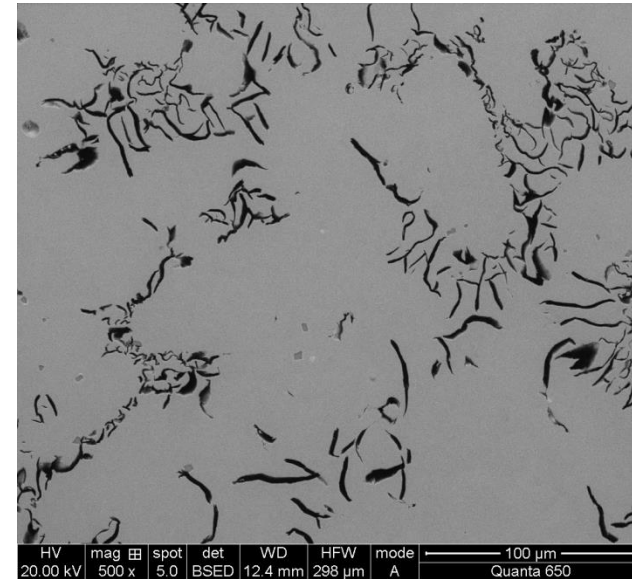
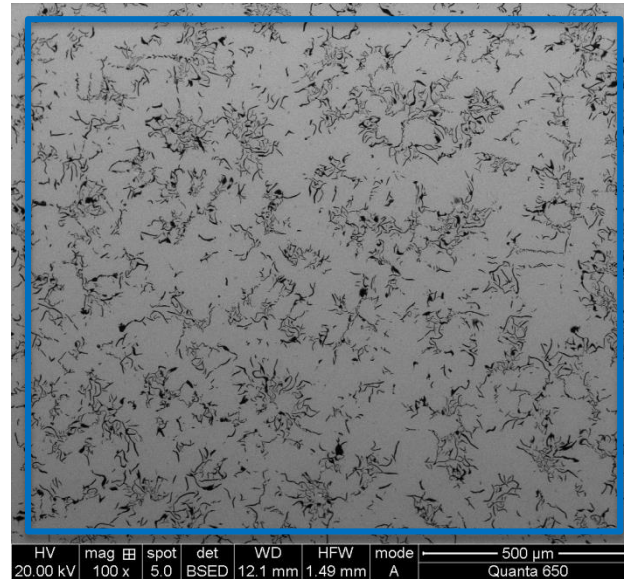


EDS @20keV  
Low  
magnification  
(blue)  
Higher  
magnification  
shows MnS and  
Mo inclusions.

Spectrum Label	Spectrum 10	Spectrum 11	Spectrum 13
C	41.78	54.08	53.80
O	1.37	3.04	1.21
Al	0.03	0.14	0.05
Si	1.05	0.72	1.70
P	0.07	0.00	0.04
S	10.37	0.17	0.08
V	0.05	0.67	0.02
Cr	0.19	1.21	0.09
Mn	11.11	0.50	0.42
Fe	33.07	25.77	42.18
Cu	0.10	0.09	0.31
Nb	0.00	0.00	0.01
Mo	0.82	13.61	0.09
Total	100.00	100.00	100.00

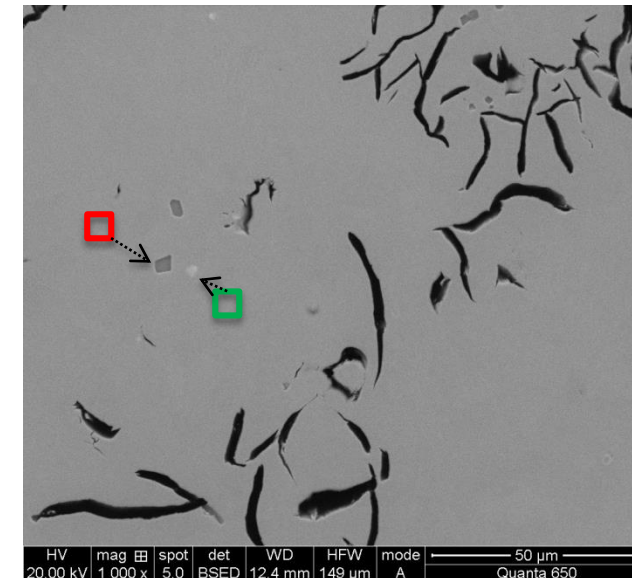


BATCH C  
CROSS  
SECTION  
Unetched



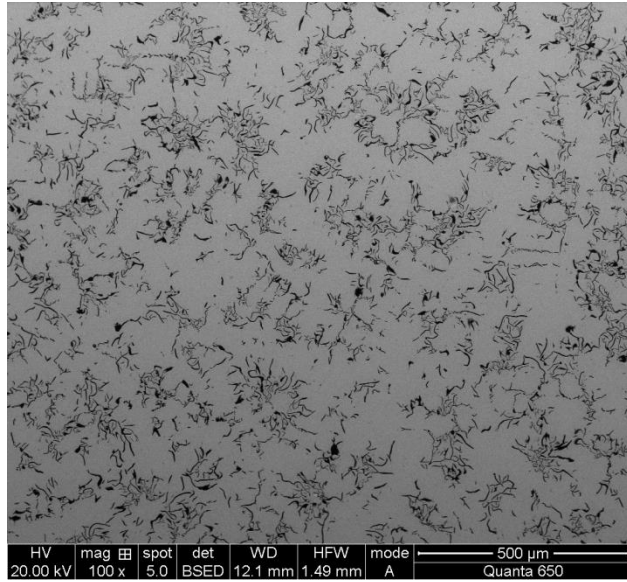
EDS @20keV  
Low  
magnification  
(blue)  
Higher  
magnification  
shows MnS and  
Nb inclusions.  
These are  
smaller than  
Production.

Spectrum Label	Spectrum 15	Spectrum 22	Spectrum 23
C	55.76	50.07	39.74
O	1.24	5.19	1.72
Al	0.02	0.00	0.08
Si	1.57	0.97	0.88
P	0.19	0.50	0.26
S	0.06	0.30	13.45
Ti	0.01	2.10	0.00
V	0.01	0.82	0.03
Cr	0.23	0.74	0.34
Mn	0.33	0.38	14.55
Fe	40.36	27.73	28.14
Cu	0.20	0.11	0.11
Nb	0.00	9.75	0.05
Mo	0.02	1.33	0.65
Total	100.00	100.00	100.00

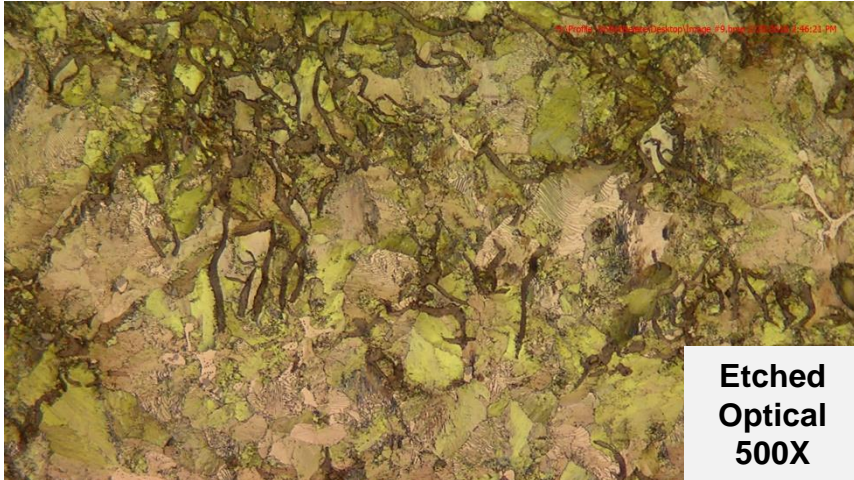
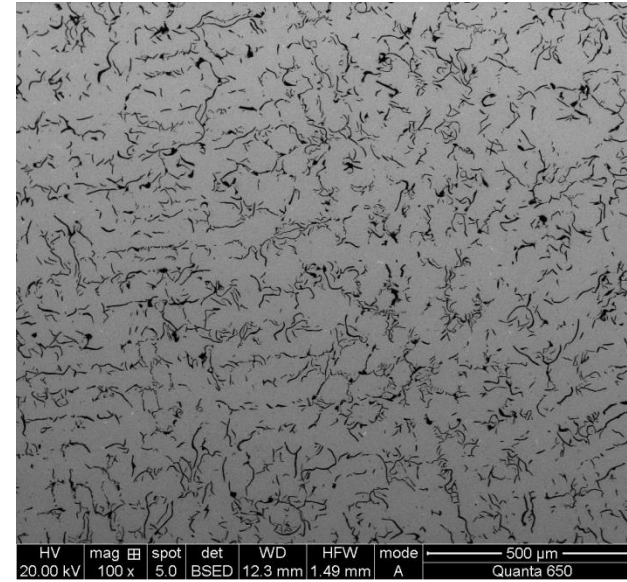




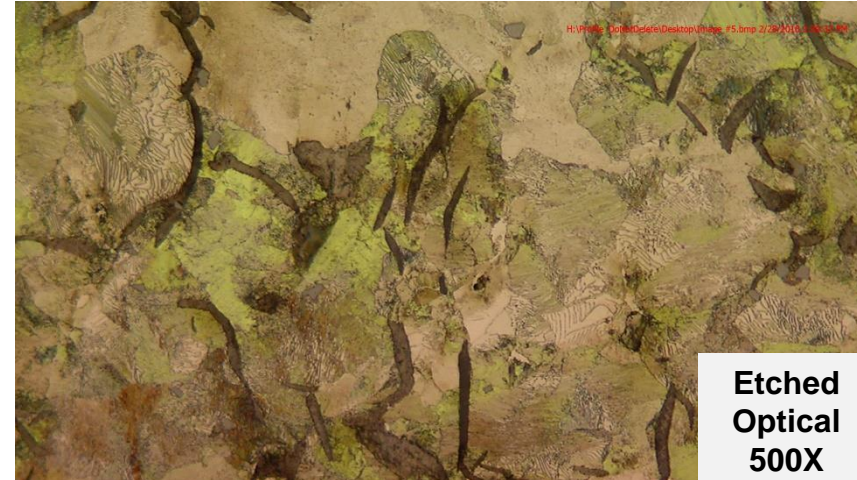
# BATCH C



# PNB



HRC = 27  
average



HRC = 23  
average

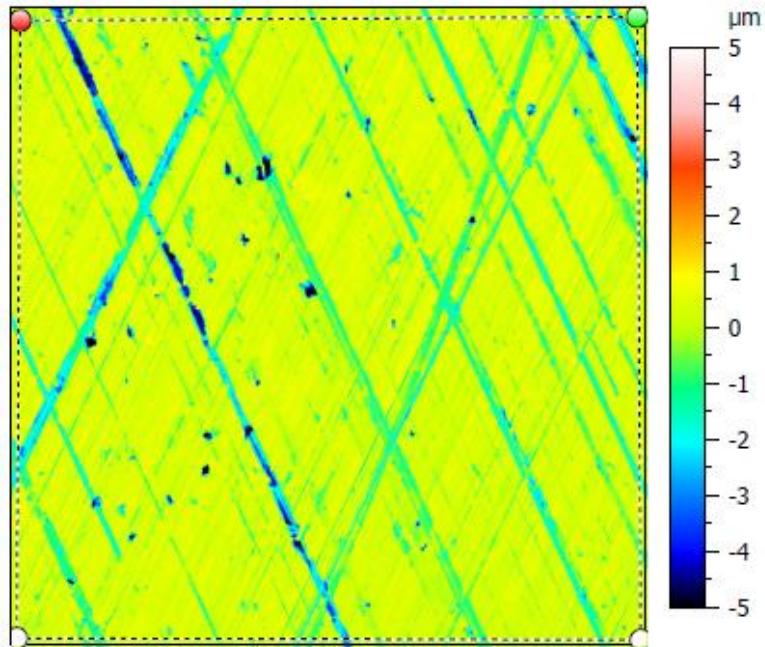


# Surface Analysis

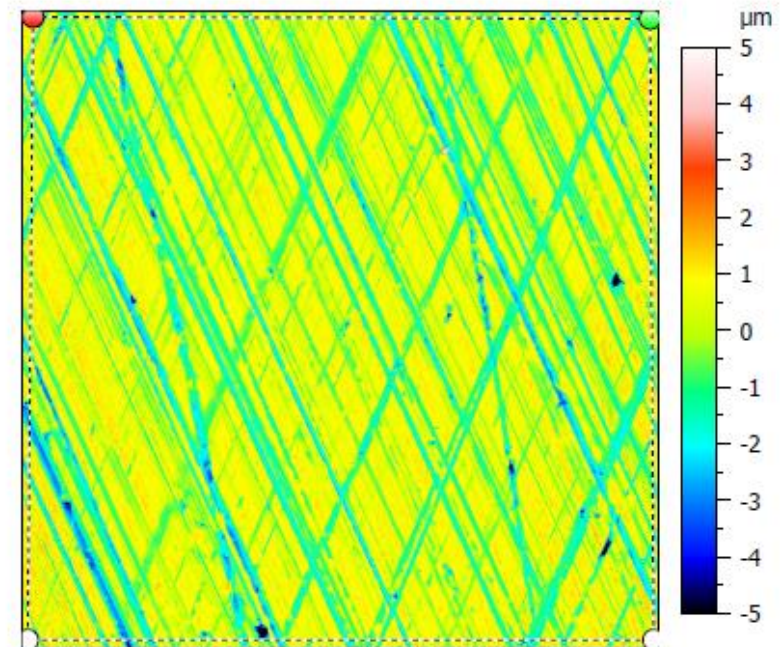


# White Light Interferometry

"Batch C TDC"

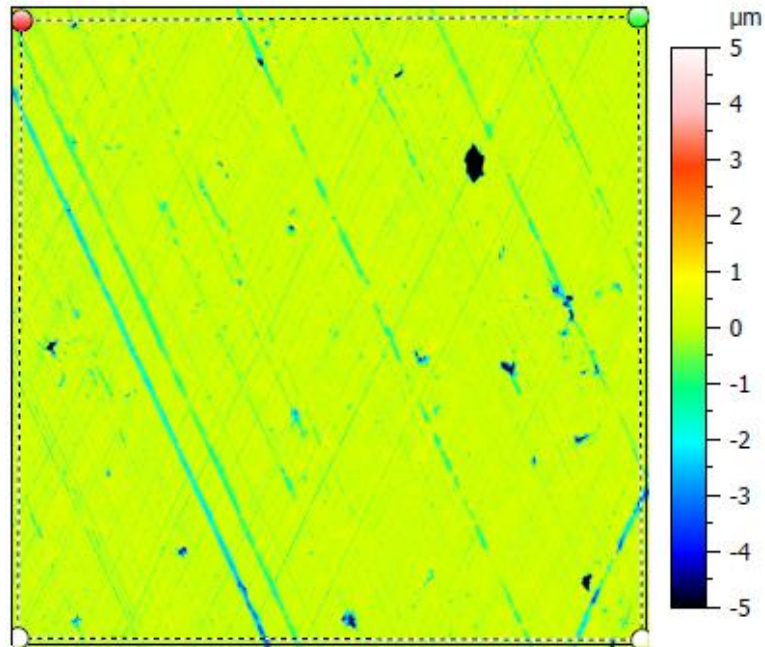


"PNB TDC"

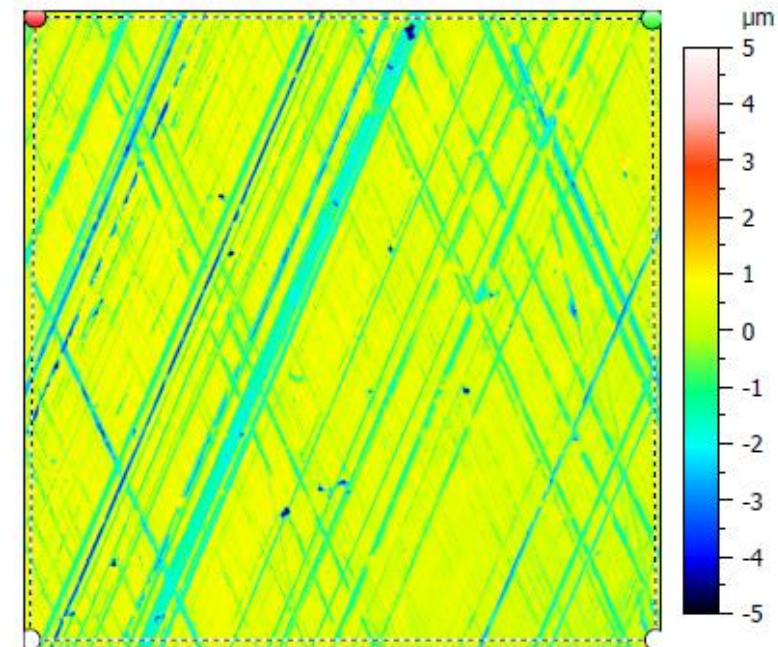


The PNB has more hone

"Batch C Mid Stroke"



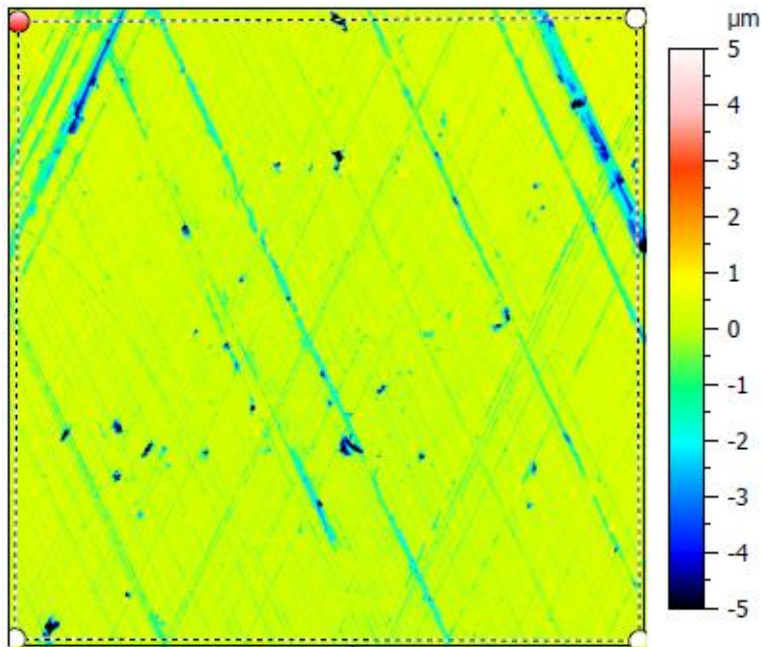
"PNB Mid Stroke"



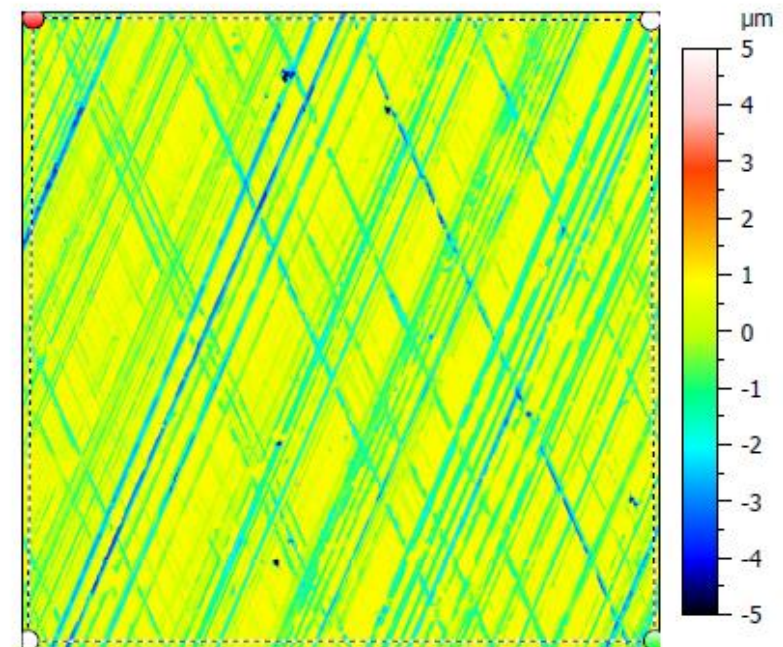
The PNB seems consistently honed in both directions



"Batch C BDC"

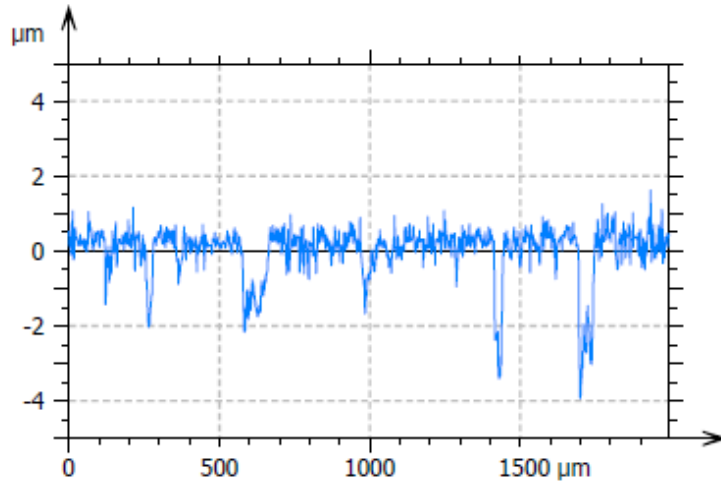


"PNB BDC"

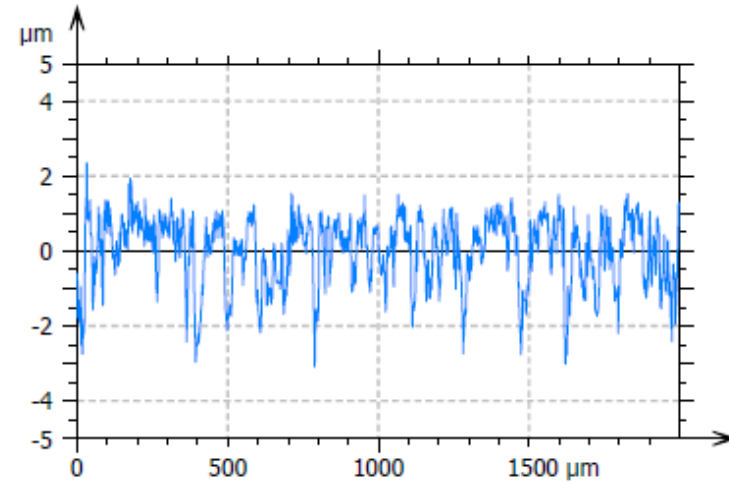


The PNB is again honed in both directions

"Batch C TDC"



"PNB TDC"

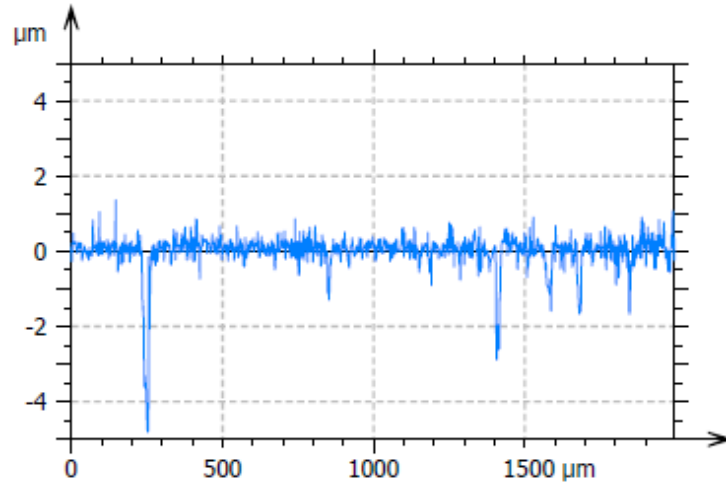


The PNB liner has a rougher hone

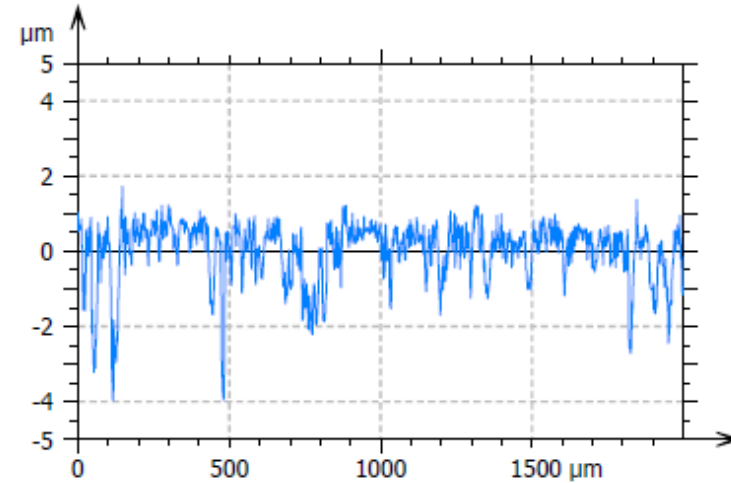


# Profilometry – Mid-Stroke

"Batch C Mid Stroke"

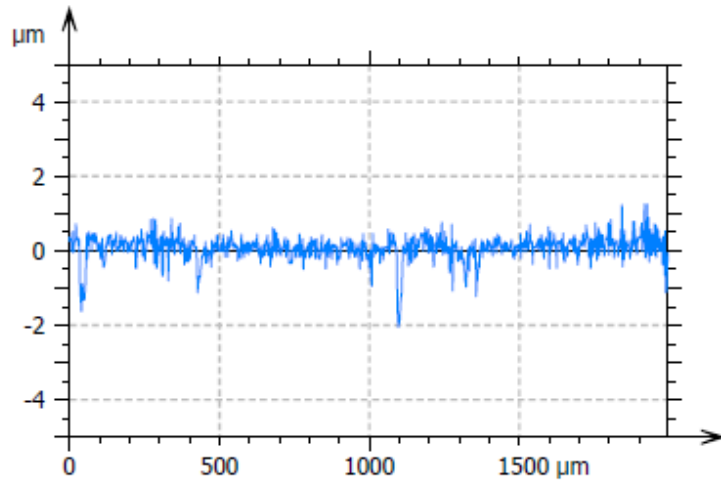


"PNB Mid Stroke"

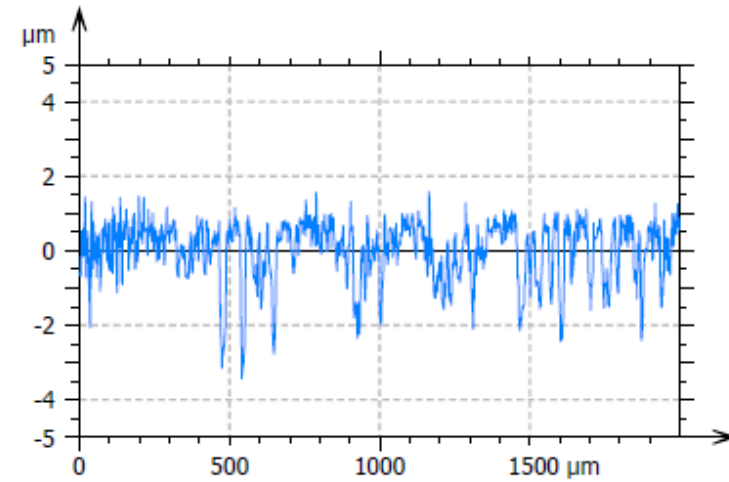


The PNB hone is more consistently negative

"Batch C BDC"



"PNB BDC"



The PNB hone is consistently rougher/deeper in both 2D and 3D

# Cylinder Liner Roughness



## Roughness Parameters

Liner	Location	Spk	Svk	Sa	Sk	Rpk	Rvk	Ra	Rk	Rvo
PNB	TDC	0.339	1.519	0.773	1.844	0.377	1.402	0.747	1.870	0.145
PNB	MS	0.277	1.658	0.566	1.043	0.280	1.727	0.596	1.097	0.182
PNB	BDC	0.300	1.571	0.658	1.348	0.269	1.480	0.628	1.296	0.172
Batch C	TDC	0.312	1.676	0.440	0.697	0.247	1.298	0.396	0.642	0.147
Batch C	MS	0.265	0.950	0.234	0.459	0.258	1.416	0.292	0.527	0.118
Batch C	BDC	0.269	1.306	0.299	0.552	0.271	0.727	0.227	0.510	0.057

# Conclusions



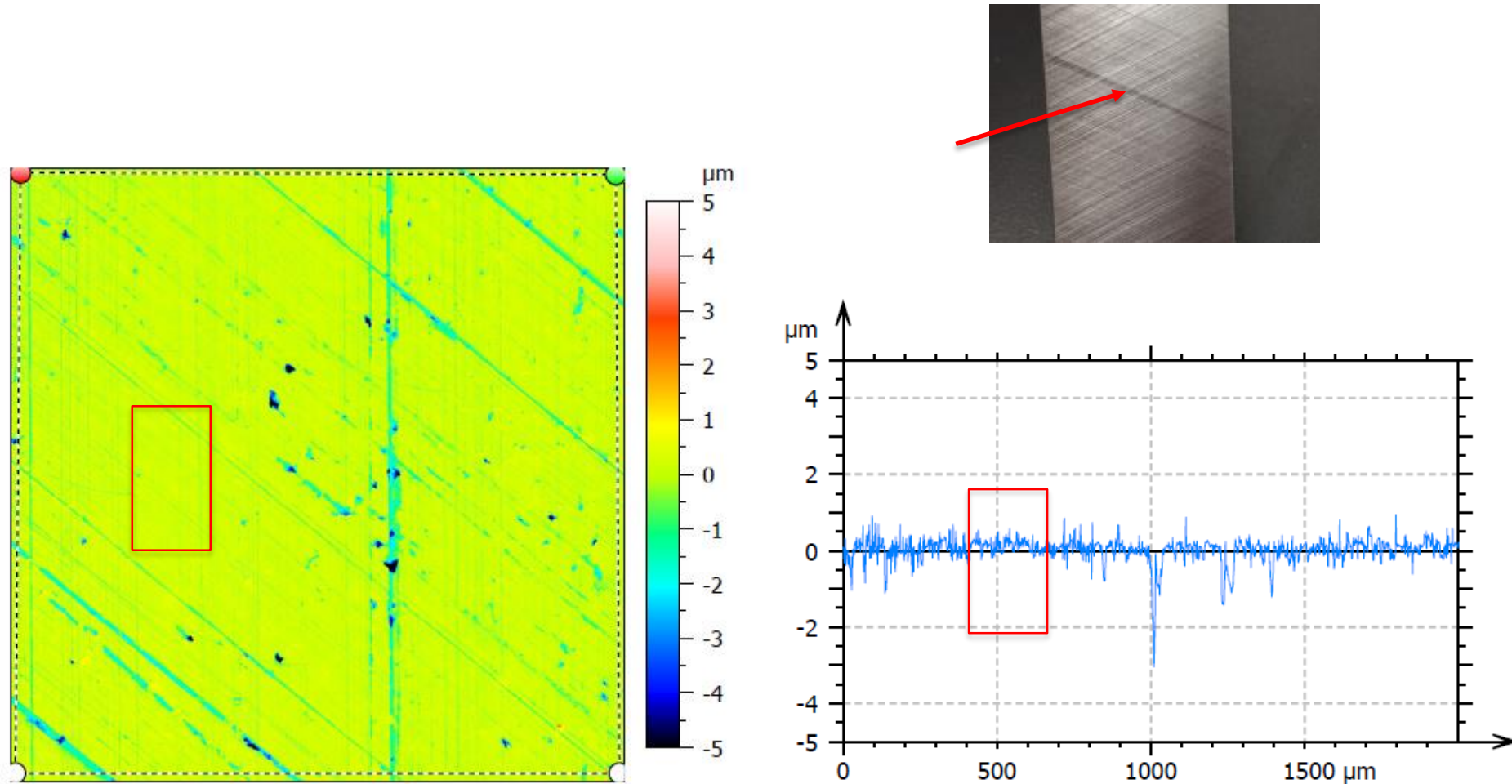
- Visually the PNB liner is more consistently honed than the Batch C liner
- Roughness parameters support the Batch C liner does not have as many valleys
- This was one of each liner and they fall within the statistical expectations

**The PNB liner is rougher than the Batch C liner, but within expected limits**



## Batch C Liner Abnormal Hone Mark

# Abnormal hone pattern



Several of these “dark” hones that have little to no valleys



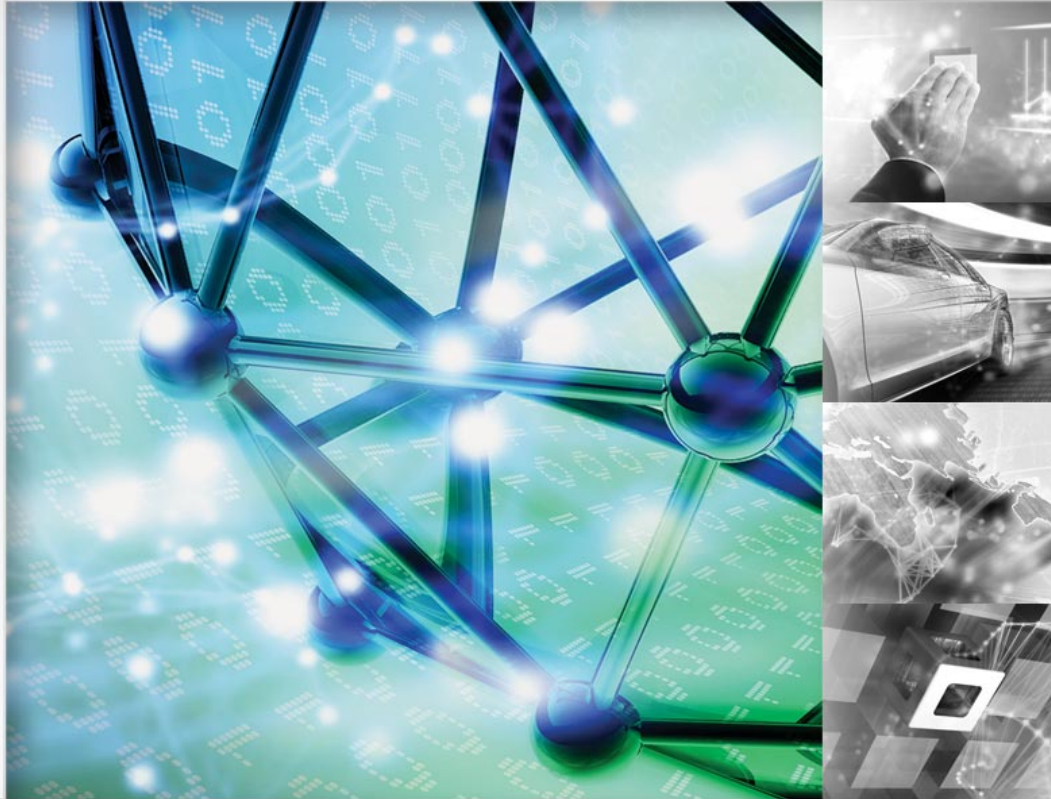
## Working together, achieving great things

When your company and ours combine energies, great things can happen. You bring ideas, challenges and opportunities. We'll bring powerful additive and market expertise, unmatched testing capabilities, integrated global supply and an independent approach to help you differentiate and succeed.

# Next Steps Decided During 01MAR2018 Meeting:

- SP Discussion:
  - Next Steps for referencing (see below)
  - In parallel additional material/surface analysis (4 additional liners for PNB and Batch C)
    - 1 PNB and 1 Batch C liner material analysis at top and bottom to look at gravity vs. spun casting differences.
- 3 Data Points – Intertek/SWRI/Lubrizol – Matrix Stands
  - Batch B – Top Ring
  - Batch A – Second and Third Ring
  - Batch A – Pistons
  - Batch C – Liners
  - Oil 864-1
- Planned to start in the next 1 to 2 weeks depending on the lab.





# DD13 Scuffing Test Liner Comparison and Equating Specs

Kevin O'Malley  
The Lubrizol Corporation  
February 2018

# Summary



## Current Situation:

- Initial liner spec guidelines were set using 0.0002" radius stylus and are based on average measurements per liner:
  - Rvk: 0.5 to 1.8; Rk: 0.2 to 0.8; Rpk: 0.2 max
- DD13 reference tests have liners measured using 0.0001" radius stylus.
  - The average measurement per liner is provided in the ltms.csv file.
- TEI has measured 150 Batch C liners using both styluses; 4 measurements are provided for each liner using each stylus.

## Findings:

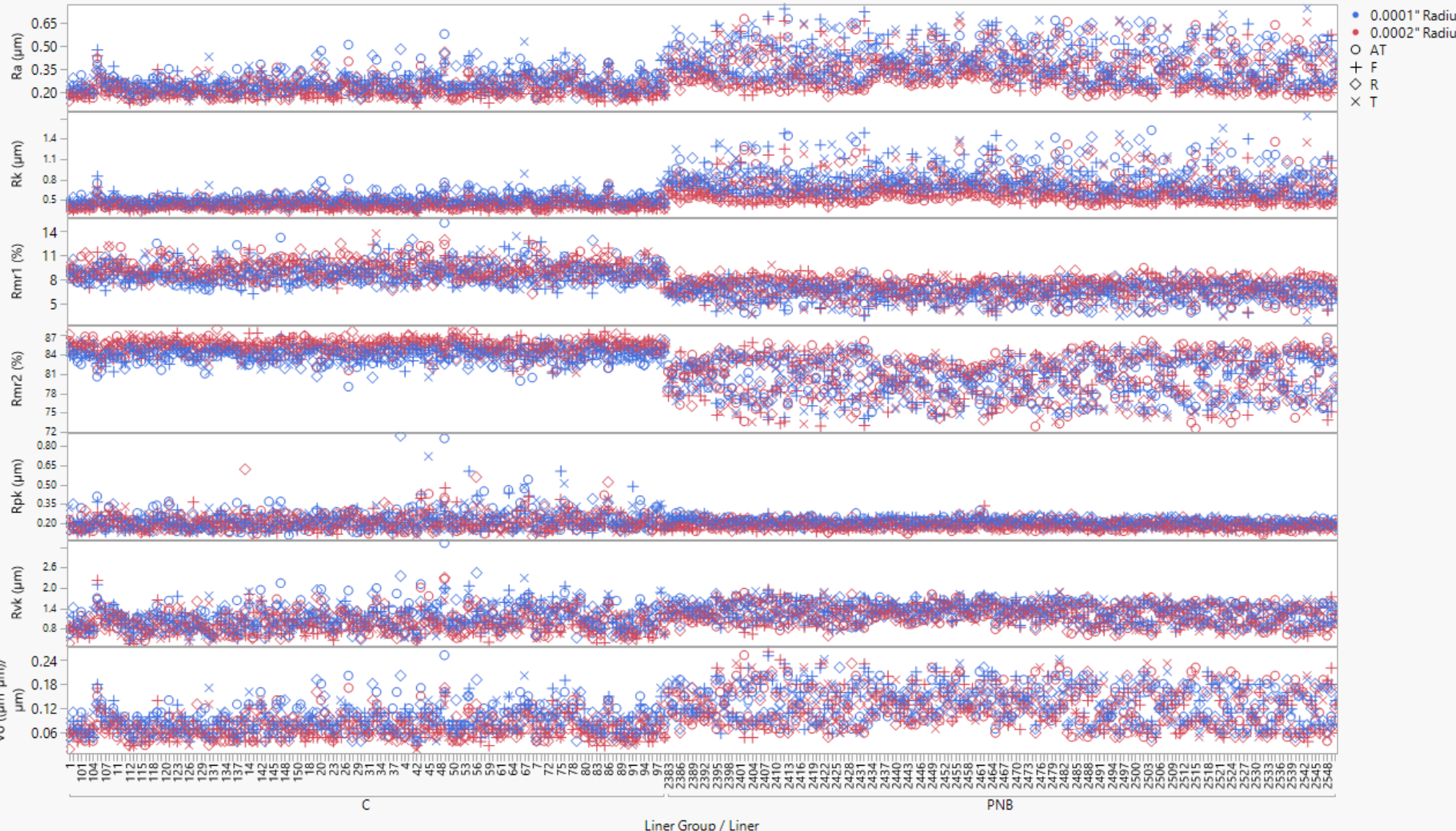
- Batch C liners differ from PNB liners
- If batch C liners are acceptable for use, the proposed limits below would ensure the same probability of acceptance for batch C liners using the 0.0001" radius stylus as PNB liners using the 0.0002" radius stylus.

	Current Daimler Spec using 0.0002" stylus	Proposed Spec for Batch C Liners using 0.0001" stylus
Rvk	0.5 to 1.8	0 to 2.31
Rk	0.2 to 0.8	0.11 to 0.63
Rpk	0.2 max	0.27 max

# Liner Measurements



Batch C liners differ from PNB liners

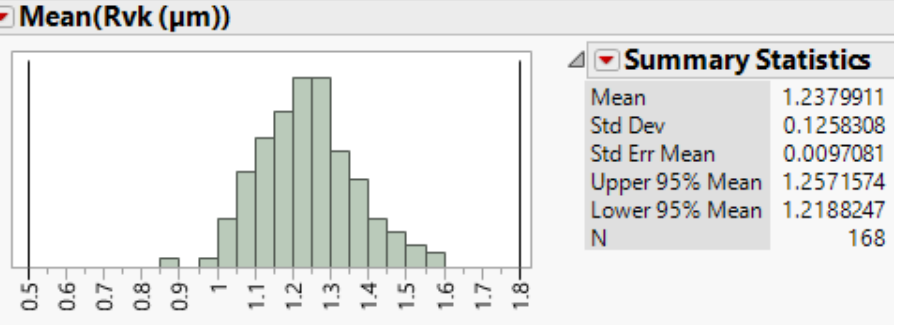
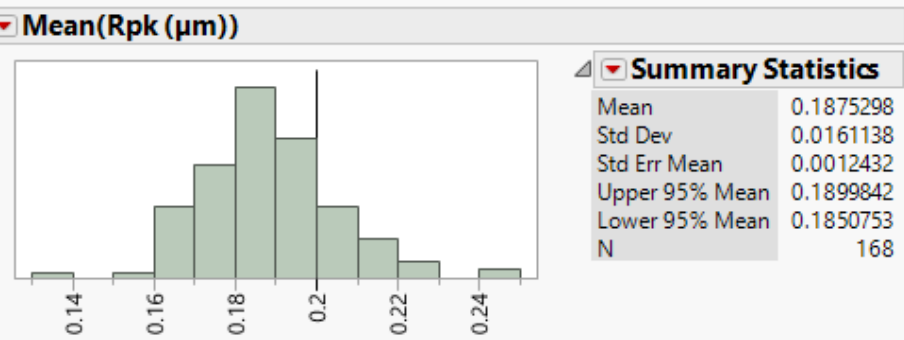
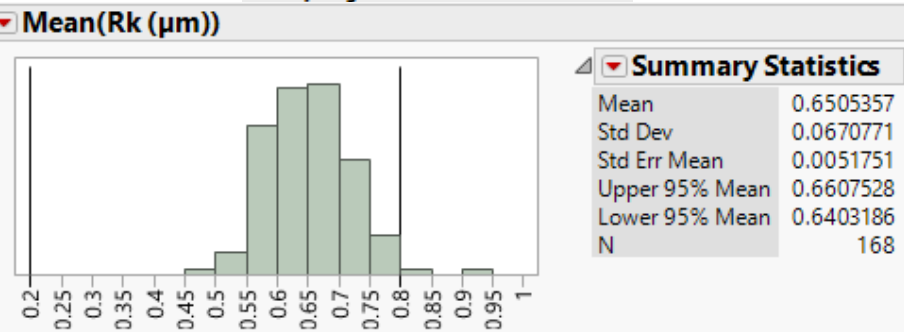


# Deriving equivalent specs for 0.0001" Radius Stylus

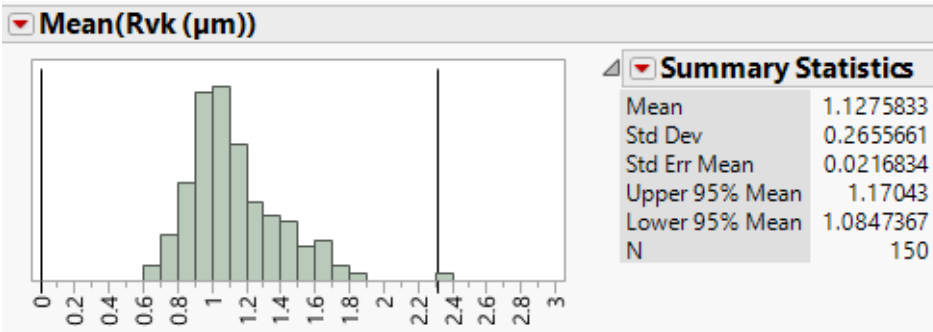
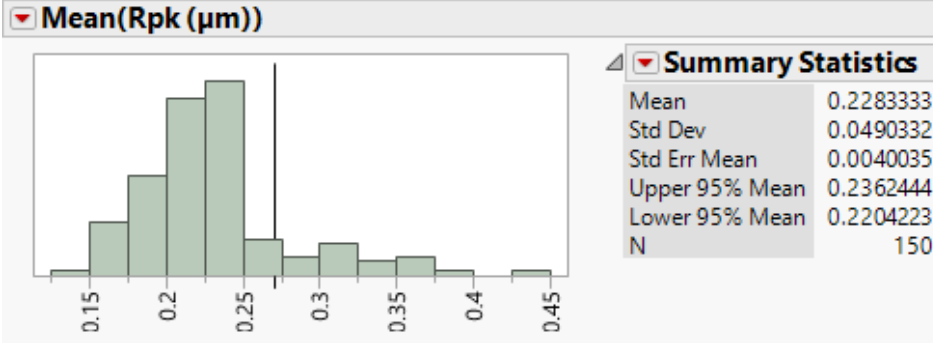
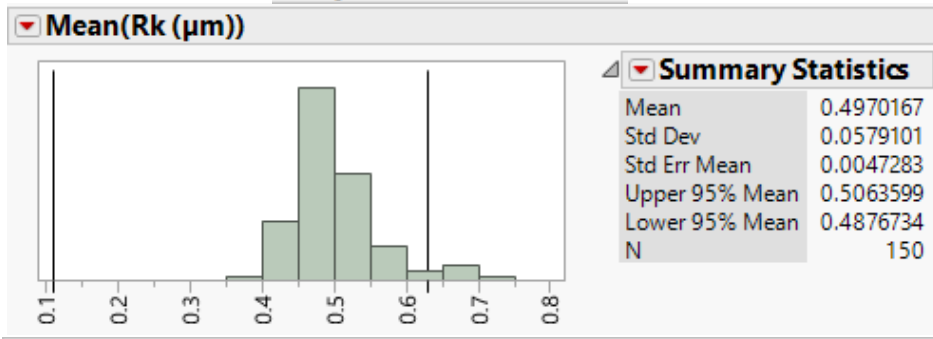


Proposed Batch C liner specs were derived to achieve similar probability of acceptance as PNB using Daimler specs (assumption of normality was used in calculations; the four measurements for each liner were averaged)

**PNB, Stylus=0.0002" Radius**



**C, Stylus=0.0001" Radius**







## Working together, achieving great things

When your company and ours combine energies, great things can happen. You bring ideas, challenges and opportunities. We'll bring powerful additive and market expertise, unmatched testing capabilities, integrated global supply and an independent approach to help you differentiate and succeed.