

Mack T-12 “Y” Top Ring analysis

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Mack T-12 New Top Ring Batch

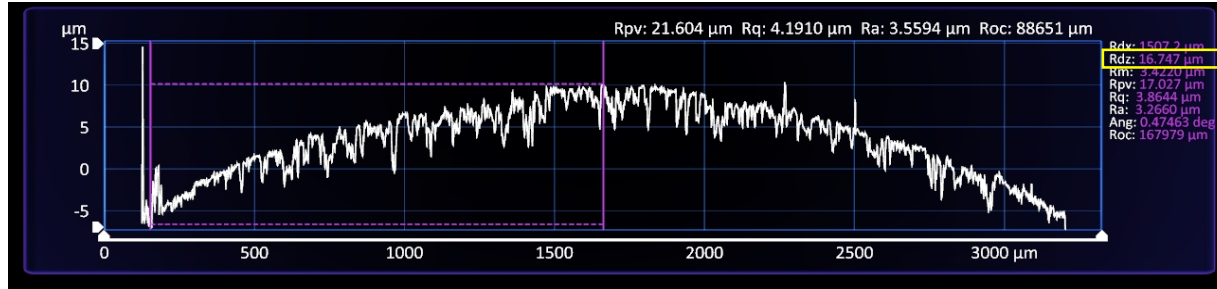


- A new batch of top rings is available for the Mack T-12
- The new top ring batch is the “Y” batch
- Infineum has conducted analysis of this “Y” top ring batch and has compared it to data of previous top ring batches that was previously shared with the Surveillance Panel

Rings used in this analysis

- “S” new top ring
- “T” new top ring
- “U” new top ring
- “X” new top ring
- “Y” new top ring

Top Ring Barrel Rise



Top Ring Batch	Barrel Rise (μm)
S	24.7 – 25.8
T	11.1 – 14.9
U	13.5 – 14.8
X	12.1 – 16.0
Y	14.8 – 18.2

Top Ring Coating Elemental Analysis

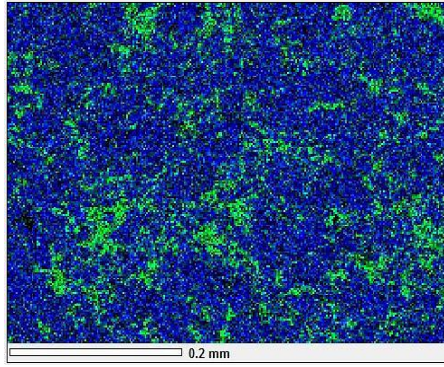


Ring	S	T	T	U	X	X	X	Y	Y	Y
Element (Mole %)	Seg 1	Seg 1	Seg 2	Seg 1	Seg 1	Seg 2	Seg 3	Seg 1	Seg 2	Seg 3
Cr	41.42	30.68	25.59	19.09	37.93	38.38	36.53	35.79	28.60	37.47
Mo	1.88	2.01	1.67	1.46	1.99	1.9	1.96	1.44	2.47	1.82
Ni	7.99	8.73	6.64	5.05	7.77	7.6	7.44	7.14	8.78	6.41
Al	0.25	0.54	6.88	16.91	0.13	0.15	0.16	0.18	0.11	0.19
C	42.39	48.22	46.48	48.81	47.24	47.19	48.59	49.31	54.51	48.06
O	5.18	7.50	10.05	7.65	4.56	4.4	4.91	4.98	4.71	4.89
Si	0.55	0.77	0.60	0.79	0.3	0.37	0.41	0.43	0.50	0.81
Zn	0.35	0.59	0.38	0.25	0.08	0	0	0.29	0.32	0.34

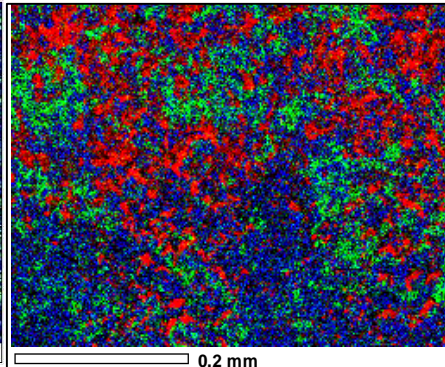
- “Y” batch is similar to “X” batch in elemental content.
“X” batch contained a different side coating without Zn.

Top Ring Coating Elemental Analysis

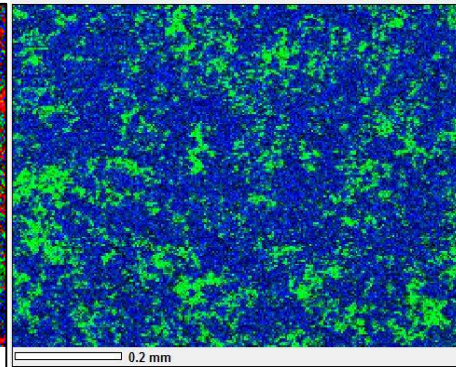
“S” ring



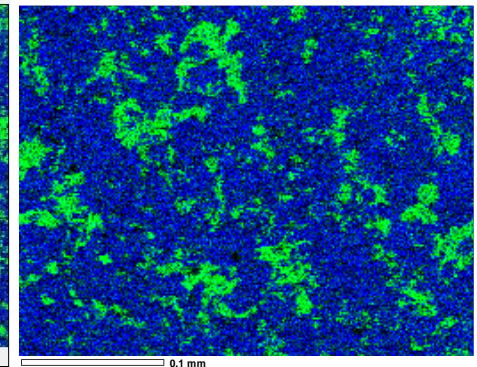
“U” ring



“X” ring



“Y” ring

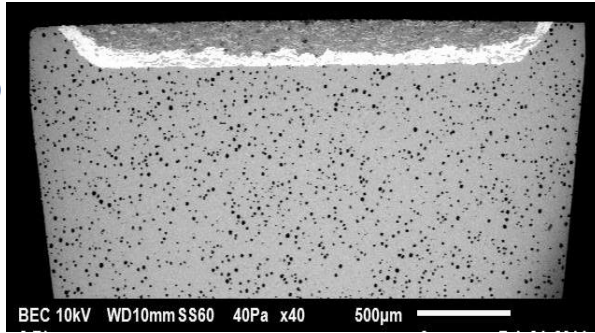


Red = Al, Blue = Cr, Green = Mo

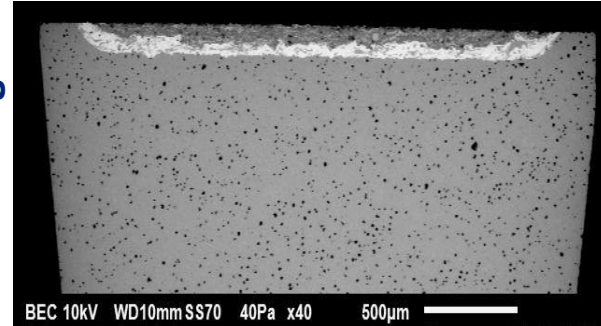
- Surface Aluminum added in the “U” batch ring is not present in the “Y” batch ring.
- Mo/Ni-rich domains are present in the coating structure of the “Y” batch ring similar to “X” batch.

Cross Section Analysis of Rings

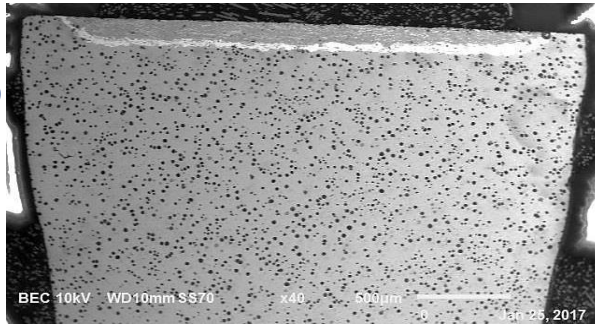
“S” ring



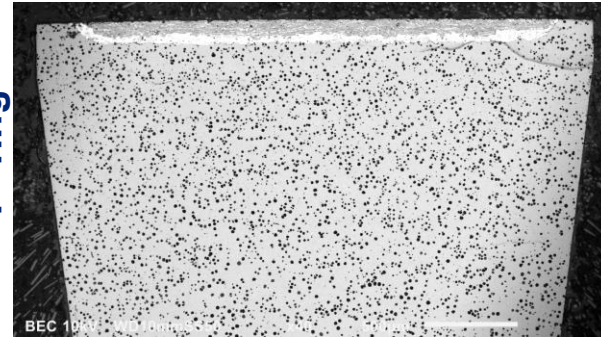
“U” ring



“X” ring



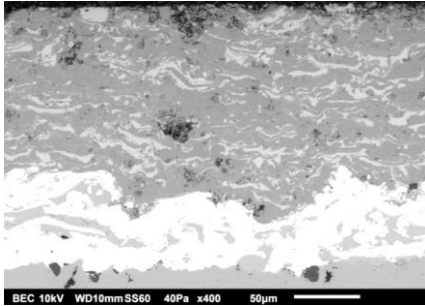
“Y” ring



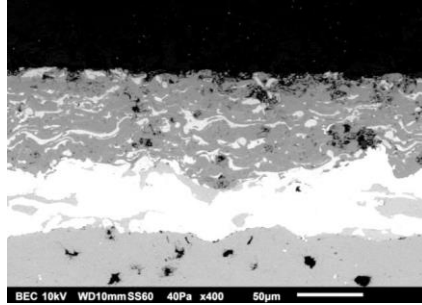
- Coating bulk structure seems to be similar in all batches
- Substrate material is ductile iron and similar for all batches

Cross Section Analysis of Rings

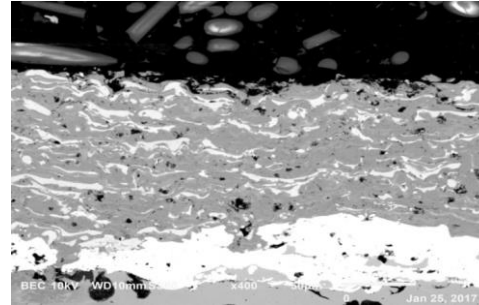
“S” ring



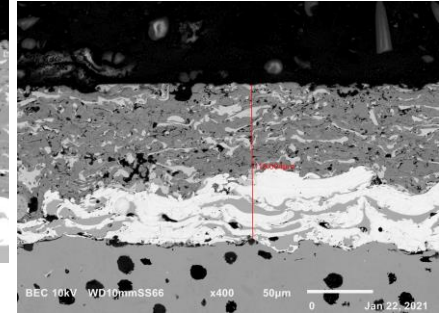
“U” ring



“X” ring



“Y” ring

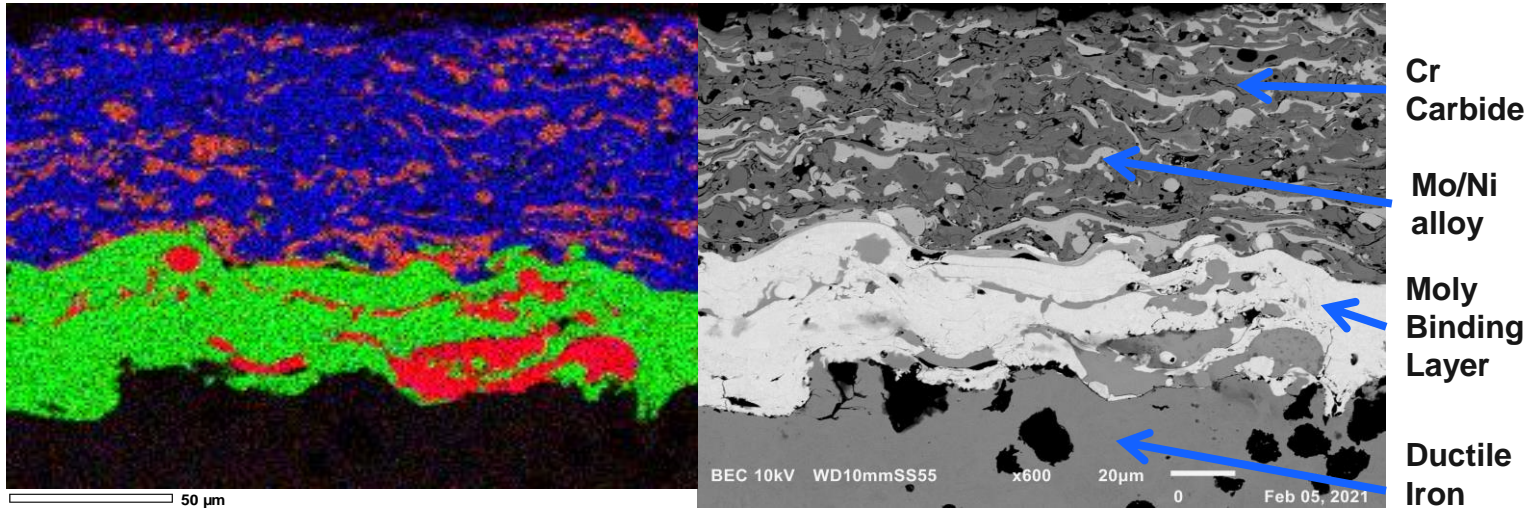


Ring Batch	Coating Thickness (µm) Including Mo Layer
S	200
U	127
X	161
Y	115-130

- Mo/Ni alloy domains are evenly distributed close to the surface as seen in previous batches.
- Mo binding layer present between ductile iron substrate and coating
- “Y” ring coating thickness is similar to “U” batch and thinner than “S” and “X”
- Coating pore structure appears to be maintained from prior batches.

Cross Section Analysis

“Y” ring

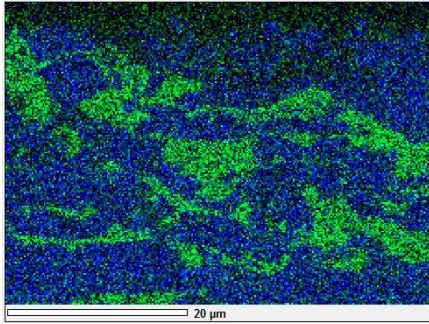


Red = Ni, Blue = Cr, Green = Mo

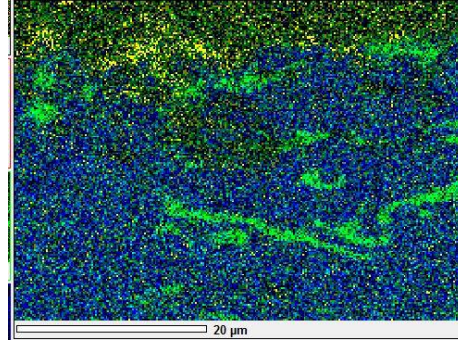
- Coating contains Ni/Mo domains that can be found at surface and in substructure.
- “Y” ring has a substantial surface and bulk pore structure

Cross Section Analysis of Rings

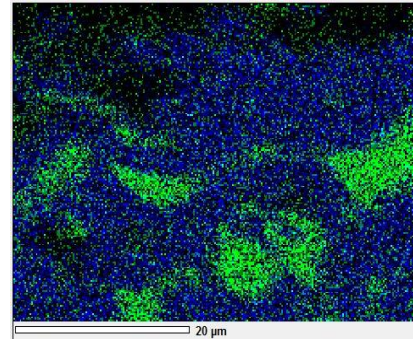
“S” ring



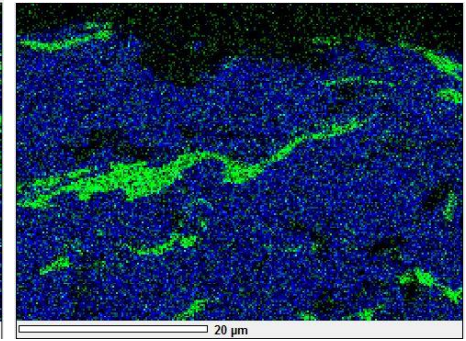
“U” ring



“X” ring



“Y” ring

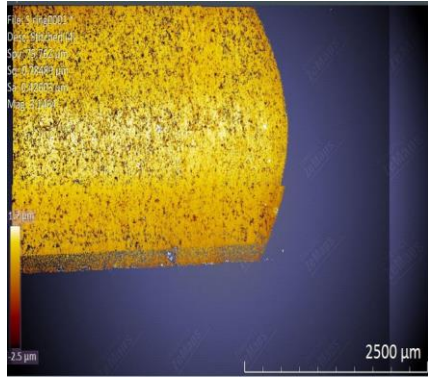


Blue = Cr, Green = Mo, Yellow=Al

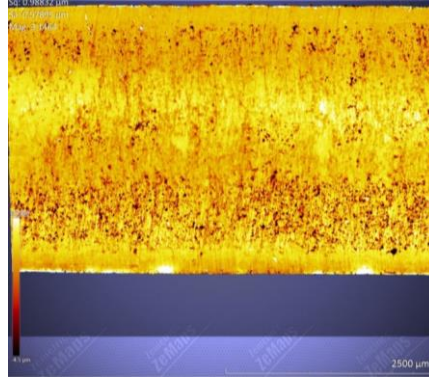
- Surface aluminum particles found in “U” batch rings are not present in “Y” batch.
- Cross-section of “Y” batch indicates similarity to “S” and “X” batch.

Top Ring Pore Density

“S” ring Sa = 0.426

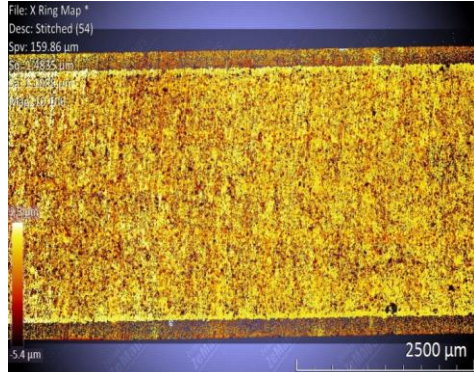


“U” ring Sa = 0.579

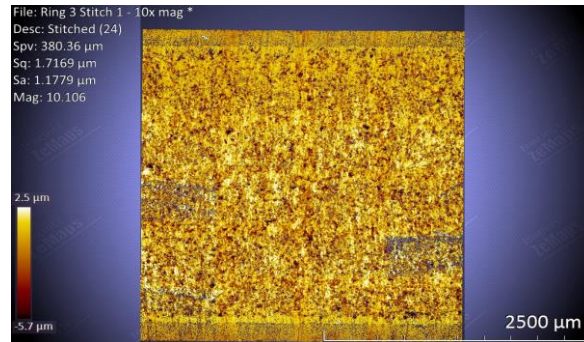


- Surface of “Y” batch ring has a similar amount of pores compared to “X” batch, but higher than previous batches.
- Surface roughness of “Y” batch rings is similar to “X” batch, but higher than previous batches.
- “Y” batch pore distribution is uniform across the surface as previously seen in “X” and “S” batches.

“X” ring Sa = 1.108



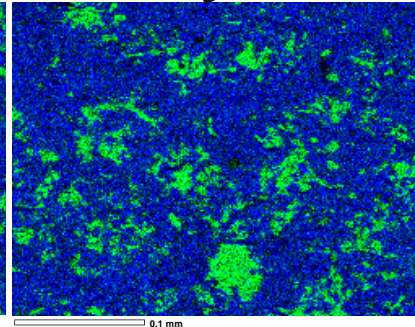
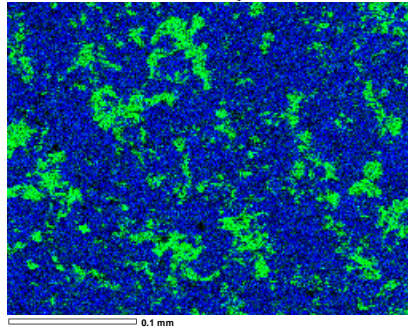
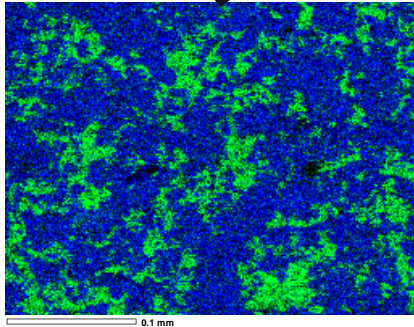
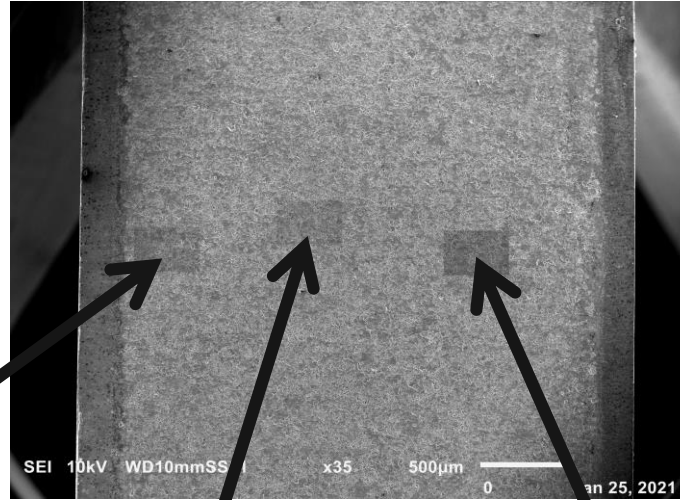
“Y” ring Avg Sa = 1.116



Molybdenum Domain Uniformity “Y” ring

- Molybdenum domains are uniform in size throughout coating surface

Blue = Cr
Green = Mo



Ring Side Coating Elemental Analysis

Ring	T	U	X	Y
Element	Mole %	Mole %	Mole %	Mole %
P	9.64	9.9	5.32	9.12
Fe	8.3	13.67	4.19	4.85
C	32.6	24.91	61.65	34.34
O	35.38	36.84	25.04	39.25
Si	0.54	0.73	0.39	0.35
Zn	12.3	13.96	0	9.55
Mn	0	0	3.41	0.09
Ca	1.24	0	0	2.46

“T” Ring



“X” Ring



- “Y” batch rings have a Zinc Phosphate coating on the sides and back similar to “T” and “U”
- “X” batch rings has a Manganese Phosphate coating on the sides and back

- The barrel rise and symmetry is similar to the previous batches of rings.
- The structure of the “Y” ring face coating is similar to the “X” ring face coating
 - Coating elemental composition is similar between “Y” and “X” batch rings.
 - Coating thickness is thinner for “Y” batch than previous ring batches.
 - Surface pore distribution is uniform in “Y” batch rings and aligned with “X” batch rings.
 - Roughness of “Y” batch rings and pore concentration is similar to “X” batch rings.
- Corrosion protection layer on side and back of ring matches the composition from “T”/”U” batch rings.

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