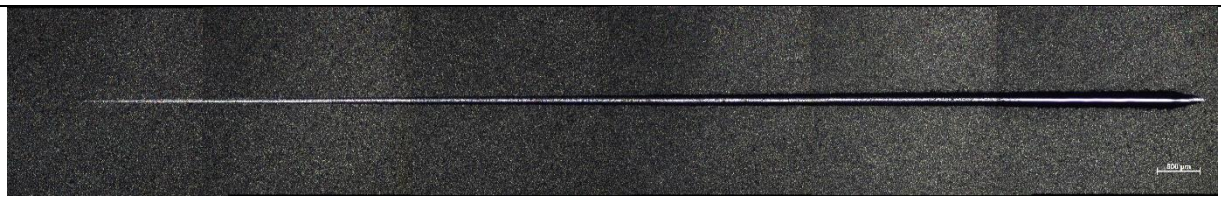
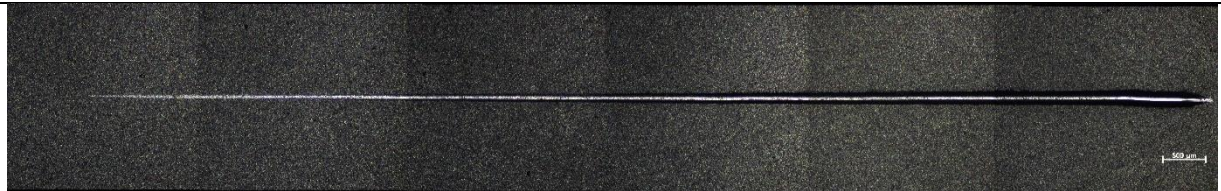
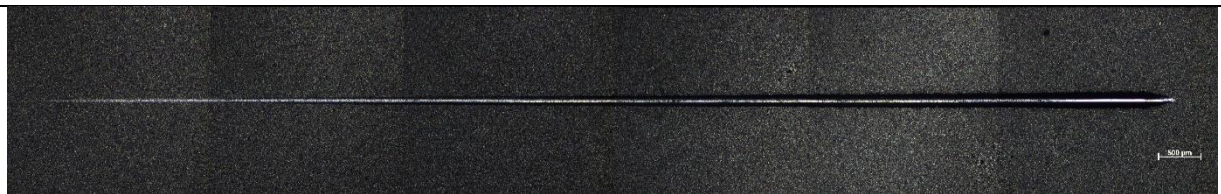
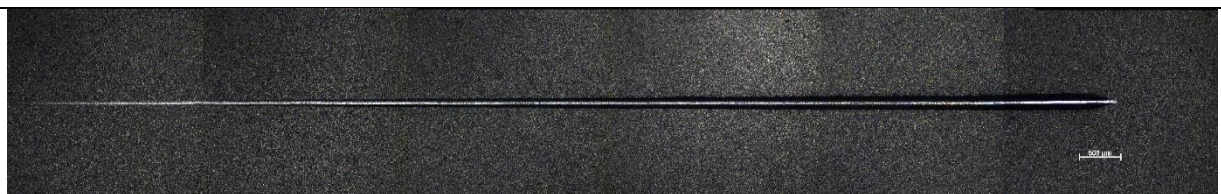
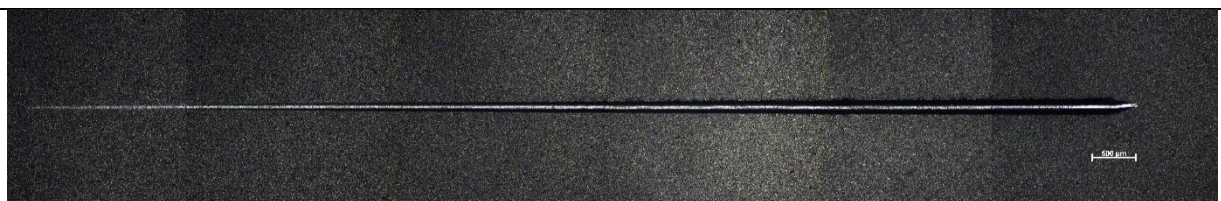
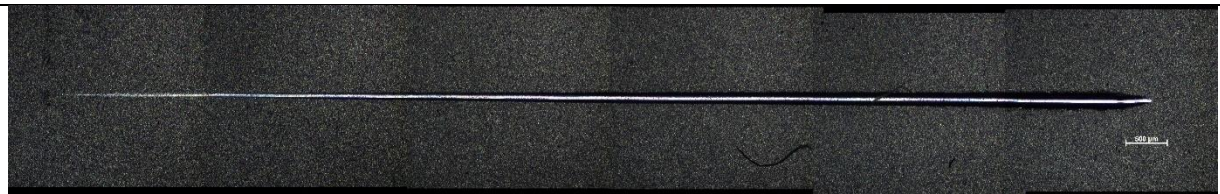
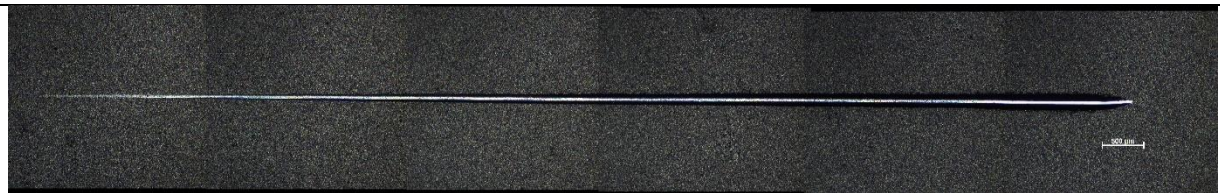
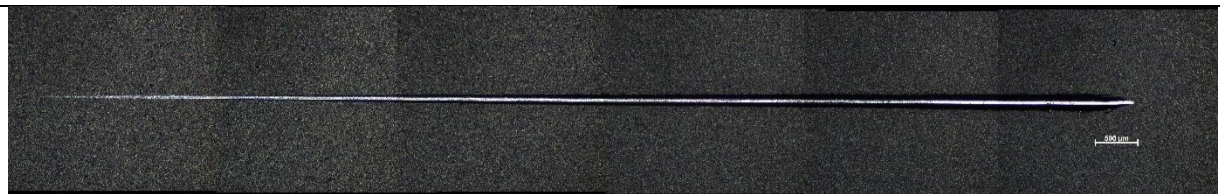
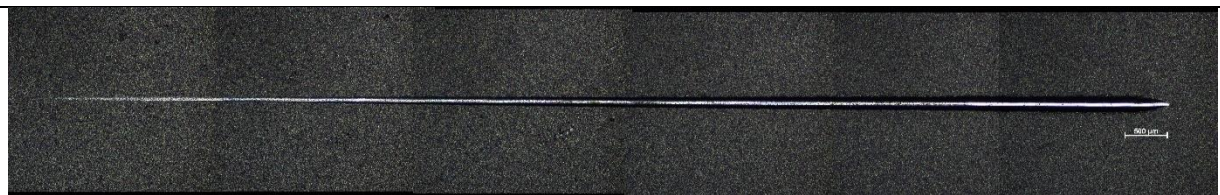
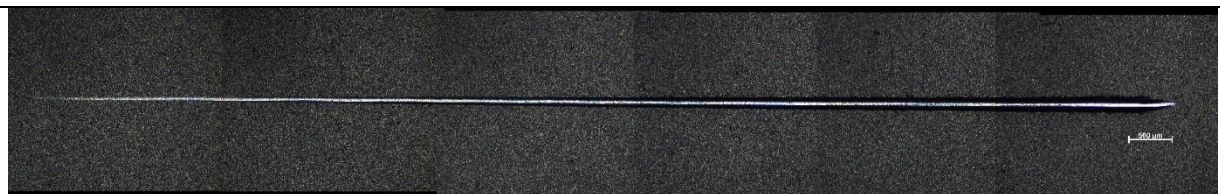


APPENDICES

- Appendix 1:** *Optical microscopic panorama photos of scratches taken by progressive loading*
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 - 1.2. *OM photos for LUMENA coating*
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 - 6.4. *The measured wear track width values for FORMER and LUMENA cotaings and for the REFERENCE material*

**P_F4a_v3_p1****P_F4a_v4_50X_p1****P_F4a_v5_50X_p1****P_F4a_v6_50X_p1****P_F4a_v7_50X_p1****P_F4a_v8_50X_p1**

**P_L4a_v1_50X_p1****P_L4a_v2_50X_p1****P_L4a_v3_50X_p1****P_L4a_v4_50X_p1****P_L4a_v5_50X_p1****P_L4a_v6_50X_p1**

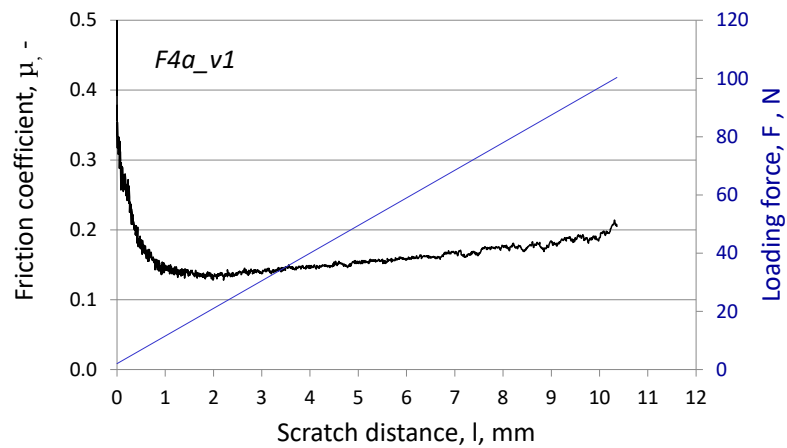
Friction coefficient/loading force vs. scratch length diagrams for **progressive** loading scratch tests
 FORMERA COATING; $F_{(\min \div \max)} = 2 \div 100 \text{ N}$; $F_{\text{grad}} = 10 \text{ N/mm}$; $L = 10 \text{ mm}$

Trial tests

Test parameters:

- Starting load=2 N
- Maximum load force=100 N
- Gradient=10 N/mm
- L=10 mm

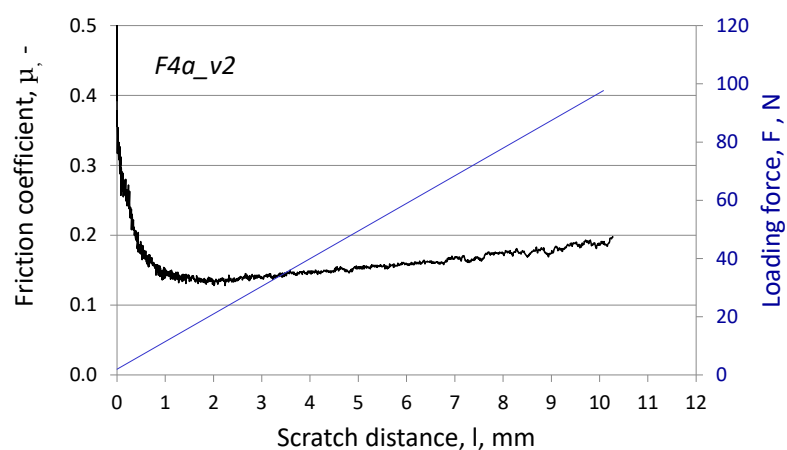
F4a_v1



Parameters:

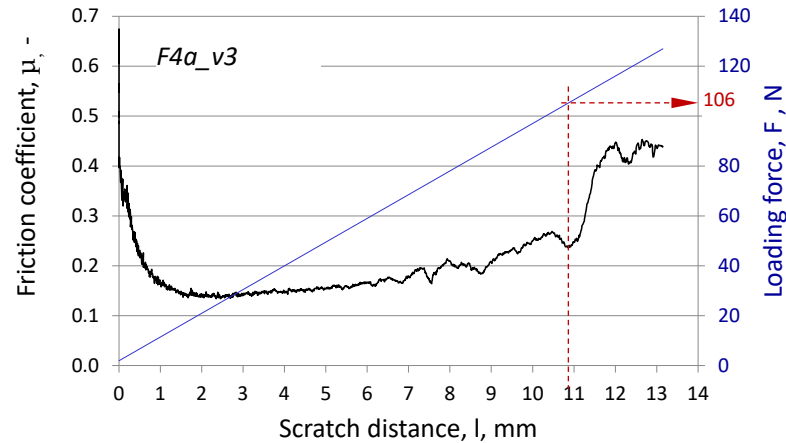
- Starting load=2 N
- Maximum load force=120 N
- Gradient=12 N/mm
- L=10 mm

F4a_v2

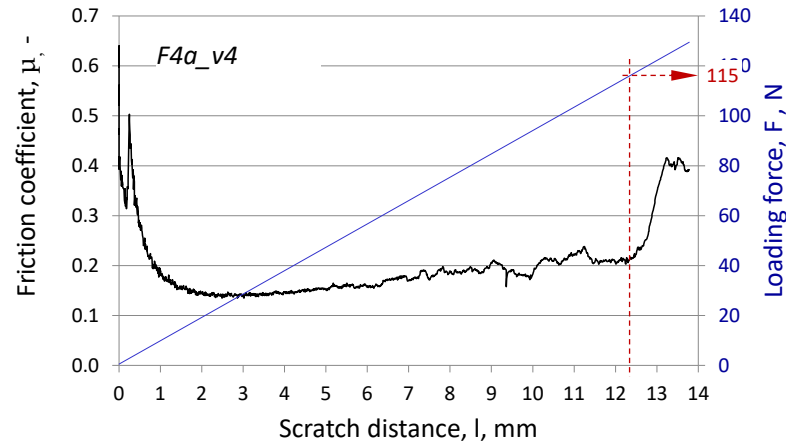


Friction coefficient/loading force vs. scratch length diagrams for **progressive** loading scratch tests
FORMERA COATING_ $F_{(min÷max)} = 2÷130\text{ N}$; $F_{grad} = 10\text{ N/mm}$; $L = 13\text{ mm}$

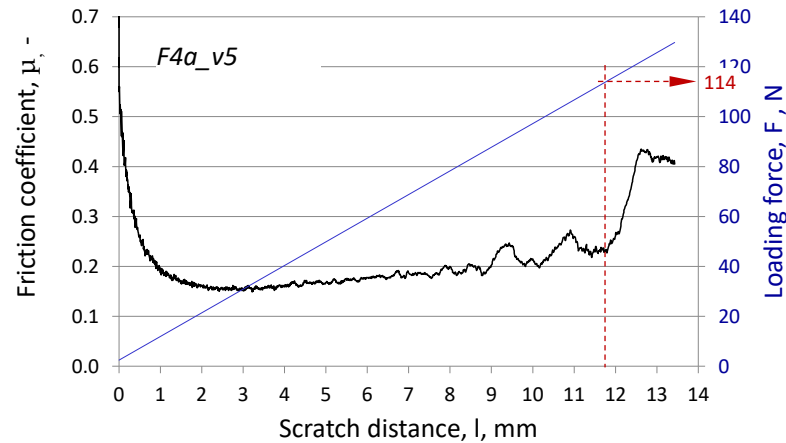
F4a_v3



F4a_v4

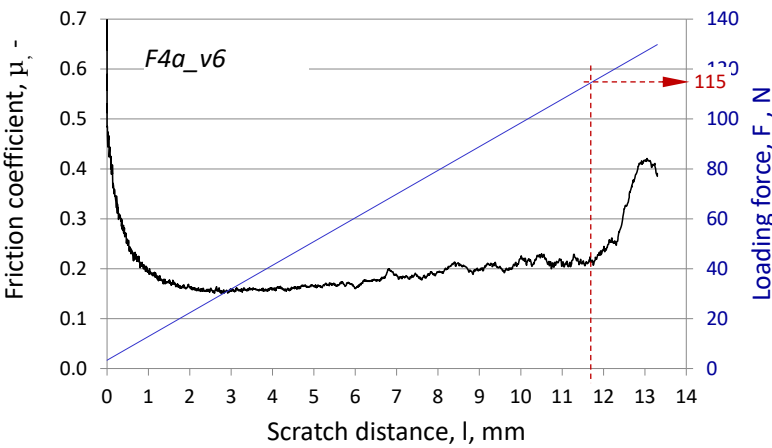


F4a_v5

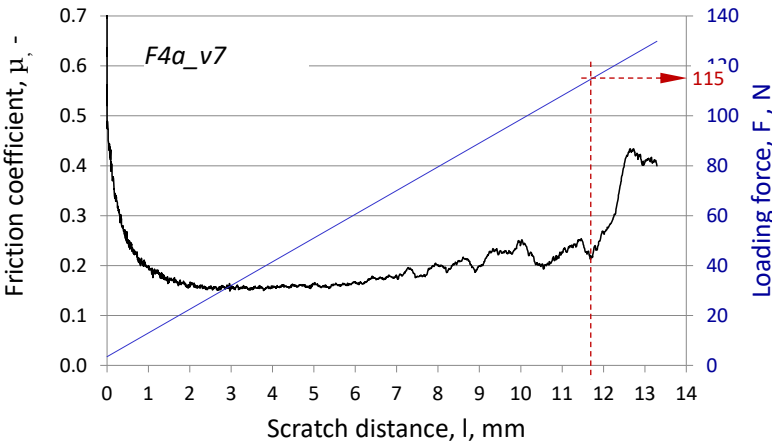


Friction coefficient/loading force vs. scratch length diagrams for **progressive** loading scratch tests
FORMERA COATING_ $F_{(min÷max)} = 2÷130\text{ N}$; $F_{grad} = 10\text{ N/mm}$; $L = 13\text{ mm}$

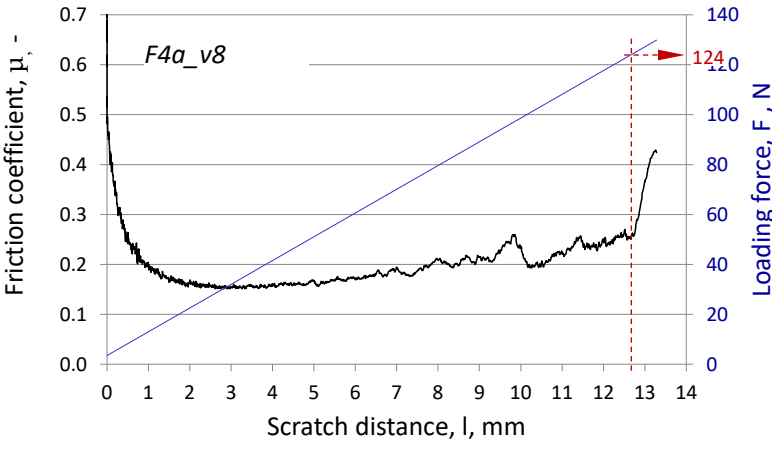
F4a_v6



F4a_v7

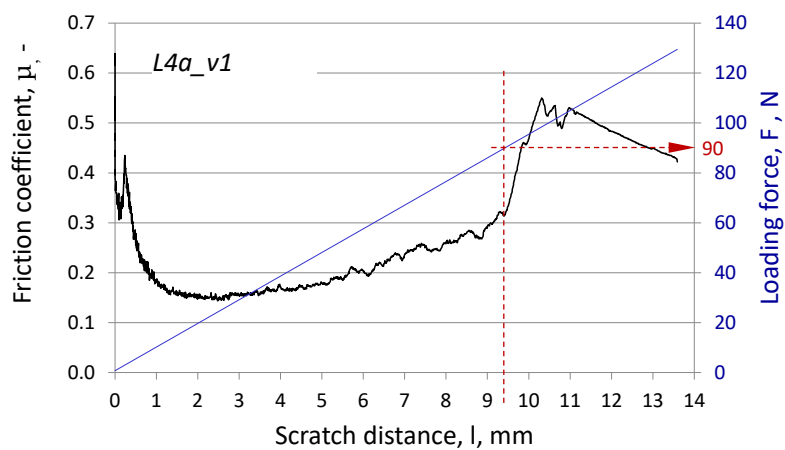


F4a_v8

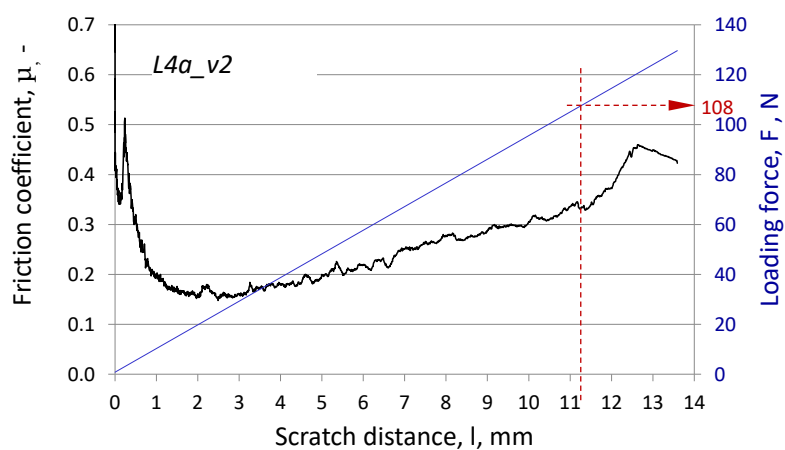


Friction coefficient/loading force vs. scratch length diagrams for **progressive** loading scratch testsLUMENA COATING_ $F_{(min÷max)} = 2÷130\text{ N}$; $F_{grad} = 10\text{ N/mm}$; $L = 13\text{ mm}$

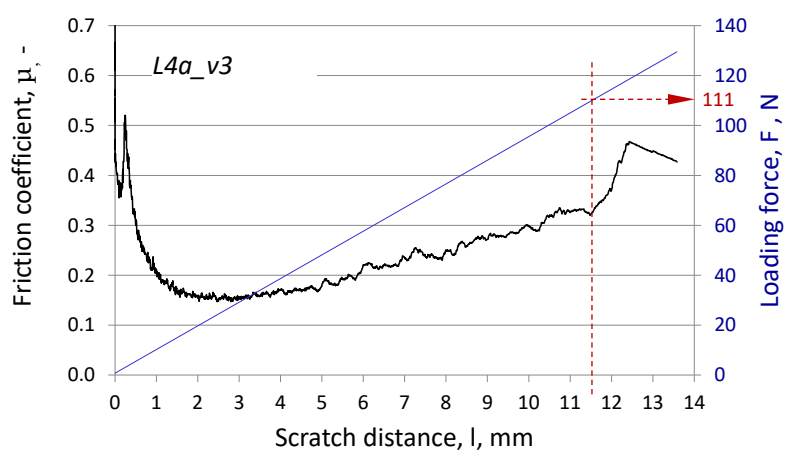
L4a_v1



L4a_v2



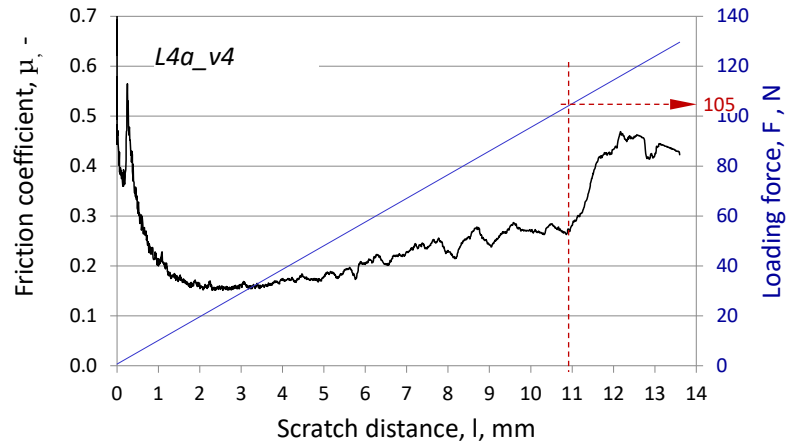
L4a_v3



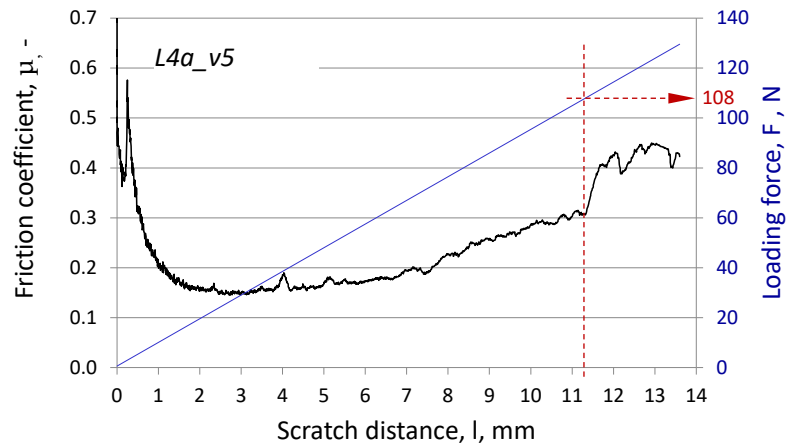
Friction coefficient/loading force vs. scratch length diagrams for **progressive** loading scratch tests

LUMENA COATING_ $F_{(\min \div \max)} = 2 \div 130$ N; $F_{\text{grad}} = 10$ N/mm; $L = 13$ mm

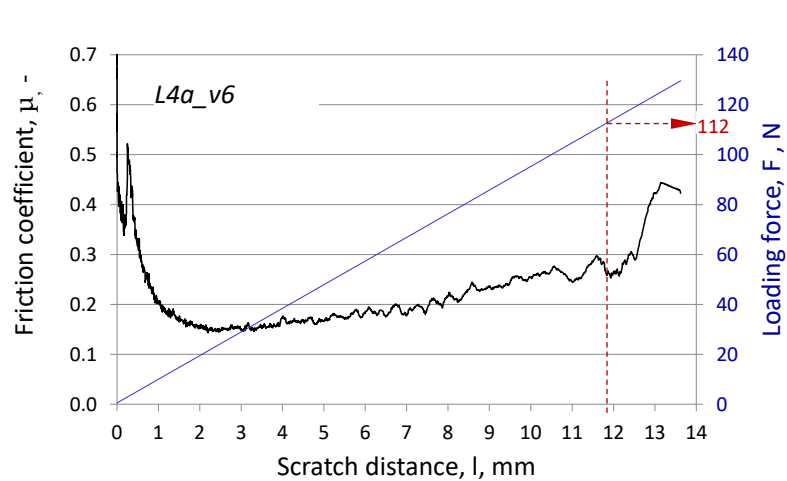
L4a_v4



L4a_v5



L4a_v6



Critical forces (F_{crit}) obtained from the **progressive** loading scratch testsLUMENA COATING_ $F_{(min \div max)} = 2 \div 130$ N; $F_{grad} = 10$ N/mm; $L = 13$ mm

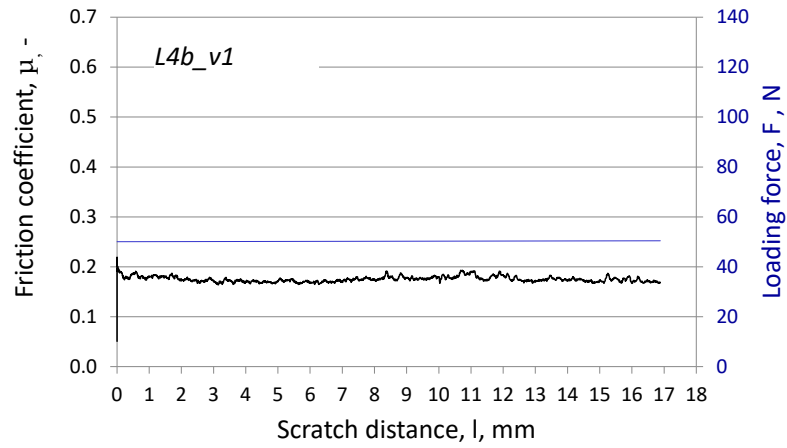
Coating	Scratch identifier	F_{crit} , N	Average	SD, μm	Var. coeff.,%
Formera	F4a_v3	106	114.8	5.71	4.97
	F4a_v4	115			
	F4a_v5	114			
	F4a_v6	115			
	F4a_v7	115			
	F4a_v8	124			
Lumena	L4a_v1	90	105.7	8.07	7.63
	L4a_v2	108			
	L4a_v3	111			
	L4a_v4	105			
	L4a_v5	108			
	L4a_v6	112			

TRIAL TESTS on LUMENA COATING

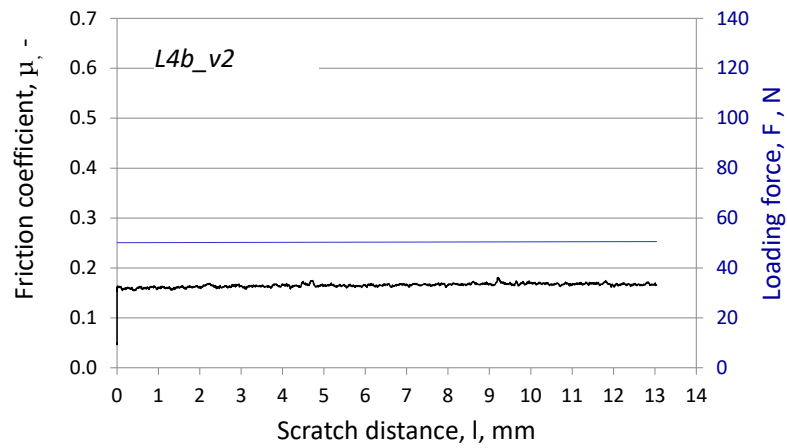
Friction coefficient/loading force vs. scratch length diagrams for constant loading scratch tests

 $F_{(\min \div \max)} = 2 \div 100 \text{ N}$; $F_{\text{grad}} = 10 \text{ N/mm}$; $L = 10 \text{ mm}$ **Trial tests****Test parameters:**

- **F=50 N**
- **L=16.88 mm**
- **L4b_v1**

**Test parameters:**

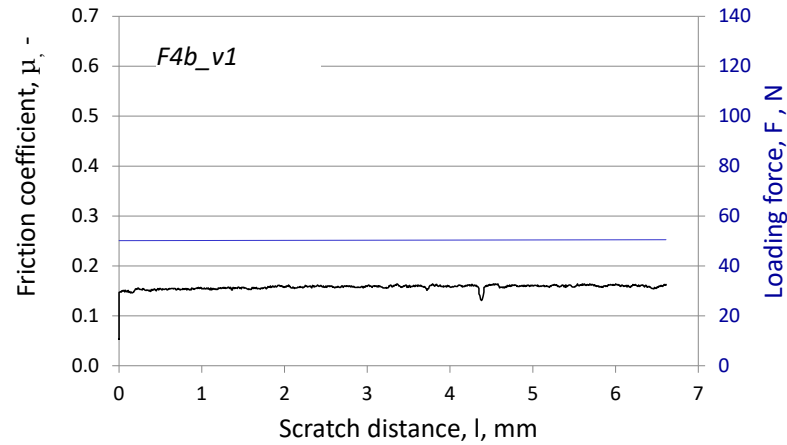
- **F=50 N**
- **L=13.8mm**



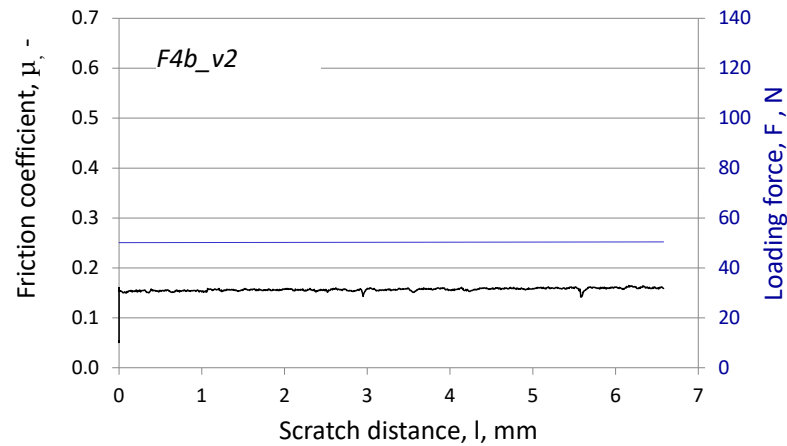
FINAL TESTS on FORMERA COATING

Friction coefficient/loading force vs. scratch length diagrams for constant loading scratch tests
F = 50, and F=80 N; L = 6.6 mm

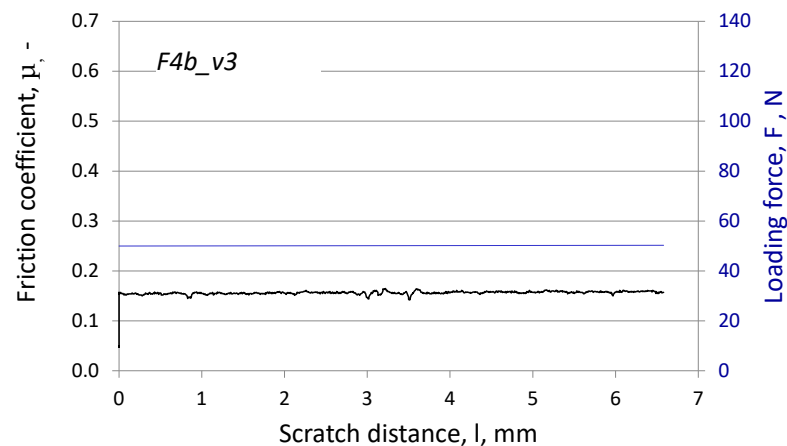
F4b_v1



F4b_v2



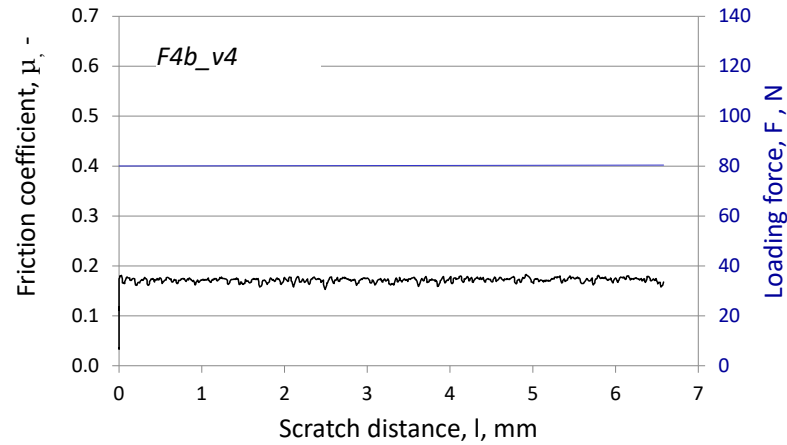
F4b_v3



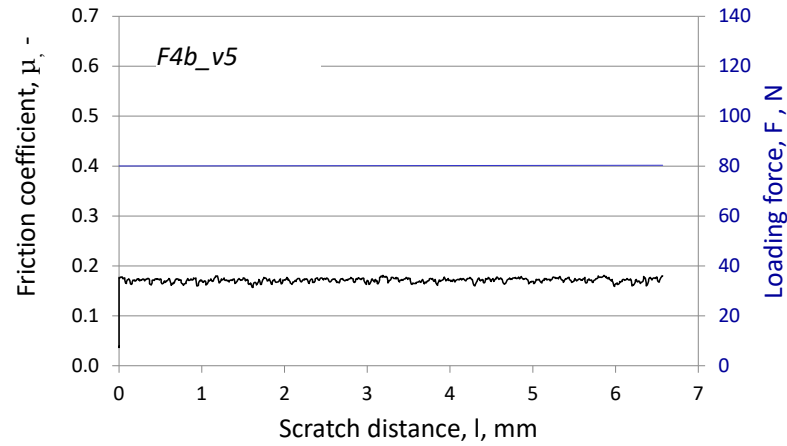
FINAL TESTS on FORMERA COATING

Friction coefficient/loading force vs. scratch length diagrams for constant loading scratch tests
F = 50, and F=80 N; L = 6.6 mm

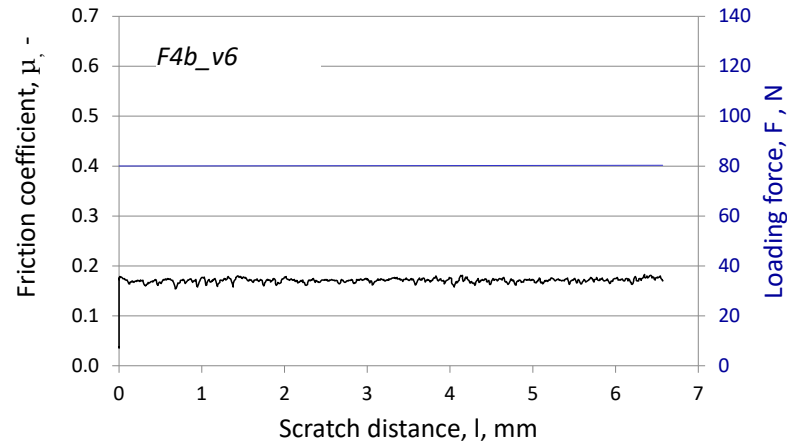
F4b_v4



F4b_v5



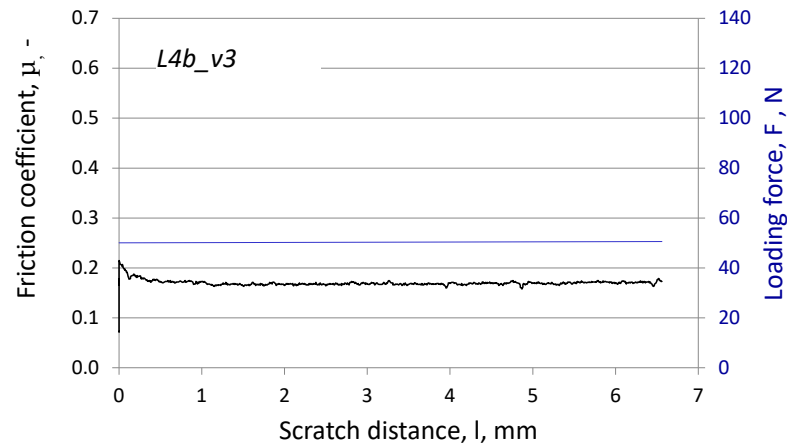
F4b_v6



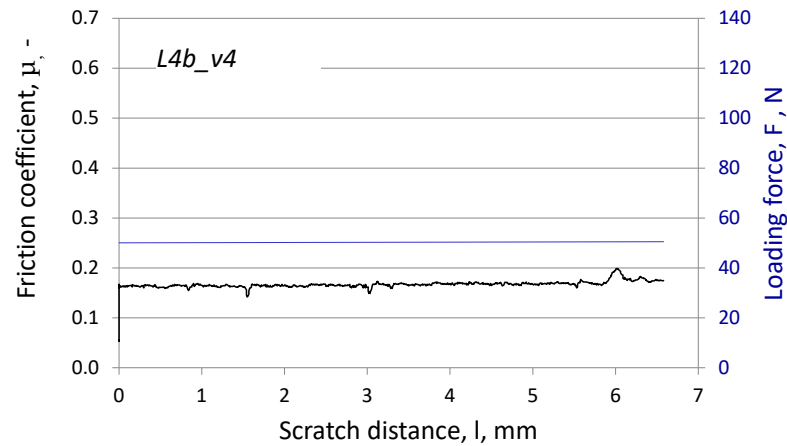
FINAL TESTS on LUMENA COATING

Friction coefficient/loading force vs. scratch length diagrams for constant loading scratch tests
F = 50, and F=80 N; L = 6.6 mm

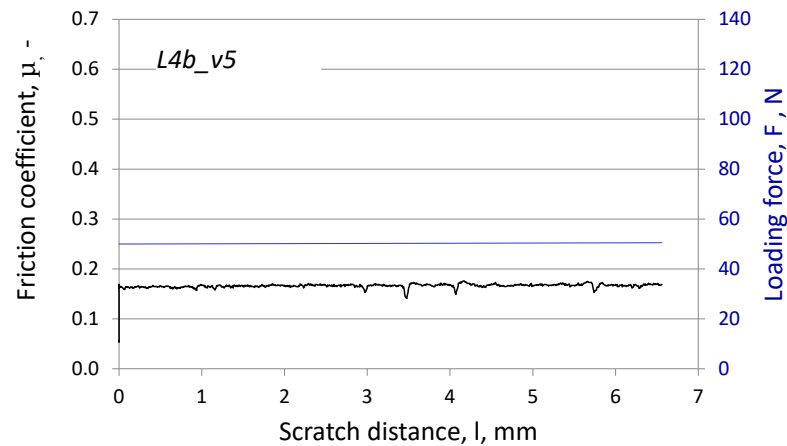
FINAL TEST
L4b_v3



L4b_v4

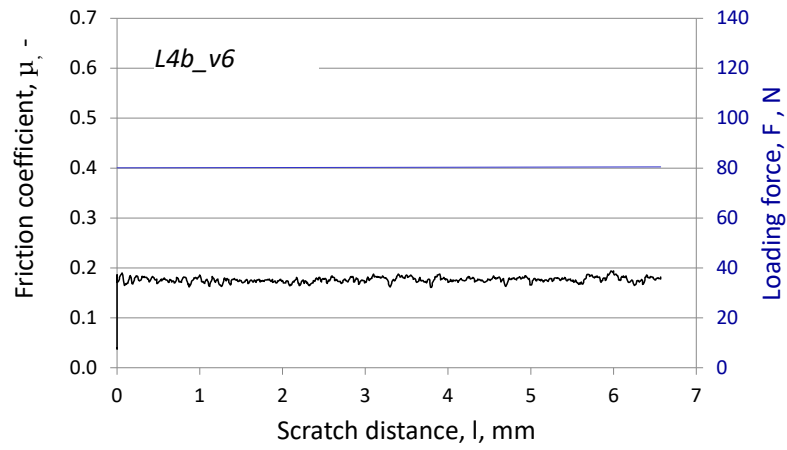


L4b_v5

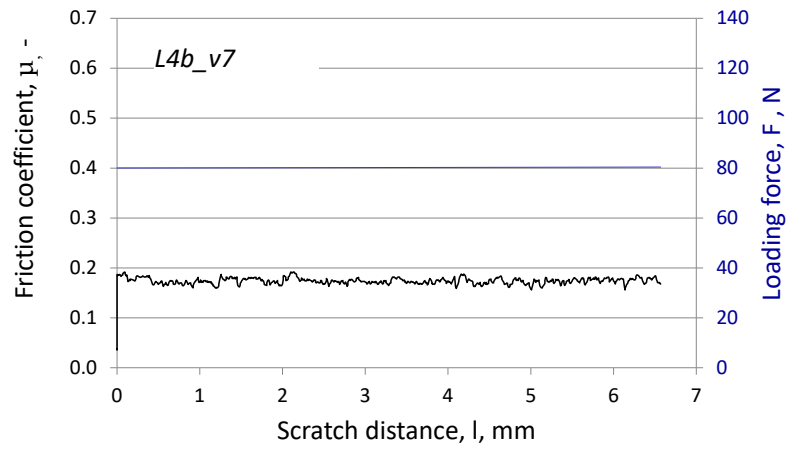


Friction coefficient/loading force vs. scratch length diagrams for **constant** loading scratch tests
FINAL TESTS on LUMENA COATING; F = 50, 80 N; L = 6.6 mm

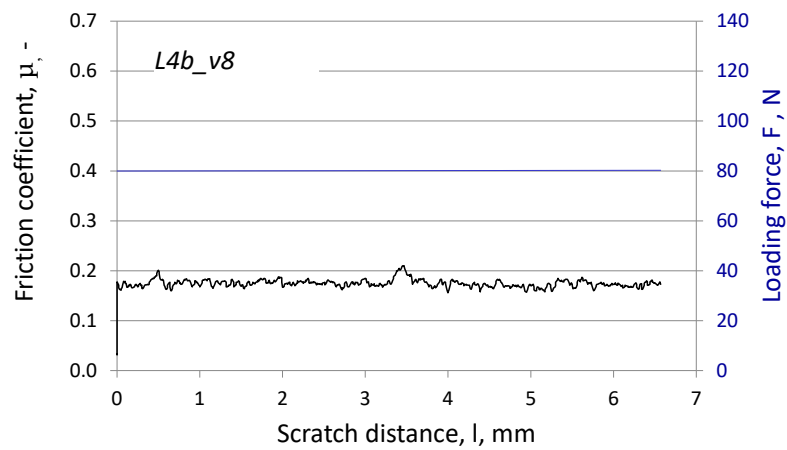
L4b_v6



L4b_v7



L4b_v8



The measured friction coefficient values for FORMERA and LUMENA COATINGS

Coating type	File name	Constant load, F, N	Friction coefficient, μ			
			Measured	Average	SD	Var. coeff., %
Formera	F4b_v1_200x_2	50	0.157	0.156	0.001	0.641
	F4b_v2_200x_2		0.156			
	F4b_v3_200x_2		0.155			
	F4b_v4_200x_2	80	0.173	0.170	0.002	1.356
	F4b_v5_200x_2		0.169			
	F4b_v6_200x_2		0.169			
Lumena	L4b_v1_200x_2	50	0.175	0.168	0.004	2.571
	L4b_v2_200x_2		0.165			
	L4b_v3_200x_2		0.170			
	L4b_v4_200x_2		0.166			
	L4b_v5_200x_2		0.165			
	L4b_v6_200x_2	80	0.175	0.173	0.002	0.881
	L4b_v7_200x_2		0.172			
	L4b_v8_200x_2		0.173			

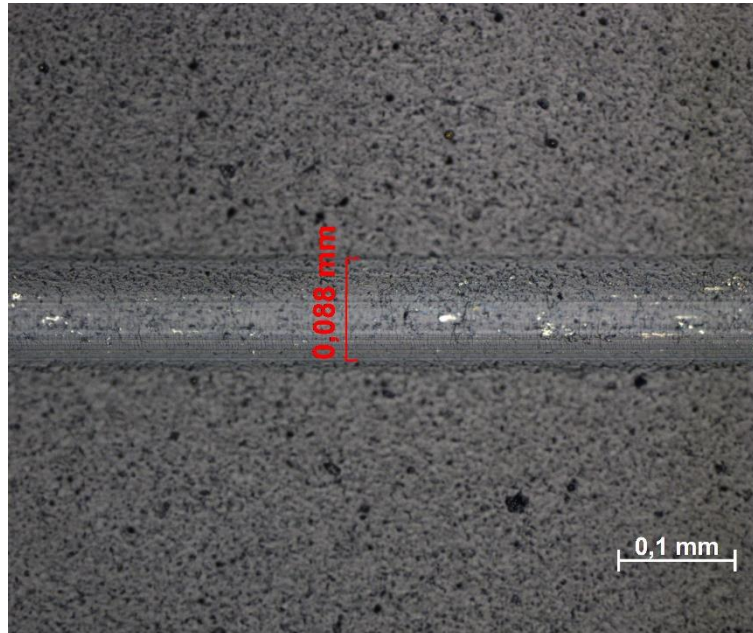
Optical microscopic measurements of the scratch width for constant load scratch tests

F = 50, and F=80 N; L = 6.6 mm

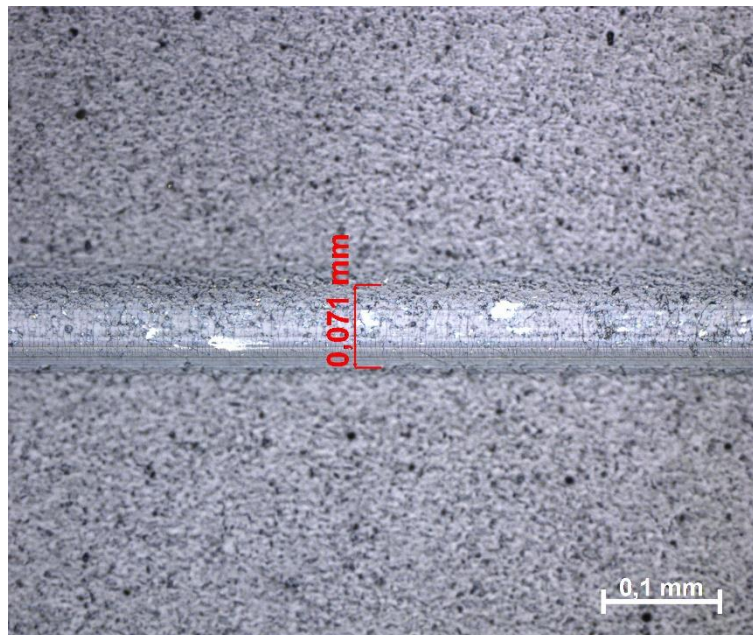
TRIAL TESTS on LUMENA COATING

Trial tests

Test parameters: F=50 N, L=16.88 mm, File: L4b_v1



Test parameters: F=50 N, L=13.8mm, File: L4b_v2

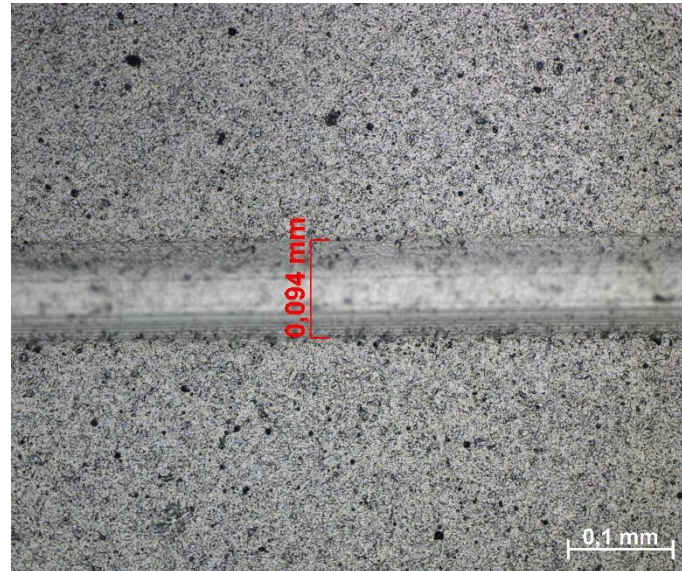


Optical microscopic measurements of the scratch width for constant load scratch tests

F = 50, and F=80 N; L = 6.6 mm

FORMERA COATING

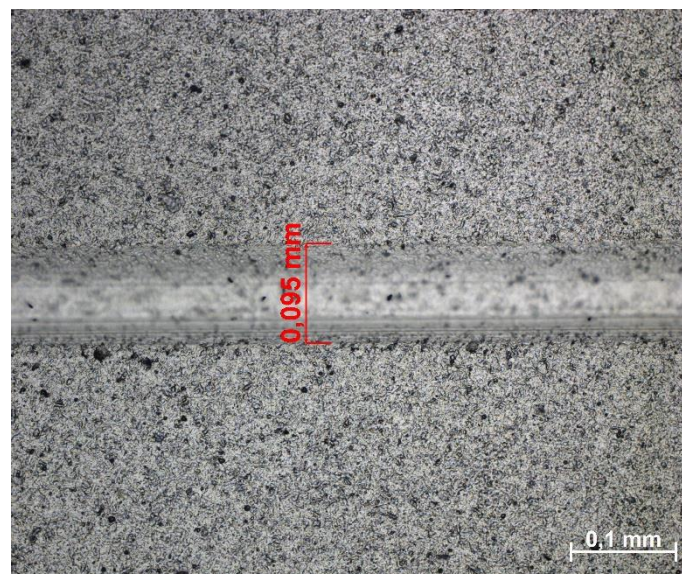
F4b_v1



F4b_v2



F4b_v3

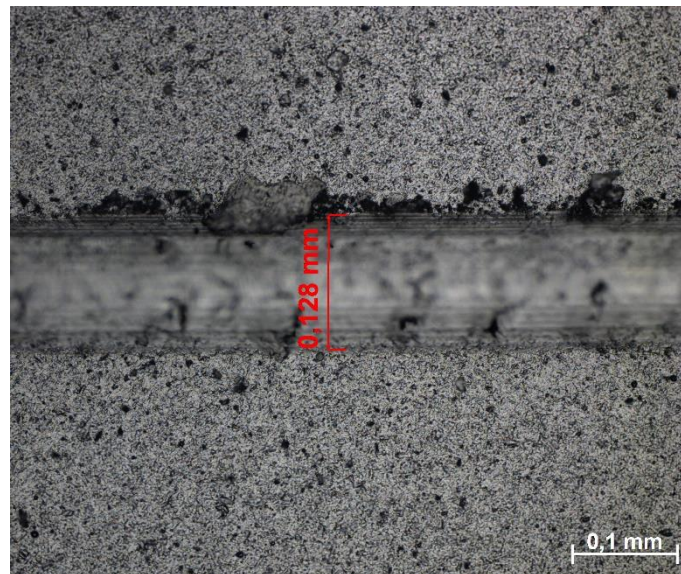


Optical microscopic measurements of the scratch width for constant load scratch tests

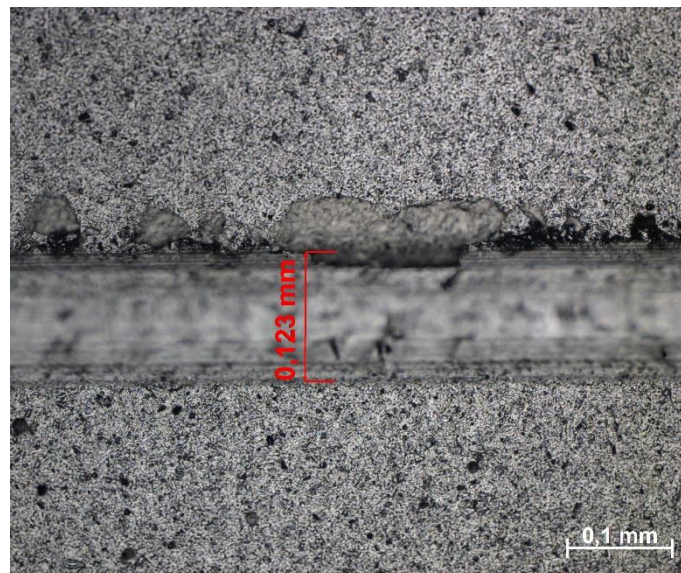
F = 50, and F=80 N; L = 6.6 mm

FORMERA COATING

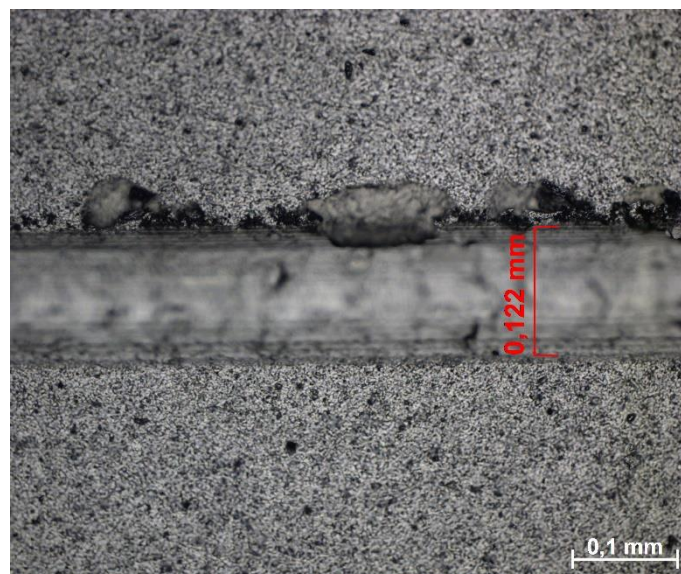
F4b_v4



F4b_v5



F4b_v6



Optical microscopic measurements of the scratch width for constant load scratch tests

F = 50, and F=80 N; L = 6.6 mm

LUMENA COATING

FINAL TEST

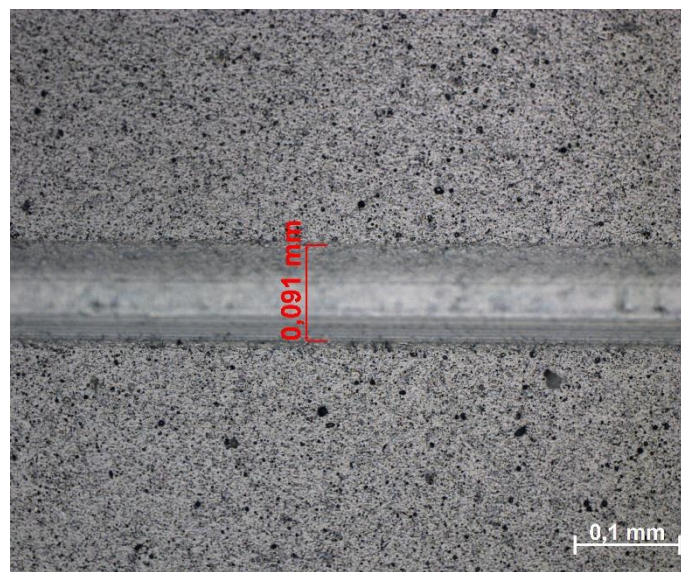
L4b_v3



L4b_v4



L4b_v5

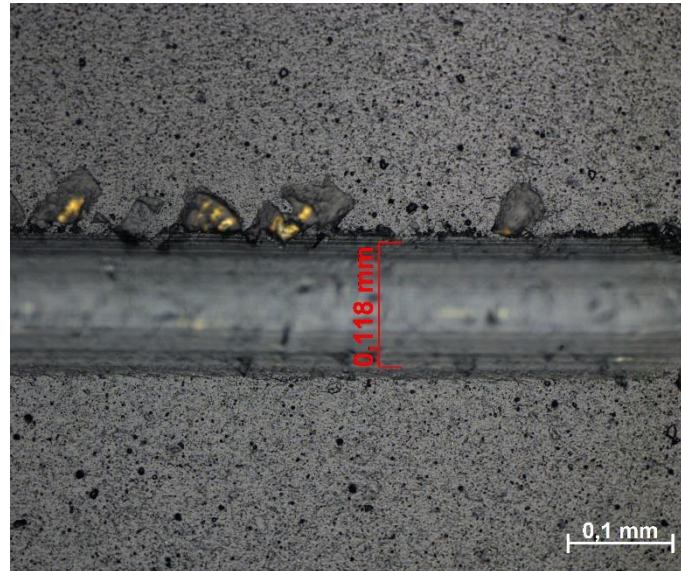


Optical microscopic measurements of the scratch width for constant load scratch tests

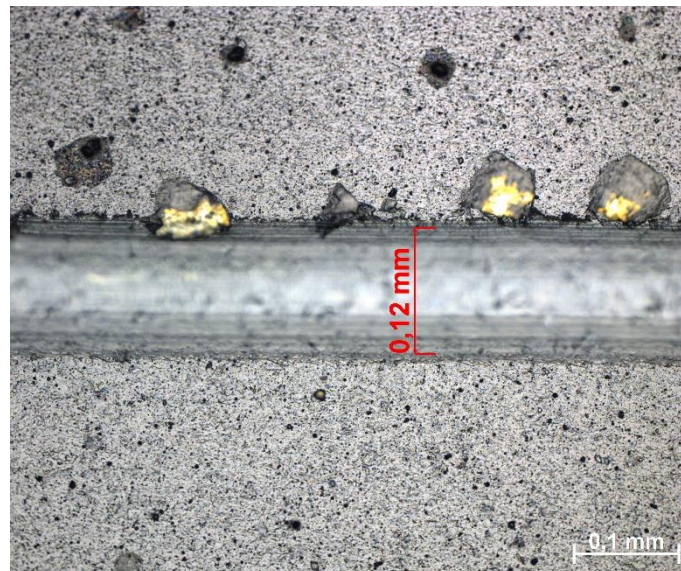
F = 50, and F=80 N; L = 6.6 mm

LUMENA COATING

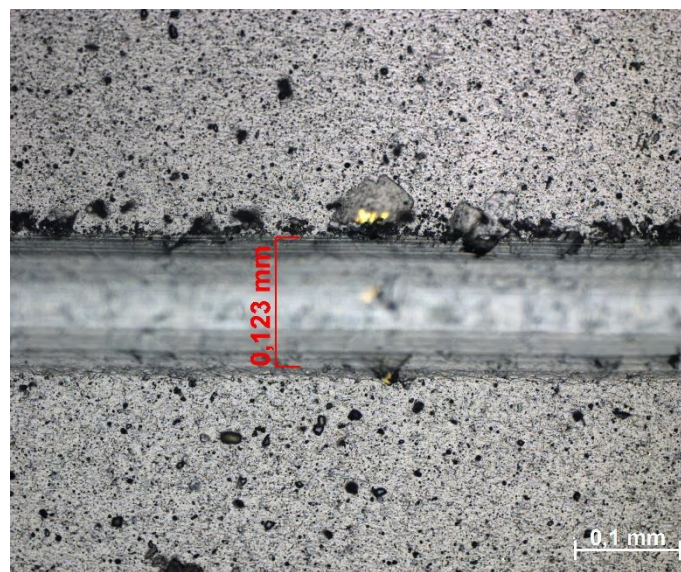
L4b_v6



L4b_v7



L4b_v8

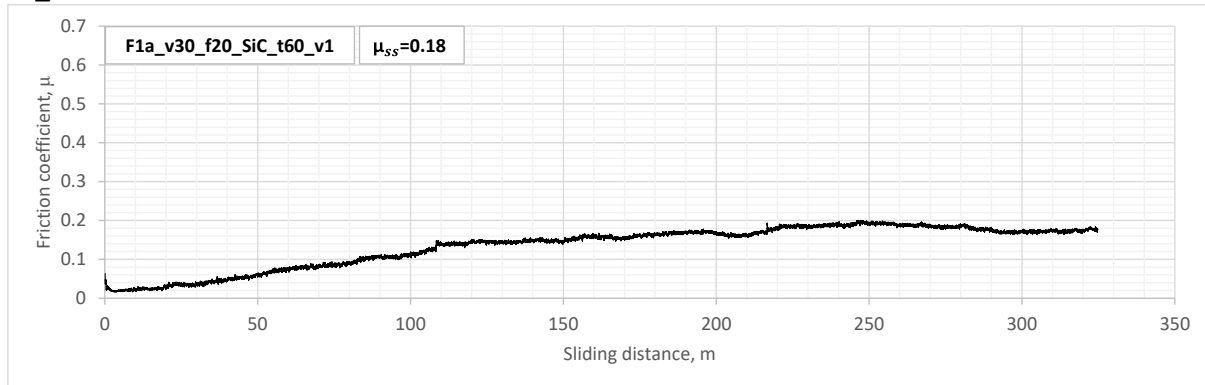
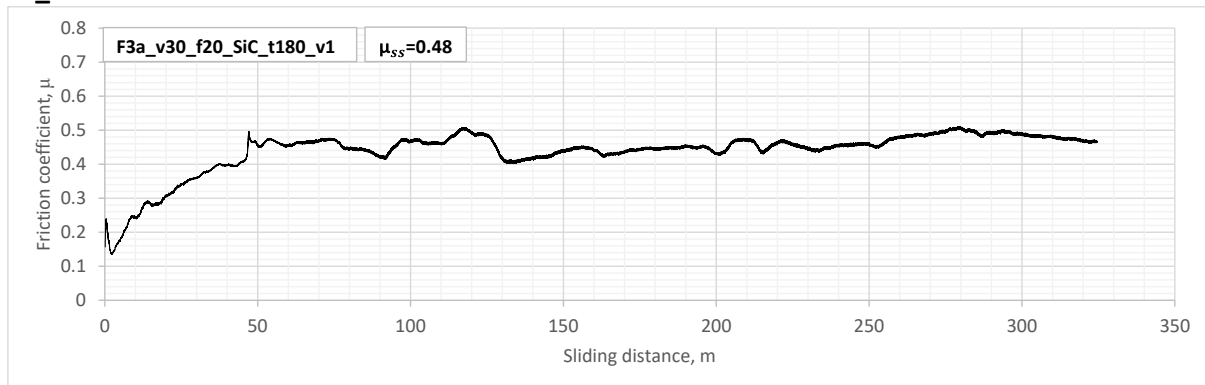
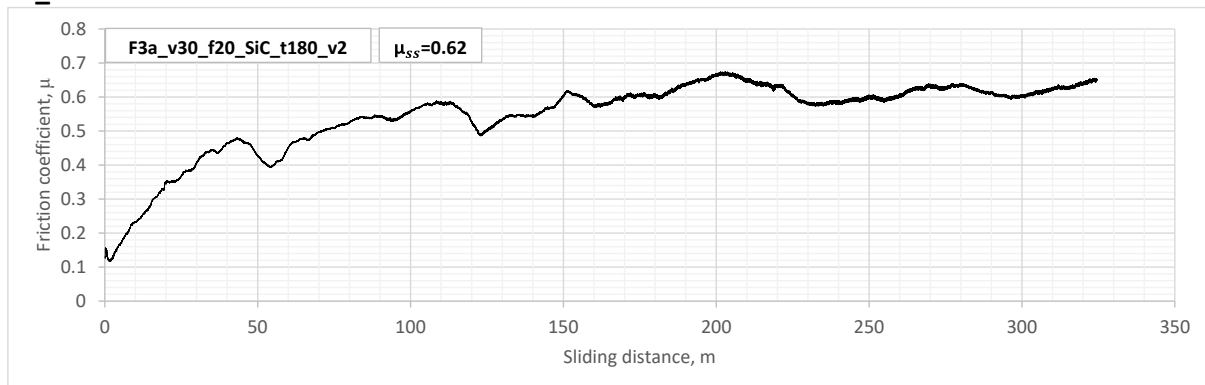
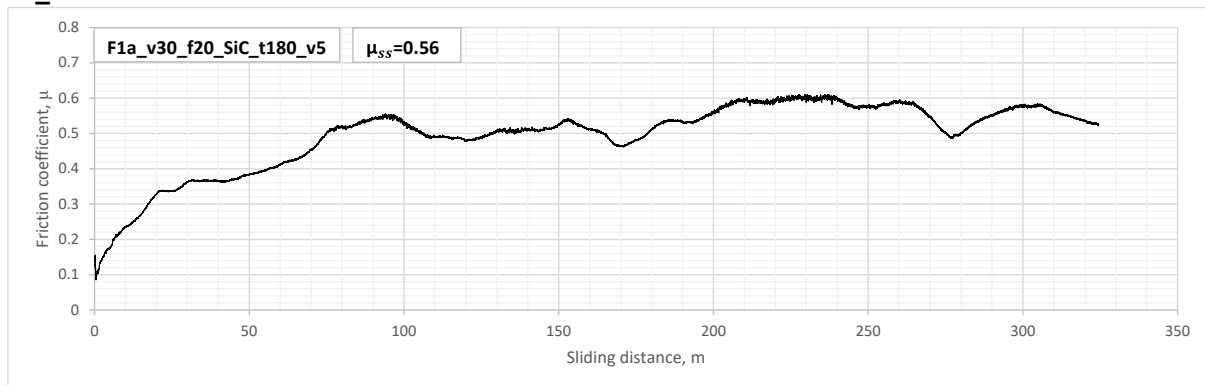


The measured scratch width values for FORMERA and LUMENA COATINGS

Coating type	File name	Constant load, F, N	Scratch width, μm			
			Measured	Average	SD	Var. coeff., %
Formera	F4b_v1_200x_2	50	94	93.3	2.1	2.2
	F4b_v2_200x_2		91			
	F4b_v3_200x_2		95			
	F4b_v4_200x_2	80	128	124.3	3.2	2.6
	F4b_v5_200x_2		123			
	F4b_v6_200x_2		122			
Lumena	L4b_v1_200x_2	50	88	83.8	8.9	10.7
	L4b_v2_200x_2		71			
	L4b_v3_200x_2		91			
	L4b_v4_200x_2		78			
	L4b_v5_200x_2		91			
	L4b_v6_200x_2	80	118	120.3	2.5	2.1
	L4b_v7_200x_2		120			
	L4b_v8_200x_2		123			

Friction coefficient vs. sliding distance diagrams obtained from ball-on disc test
 $v = 30 \text{ mm/s}$, $n = 95.542 \text{ 1/min}$, $t = 180 \text{ min}$, $F = 20 \text{ N}$

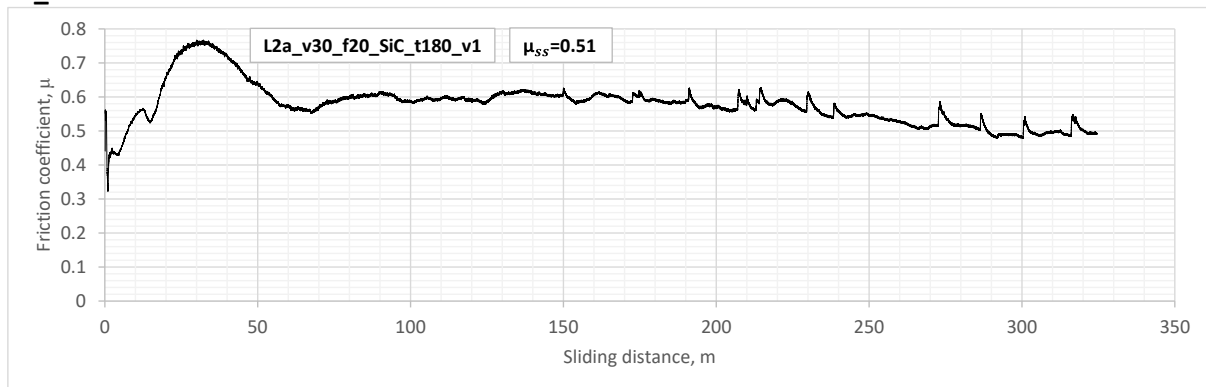
LUMENA coating

F1_1**F3_1****F3_2****F1_5**

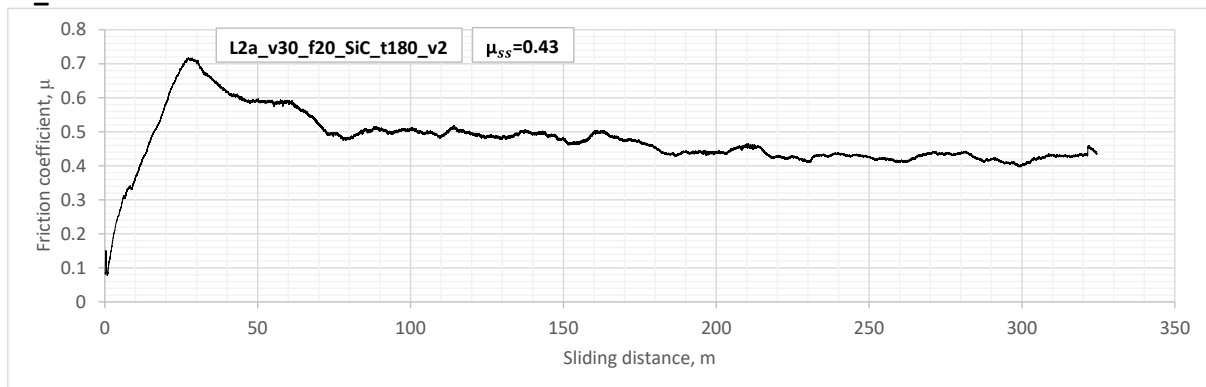
Friction coefficient vs. sliding distance diagrams obtained from ball-on disc test
 $v = 30 \text{ mm/s}$, $n = 95.542 \text{ 1/min}$, $t = 180 \text{ min}$, $F = 20 \text{ N}$

LUMENA coating

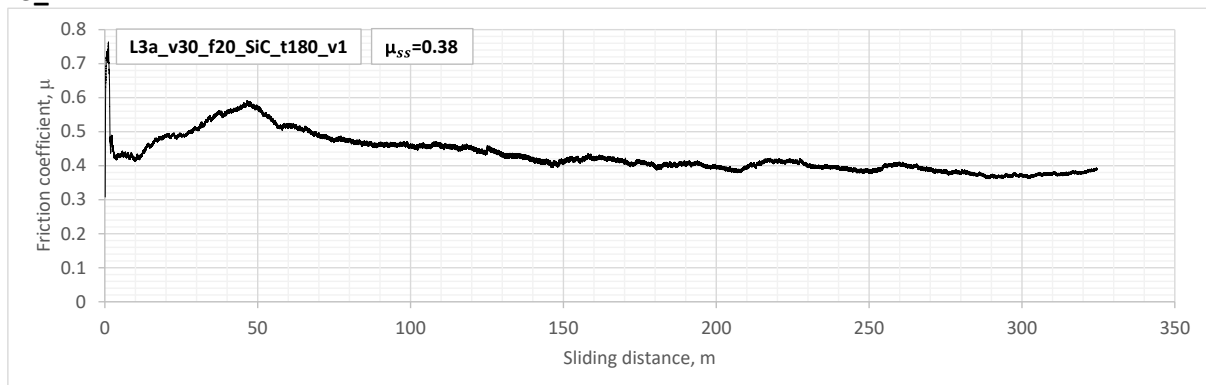
L2_1



L2_2

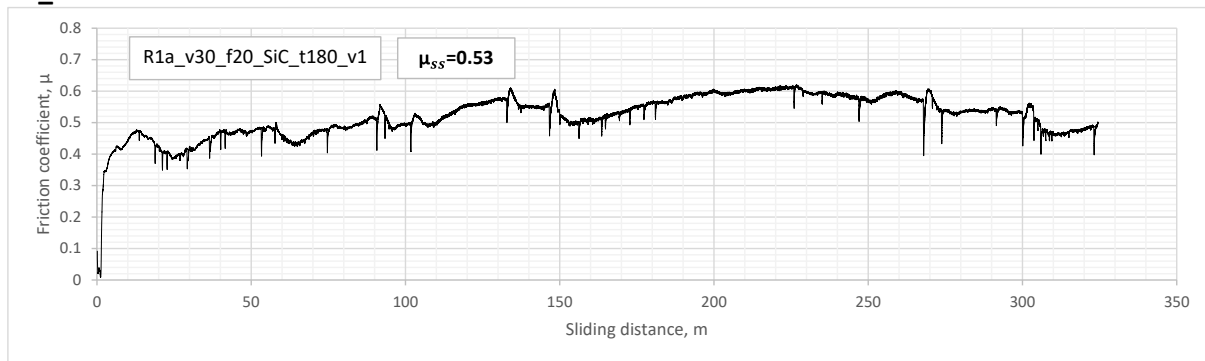
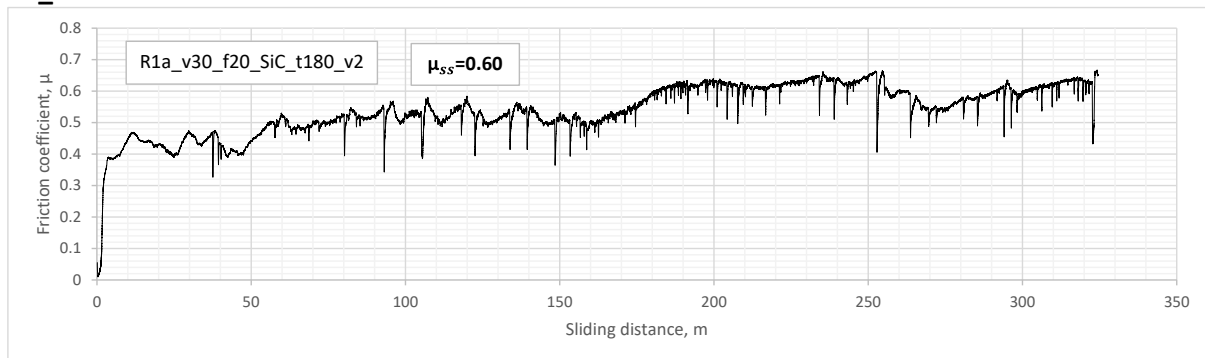
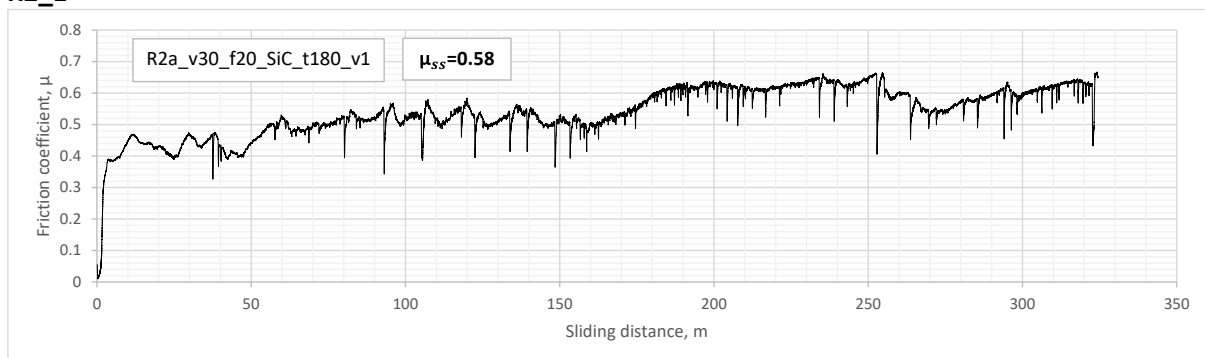


L3_1



Friction coefficient vs. sliding distance diagrams obtained from ball-on disc test
 $v = 30 \text{ mm/s}$, $n = 95.542 \text{ 1/min}$, $t = 180 \text{ min}$, $F = 20 \text{ N}$

Uncoated REFERENCE material

R1_1**R1_2****R2_1**

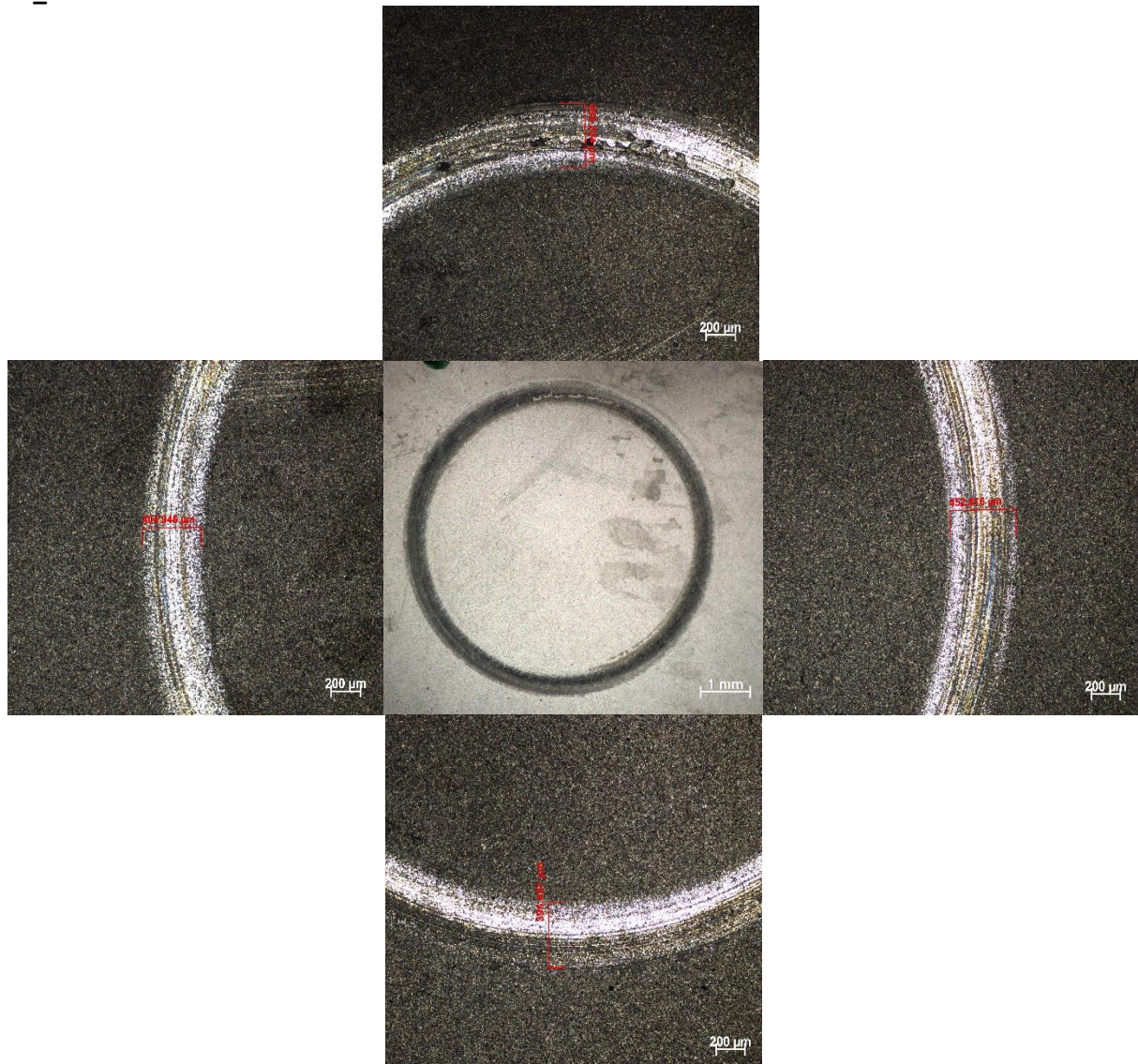
The steady -state friction coefficient values obtained from ball-on disc test
 $v = 30 \text{ mm/s}$, $n = 95.542 \text{ 1/min}$, $t = 180 \text{ min}$, $F = 20 \text{ N}$

Coating type	File name	Steady state friction coefficient, μ_{ss} , –			
		Measured	Ave-rage	Stand. dev.	Var. coeff.,%
Formera	F3a_v30_f20_SiC_t180_v1	0.481	0.55	0.07	12.36
	F3a_v30_f20_SiC_t180_v2	0.617			
	F1a_v30_f20_SiC_t180_v5	0.556			
Lumena	L3a_v30_f20_SiC_t180_v1	0.381	0.44	0.07	15.31
	L2a_v30_f20_SiC_t180_v1	0.514			
	L2a_v30_f20_SiC_t180_v2	0.425			
Uncoated reference	R1a_v30_f20_SiC_t180_v1	0.53	0.57	0.04	6.33
	R1a_v30_f20_SiC_t180_v2	0.60			
	R2a_v30_f20_SiC_t180_v1	0.58			

Optical microscopic measurements of the wear track width from ball-on-disc wear test,
 $v=30$ mm/s, $n=95.5$ 1/min, $t=180$ min, $F=20$ N

FORMERA COATING

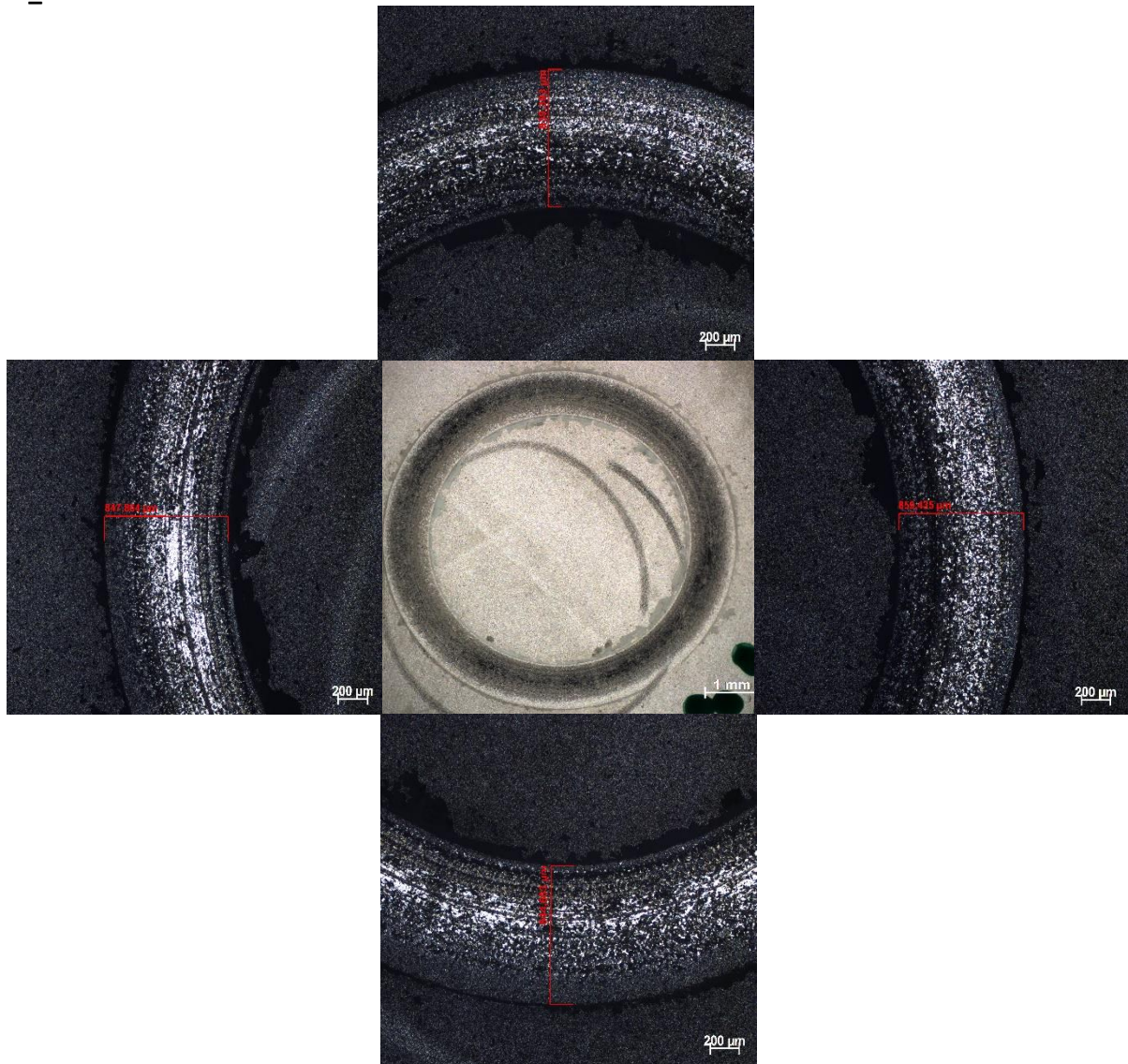
F1_1



Optical microscopic measurements of the wear track width from ball-on-disc wear test,
 $v=30$ mm/s, $n=95.5$ 1/min, $t=180$ min, $F=20$ N

FORMERA COATING

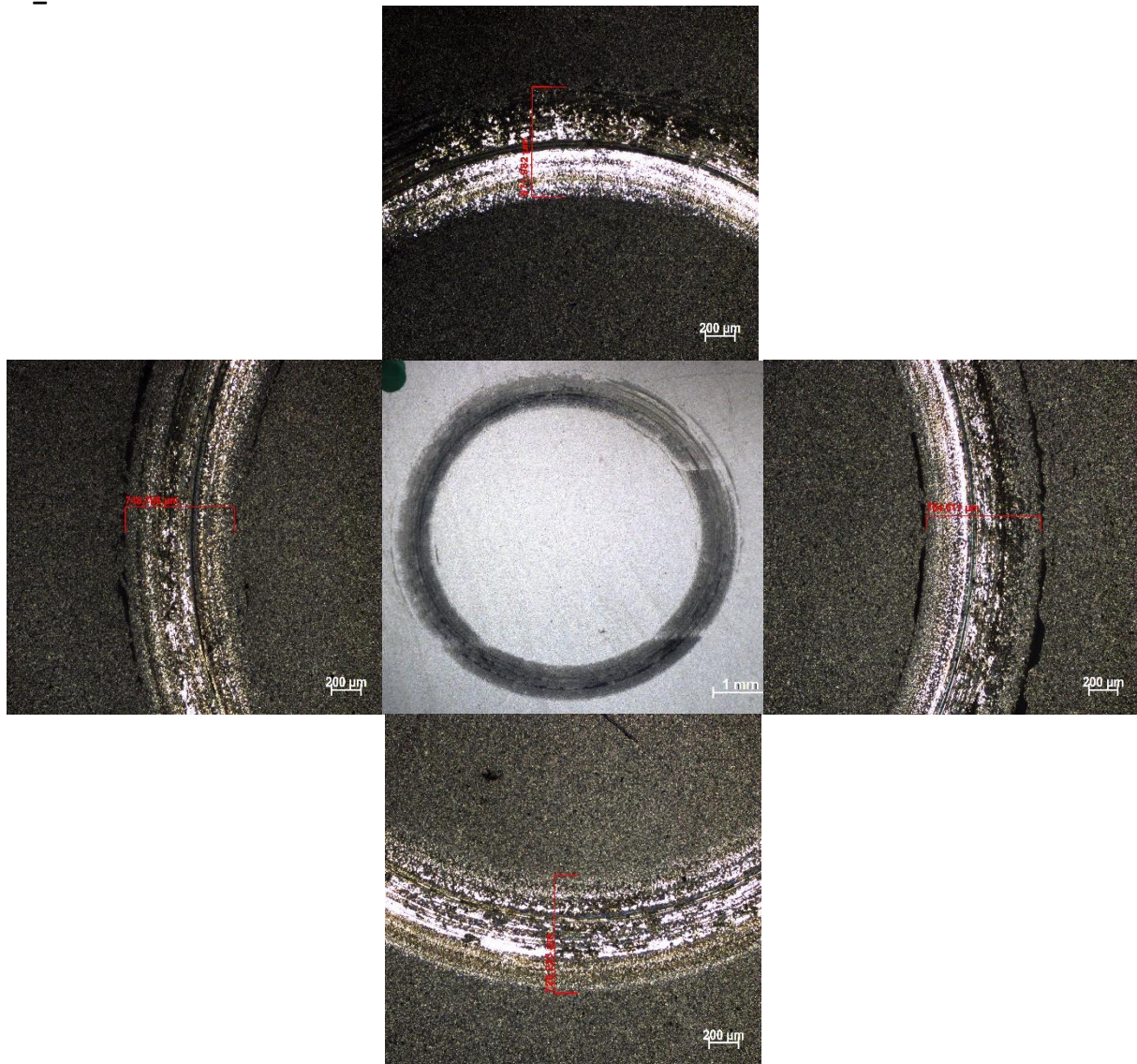
F1_5



Optical microscopic measurements of the wear track width from ball-on-disc wear test,
 $v=30$ mm/s, $n=95.5$ 1/min, $t=180$ min, $F=20$ N

FORMERA COATING

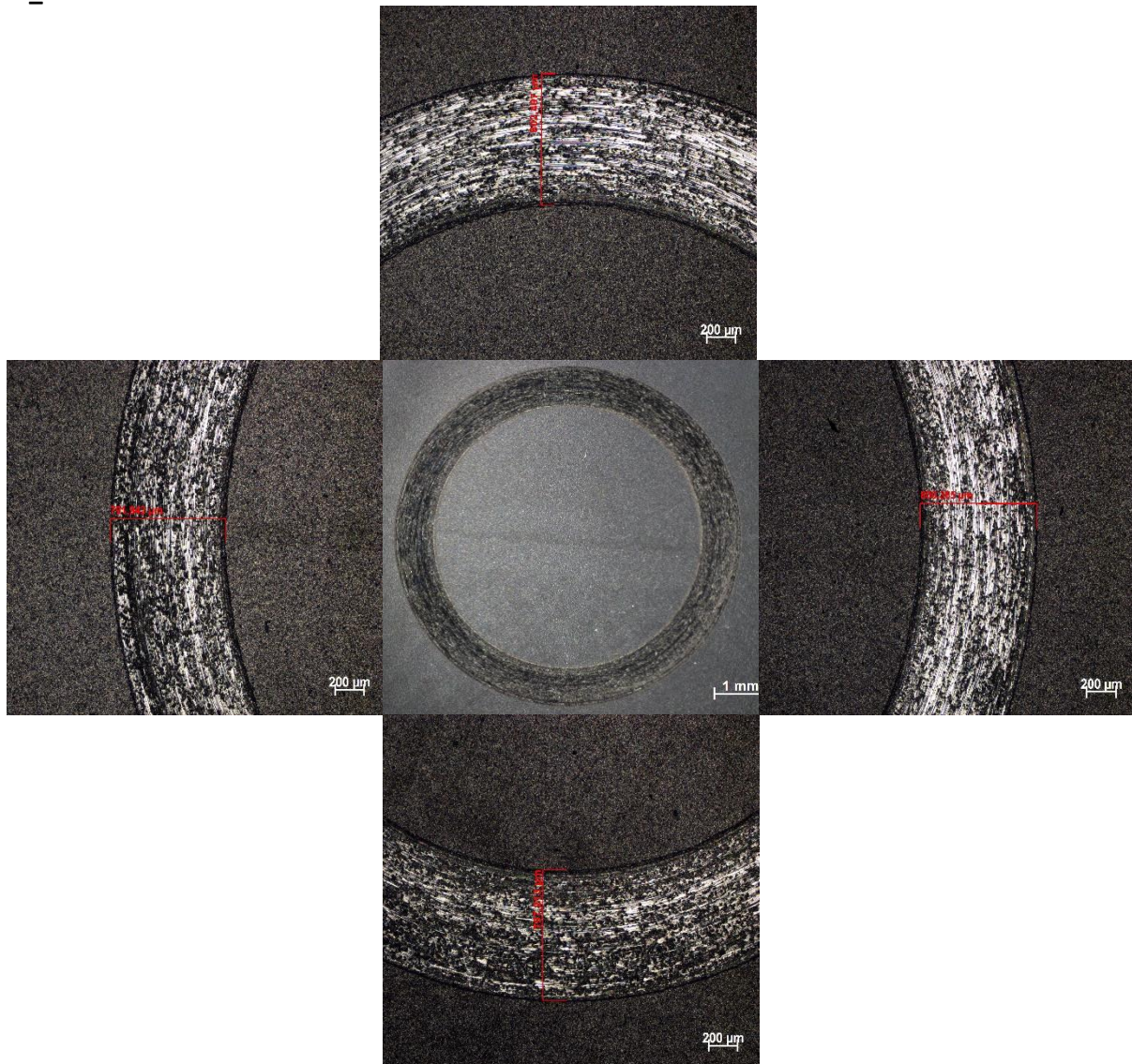
F3_1



Optical microscopic measurements of the wear track width from ball-on-disc wear test,
 $v=30$ mm/s, $n=95.5$ 1/min, $t=180$ min, $F=20$ N

LUMENA COATING

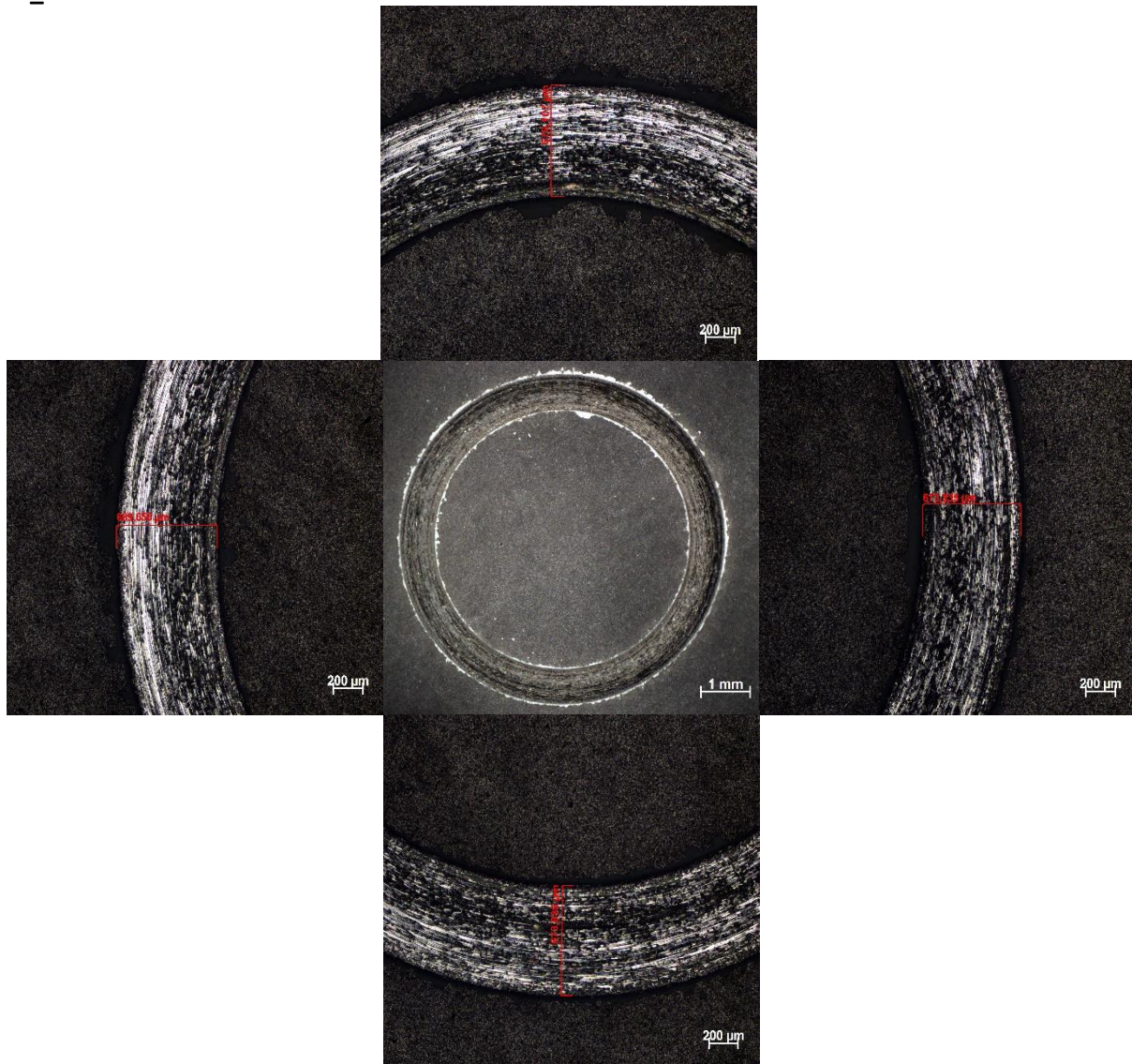
L2_1



Optical microscopic measurements of the wear track width from ball-on-disc wear test,
 $v=30$ mm/s, $n=95.5$ 1/min, $t=180$ min, $F=20$ N

LUMENA COATING

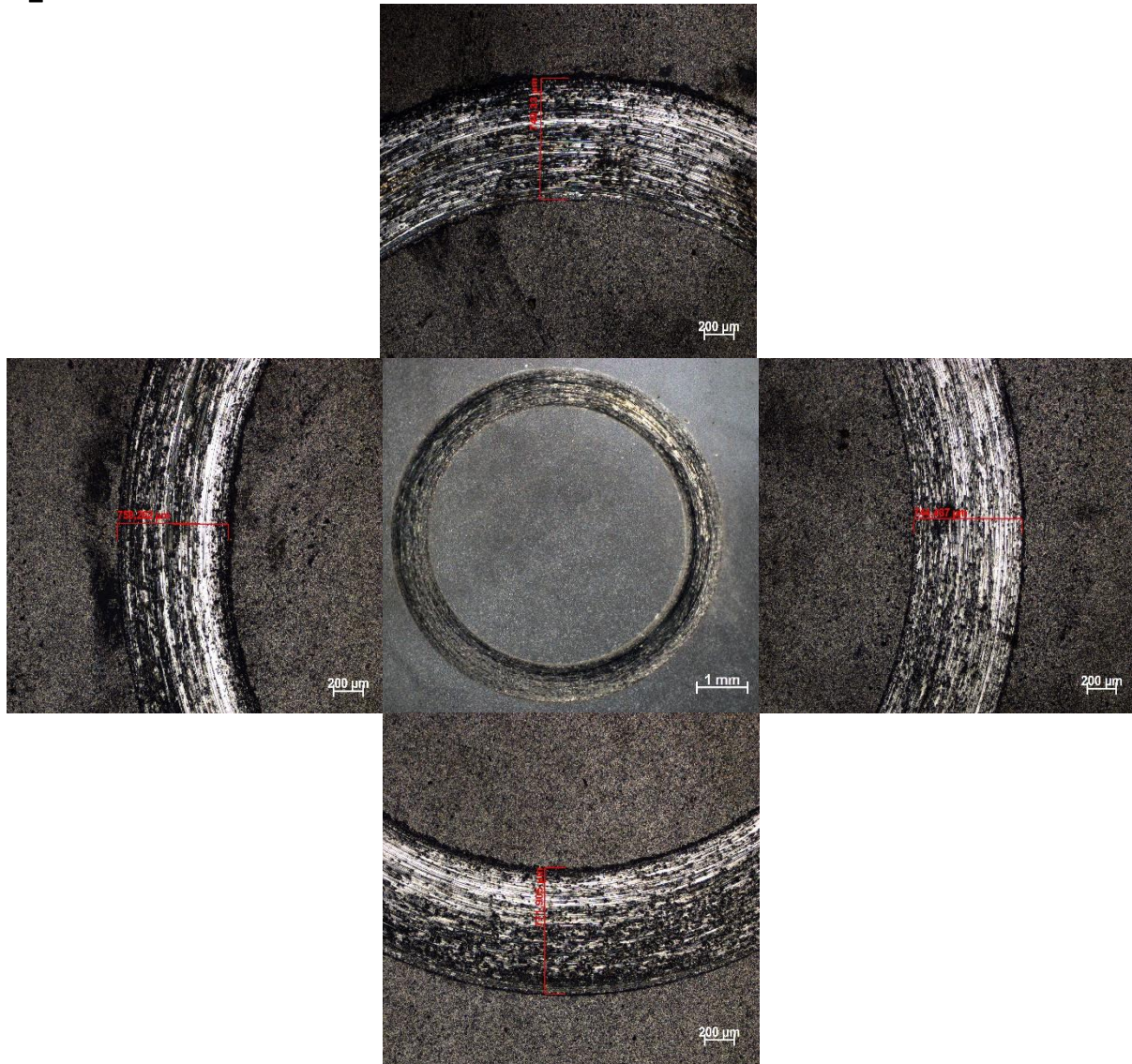
L2_2



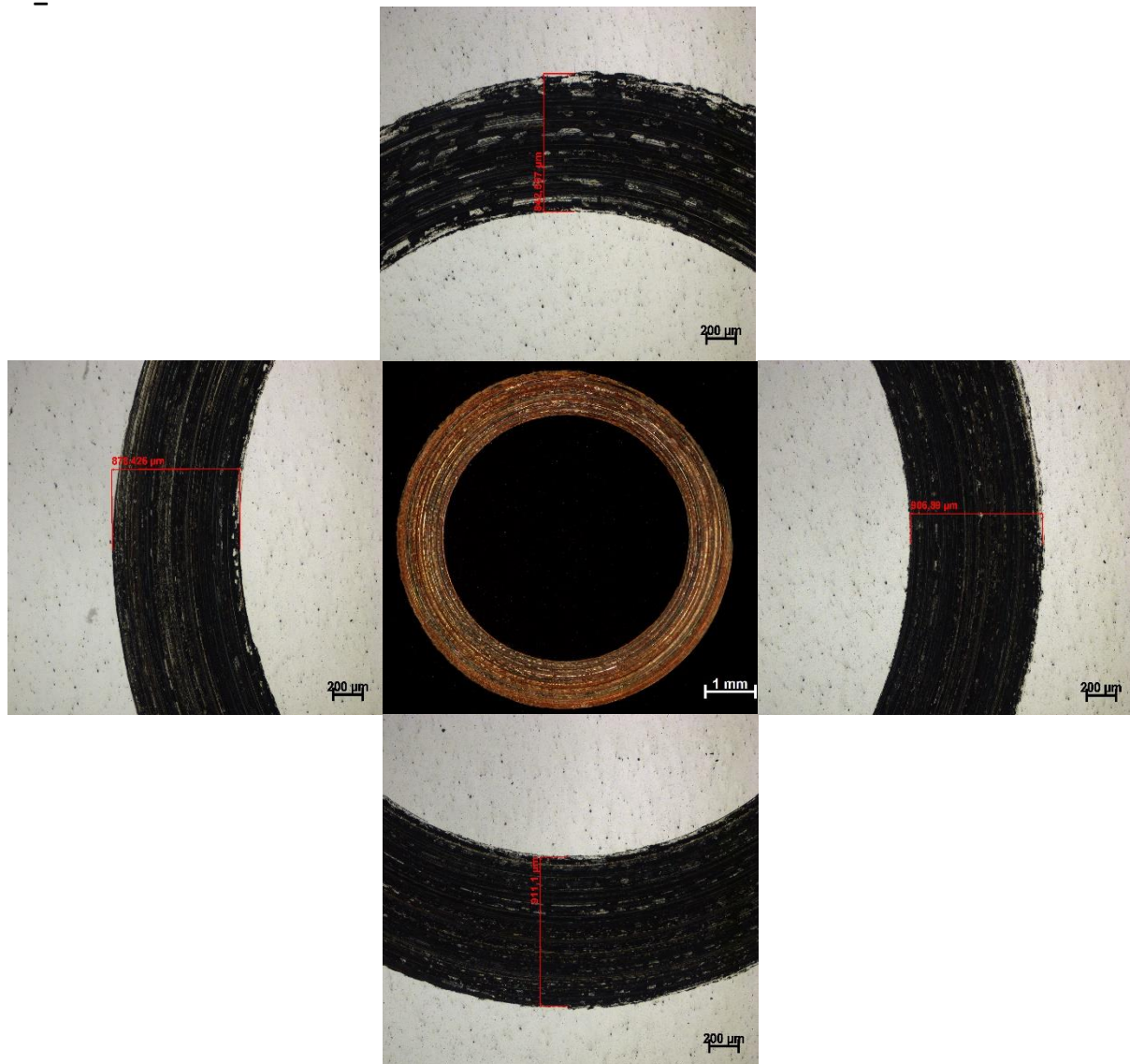
Optical microscopic measurements of the wear track width from ball-on-disc wear test,
 $v=30$ mm/s, $n=95.5$ 1/min, $t=180$ min, $F=20$ N

LUMENA COATING

L3_1

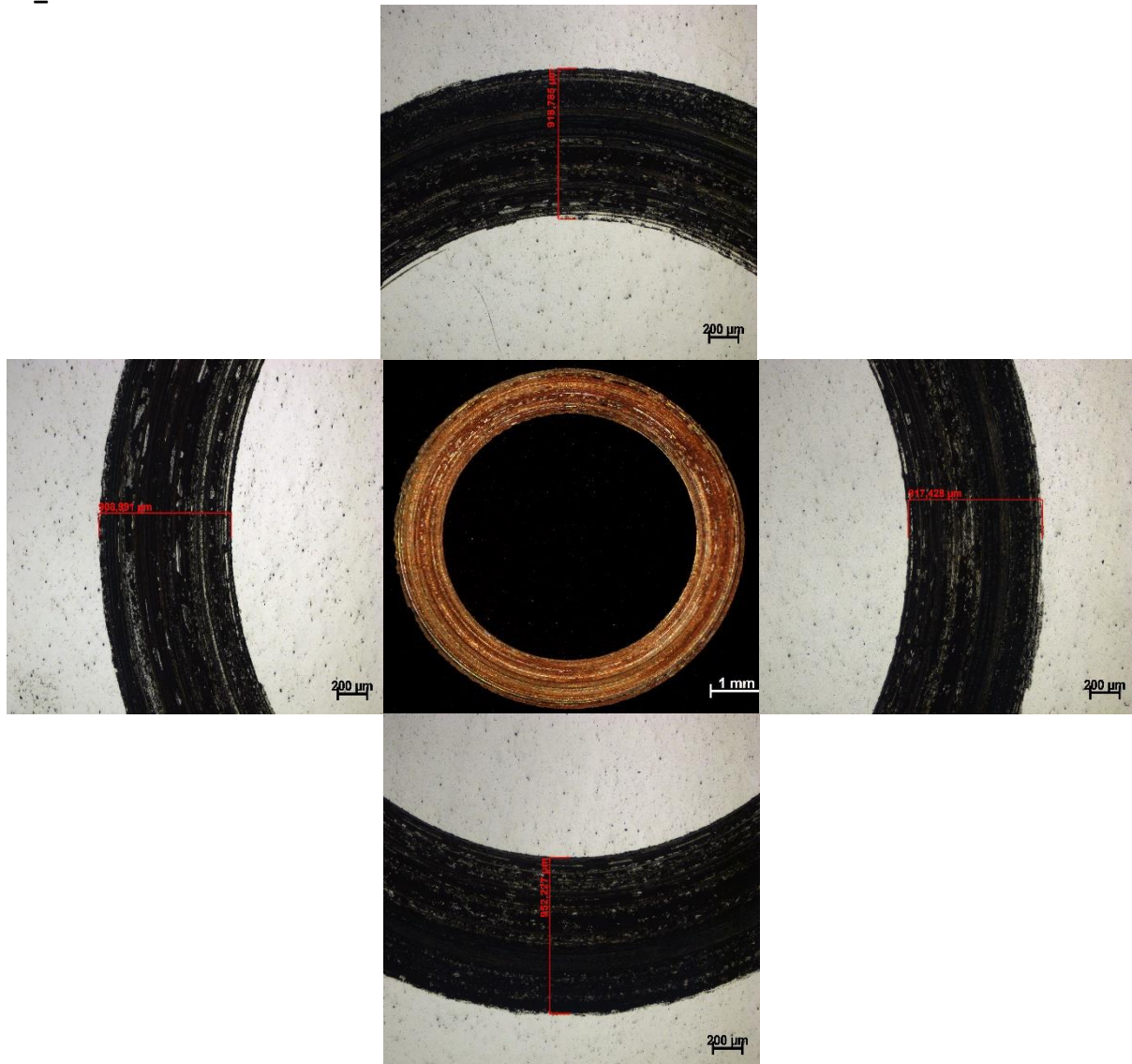


Optical microscopic measurements of the wear track width from ball-on-disc wear test,
 $v=30\text{ mm/s}$, $n=95.5\text{ 1/min}$, $t=180\text{ min}$, $F=20\text{ N}$

UNCOATED REFERENCE MATERIAL**R1_1**

Wear track width values obtained from ball-on-disc wear tests,
 $v=30$ mm/s, $n=95.5$ 1/min, $t=180$ min, $F=20$ N

R2_1



Wear track width values obtained from ball-on-disc wear tests,
v=30 mm/s, n=95.5 1/min, t=180 min, F=20 N

Tested surface	File name	v, mm/s	F, N	Wear width, μm						
				Mea- sured	Average by track	SD, μm	var. coeff., %	Average by coating	SD, μm	var. coeff., %
REFERENCE MATERIAL (precipitation hardened)	R1a_v30_f20_ SiC_t180_v1	30	20	843	885	31.6	3.6	908.2	34.2	3.8
				907						
				911						
				878						
	R1a_v30_f20_ SiC_t180_v2	30	20	865	902	28.4	3.1			
				902						
				933						
				909						
	R2a_v30_f20_ SiC_t180_v1	30	20	919	938	23.0	2.5			
				917						
				952						
				962						
FORMERA coating	F1a_v30_f20_ SiC_t60_v1	30	20	405	411	28.5	6.9	663.5	195.1	29.4
				390						
				453						
				396						
	F3a_v30_f20_ SiC_t180_v1	30	20	749	731	47.6	6.5			
				672						
				785						
				720						
	F1a_v30_f20_ SiC_t180_v5	30	20	848	848	8.5	1.0			
				839						
				859						
				845						
LUMENA coating	L3a_v30_f20_ SiC_t180_v1	30	20	759	754	14.4	1.9	743.7	52.0	7.0
				740						
				744						
				772						
	L2a_v30_f20_ SiC_t180_v1	30	20	792	798	4.6	0.6			
				802						
				800						
				797						
	L2a_v30_f20_ SiC_t180_v2	30	20	690	679	7.4	1.1			
				679						
				674						
				674						