



TOUGHGUARD Never Wax System: Surface Roughness Report.

The following is a report conducted by Gii Brougher on the surface roughness of a painted surface before and after TOUGHGUARD treatment.

Experimental Apparatus: Surface roughness was measured using a Zygo Newview 7300 Optical Profilometer, which has a claimed vertical resolution of 0.1nm

Method: A 0.125" thick sheet of Aluminum was sheared and polished. This surface was then spray painted with acrylic paint and allowed to cure for three days. The painted surface was viewed under an optical profilometer, using mapped coordinates for 7 data points, before and after Toughguard treatment. Toughguard was applied to a painted aluminum surface with a small rag, in a circular pattern, until buffed on smoothly; the surface was then allowed to cure for 48 hours. Using an optical profilometer, a rectangular region was scanned (0.70mm by 0.52mm) at each data point. The experiment was repeated a second time with 8 data points, following two treatments of Toughguard.

Analysis: Using light interference signals, the optical profilometer acquired reconstructed 3D images of the sample's surface. Below are two computer generated 3D images taken from the sample surface both before (Fig.1) and after (Fig. 2) Toughguard treatment. The surface appears to be visually smoother after treatment.

Results summary: Application of Toughguard (on a spray painted aluminum metal surface) was shown to decrease surface roughness by an average of 28nm over a 0.70mm by 0.52mm area.

Figure 1. (3D profile before treatment.)

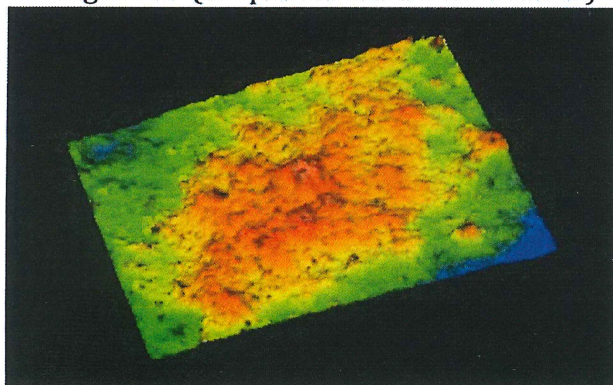
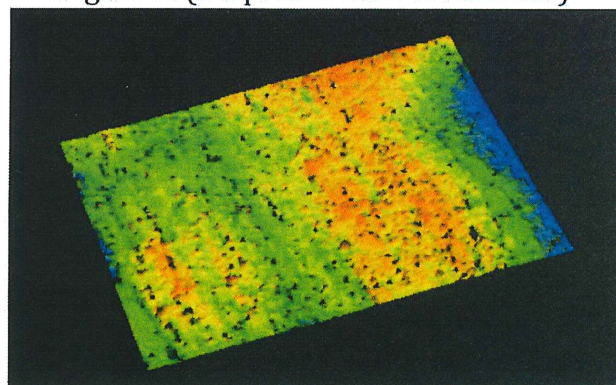


Figure 2. (3D profile after treatment.)



The average surface roughness* observed before treatment was 170nm (Fig. 1). After treatment the average roughness was observed at 110nm. (Fig. 2)

(*Average roughness is the average absolute value of pits and holes on the surface.)



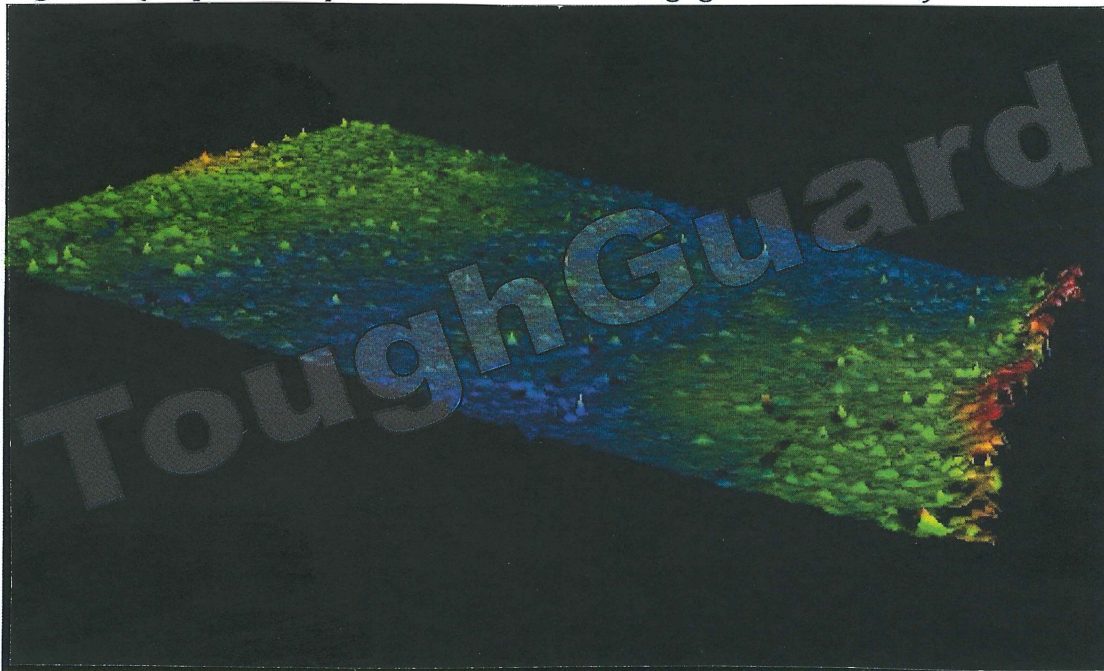
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The following two images show the 3D surface in more detail:

Figure 3. (3D profile of painted surface before Toughguard treatment)



Figure 4. (3D profile of painted surface after Toughguard treatment)



(The average surface roughness observed before treatment (Fig. 3) was measured at 132nm; the average roughness after treatment (Fig. 4) was measured at 116nm.

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Ra= roughness average

Figure 5. (Profile before treatment; Ra=178nm)

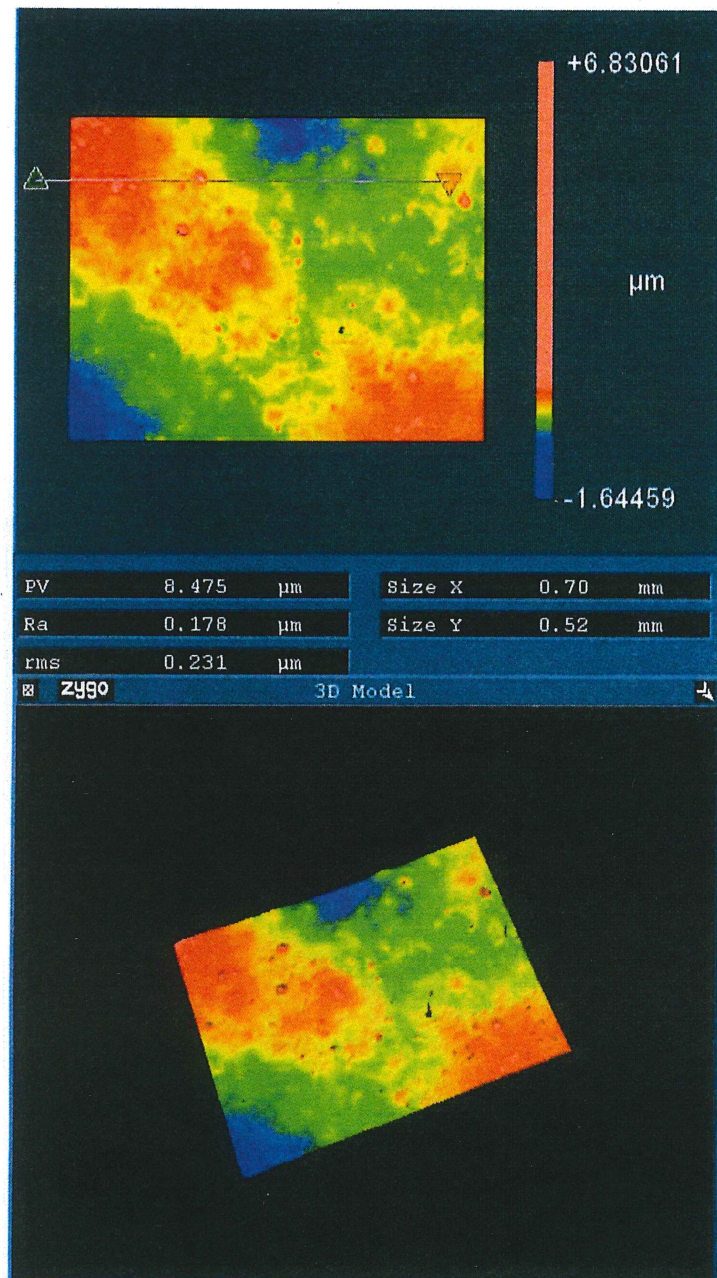
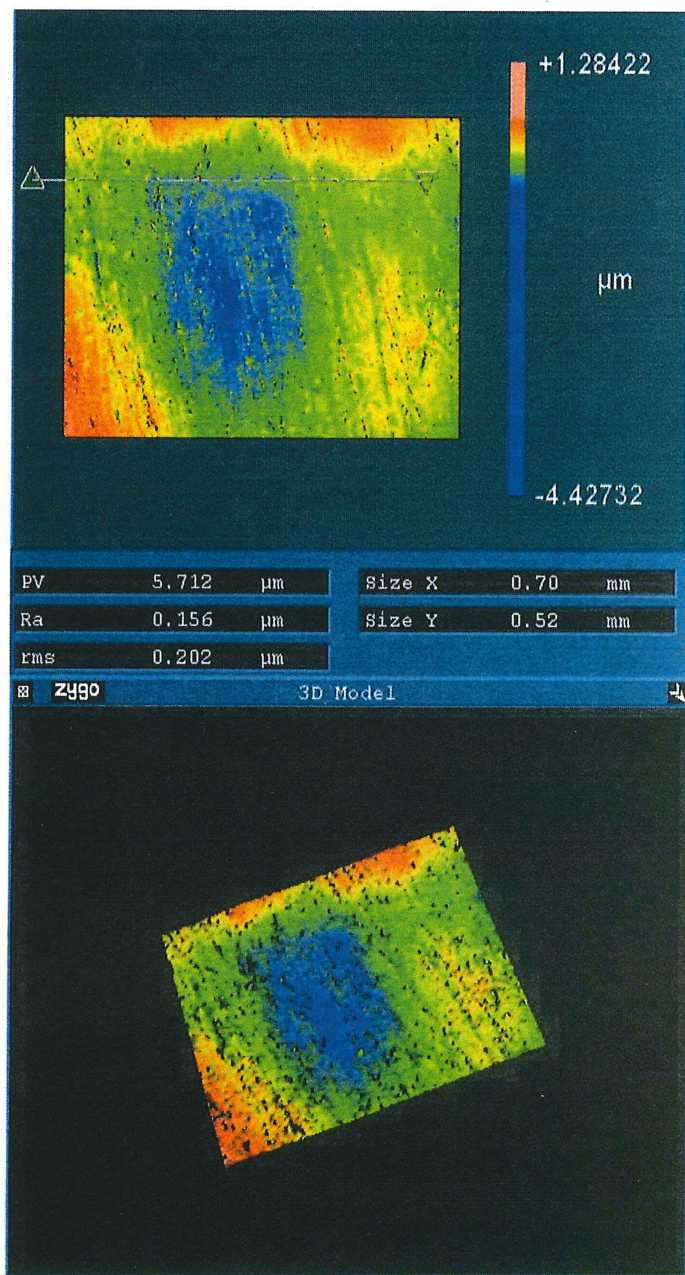


Figure 6. (Profile after treatment; Ra=156nm)



Figures 5 and 6: These two profiles show the surfaces to be smoother after Toughguard application, decreasing average roughness by ~22nm.

The statistics shown on the next page verifies this observed trend.

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Statistics from experiment

TRIAL 1 1st Coat		Average Roughness		Ra	
Point	Treated um	Untreated um	Treated nm	Untreated nm	Delta Ra nm
1	0.116	0.132	116	132	16
2	0.073	0.094	73	94	21
3	0.089	0.12	89	120	31
4	0.096	0.126	96	126	30
5	0.115	0.146	115	146	31
6	0.11	0.17	110	170	60
7	0.156	0.178	156	178	22
				Mean	30
		STDEV	26	29	14
				Point	% difference
STDEV % Diff	8			1	12
AVG % Diff	22			2	22
				3	26
				4	24
				5	21
				6	35
				7	12

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TRIAL 2 1st Coat		Average Roughness		Ra	
Point	Treated um	Untreated um	Treated nm	Untreated nm	Delta Ra nm
1	0.144	0.166	144	166	22
2	0.064	0.086	64	86	22
3	0.087	0.108	87	108	21
4	0.072	0.094	72	94	22
5	0.176	0.192	176	192	16
6	0.13	0.2	130	200	70
7	0.095	0.116	95	116	21
8	0.177	0.201	177	201	24
				Mean	27
STDEV		STDEV	45	49	17
					% Diff
STDEV % Diff	9				13
MEAN % Diff	19				26
					19
					23
					8
		TOTAL Ra Diff %		21%	35
	The average Roughness is 21% smaller over the two trials				18
					12

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UNIVERSITY OF OREGON		Average Roughness		Ra	
TRIAL 2 2nd Coat					
Point	Treated um	Treated 2nd Coat nm		Trial 2 1st Coat nm	Delta nm
1	0.143	143		144	1
2	0.06	60		64	4
3	0.078	78		87	9
4	0.068	68		72	4
5	0.159	159		176	17
6	0.099	99		130	31
7	0.095	95		95	0
				Delta Average	9
				Delta STDEV	11
TRIAL 2 3rd Coat		Average Roughness		Ra	
Point	Treated um	Treated 3rd Coat nm		Trial 2 2nd Coat nm	Delta nm
1	0.139	139		143	-4
2	0.081	81		60	21
3	0.077	77		78	-1
4	0.077	77		68	9
5	0.139	139		159	-20
6	0.131	131		99	32
7	0.102	102		95	7
				Delta Average	6.285714286
				Delta STDEV	17.00700136

Conclusion from data: The Toughguard Never Wax System was observed to reduce the average roughness of a spray painted aluminum surface an average of 28nm. Multiple layers of Toughguard did not significantly improve surface roughness on the specific samples we tested.

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