

# A NEW TIN-FREE SILICONE GUM DISPERSION FOR USE AS A HIGH SLIP AGENT FOR COATINGS AND LEATHER

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# Why do this work?

- Silicone Gum Dispersions are used extensively for stain, mar resistance, feel, slip and COF reduction in leather treatments and coatings.
- These materials are hard to stabilize and manufacture.
- In-situ increase of the silicone MW with tin-based condensation catalysts is the norm.
- Regulatory and market forces make Tin unusable in new products
- Solvents in COMP

# Experimental

The experimental additives were screened at 0.5% or 1.25% in

- Solvent based acrylic clear coating
- Acrylic latex paint
- 2K Waterborne polyurethane clear coating
- 1K Waterborne polyurethane coating
- 2K Solventborne polyurethane clear coating
- 1K Solventborne polyurethane coating
- WB HG Black Enamel
- SB HG Black Enamel



# Experimental

Developmental additives started from 40A, our best offering at the time. (Tin catalyzed)

Variations included silicone oil MW, dispersants, silica and condensation catalyst.

Two control experiments were conducted in each case.

- Comparable use level of the commercially available competitive product labeled **COMP.**
- No additive labeled **CONTROL.**



# Test Panel

- For most, 1 ml coating liquid was drawn on a 4" x 6.5" Leneta paper with wire-wound rod #30. The films are dried at ambient for 4 days.
- For 1K waterborne polyurethane coating, wire-wound rod #5 is used to cast about 0.5 mil wet liquid on Leneta paper.
- The wet film prepared with 2K waterborne polyurethane clear coating is dried in a 110°C oven for 30 minutes or in an 80°C oven for 60 minutes.

# Mar Resistance

Mar resistance is measured using a Sutherland 2000 Ink Rub Tester. We used the Dry Rub method with the following settings: 100 to 500 rubs and 84 rpm stroke speed. Rubbings are done using a 4 lb test block which is attached with a 2" x 4" nylon scrubbing pad. The panels are rated based on percentage change in gloss reading before and after the rubbing test. Rating 10 is the best; 0 is the worst.



# Slip

Slip or Coefficient of Friction (COF) is measured with ChemInstruments Coefficient of Friction - 500.

Test speed: 15 cm/min; travel length: 15 cm; Sled weight: 200 grams and Sled surface which is covered with ASTM-specified rubber,

Static and Kinetic coefficients of friction are obtained directly from the equipment

The greater the value, the higher the friction is for the substrate.





Results



# Initial WB Acrylic

	WB Acrylic		
	40A	COMP	CONTROL
<b>Static COF</b>	3.135	3.218	3.637
<b>Kinetic COF</b>	0.931	0.977	1.480
<b>Gloss Before</b>	46.2	42.2	47.1
<b>Gloss After</b>	43.1	39.2	10.6
<b>% Change</b>	-6.7%	-7.0%	-77.5%
<b>Surface Appearance</b>	Many craters	Many craters	Smooth

# Initial SB Acrylic

	SB Acrylic		
	40A	COMP	CONTROL
Static COF	0.650	0.691	1.389
Kinetic COF	0.437	0.320	1.262
Gloss Before	72.9	76.2	84.9
Gloss After	65.6	64.4	18.4
% Change	-10.1%	-15.4%	-78.4%
Surface Appearance	Mild wave	Wave pattern	Smooth

# Initial WB PU 1K

	WB/PU-1K		
	40A	COMP	CONTROL
<b>Static COF</b>	0.631	0.695	0.922
<b>Kinetic COF</b>	0.328	0.372	0.648
<b>Gloss Before</b>	14.4	14.5	15.0
<b>Gloss After</b>	13.9	14.0	14.3
<b>% Change</b>	-3.6%	-3.2%	-4.7%
<b>Surface Appearance</b>	5 craters	Smooth	Smooth

# Initial WB PU 2K

	WB/PU-2K		
	40A	COMP	CONTROL
<b>Static COF</b>	0.801	0.723	1.372
<b>Kinetic COF</b>	0.638	0.401	1.925
<b>Gloss Before</b>	22.8	39.4	90.8
<b>Gloss After</b>	21.5	35.9	69.7
<b>% Change</b>	-5.7%	-8.8%	-23.2%
<b>Surface Appearance</b>	Orange peel Many craters	Orange peel	Some craters

# 40 A,B,C

- 40A performance is similar to COMP, but less compatible in some formulations.

Next variations:

- A,B,C dispersed with organic surfactants
- A,B silicone phase is high viscosity fluid
- C silicone phase contains silicone gum

# WB Acrylic

	Sample	Static COF	Kinetic COF	Gloss Before	Gloss After	% Gloss Delta	Surface Appearance
<b>WB Acrylic</b>	40B	0.696	0.644	5.0	5.1	1.0%	Droplets
	40C	0.741	0.645	4.5	5.3	16.2%	Droplets
	40A	0.812	0.659	5.2	5.6	9.0%	Droplets
	COMP	0.810	0.706	5.6	5.8	4.8%	Smooth
	CONTROL	0.791	0.754	4.6	4.5	-2.5%	Smooth



# SB Acrylic

	Sample	Static COF	Kinetic COF	Gloss Before	Gloss After	% Gloss Delta	Surface Appearance
SB Acrylic	40B	0.658	0.413	34.9	20.0	-42.8%	Smooth
	40C	0.713	0.300	33.4	21.3	-36.0%	Smooth
	40A	0.506	0.320	30.0	17.2	-42.7%	Smooth
	COMP	0.576	0.390	34.6	23.4	-32.5%	Smooth
	CONTROL	1.020	0.883	31.2	4.4	-85.8%	Smooth



# WB PU 1K

	Sample	Static COF	Kinetic COF	Gloss Before	Gloss After	% Gloss Delta	Surface Appearance
WB/PU-1K	40B	0.526	0.363	20.2	19.1	-5.4%	Smooth
	40C	0.450	0.261	20.2	18.8	-6.8%	Smooth
	40A	0.408	0.271	20.6	19.2	-6.6%	Smooth
	COMP	0.450	0.308	19.5	18.1	-7.3%	Smooth
	CONTROL	0.538	0.391	19.5	18.0	-7.5%	Smooth





# SB PU 1K

	Sample	Static COF	Kinetic COF	Gloss Before	Gloss After	% Gloss Delta	Surface Appearance
<b>1K SB/PU</b>	40B	0.747	0.510	16.3	15.1	-7.4%	Smooth
	40C	0.817	0.421	19.8	19.7	-0.6%	Smooth
	40A	0.782	0.477	19.1	19.0	-0.1%	Smooth
	COMP	0.694	0.323	18.3	18.3	-0.1%	Smooth
	CONTROL	1.012	1.218	18.7	15.4	-17.5%	Smooth



# WB PU 2K

	Sample	Static COF	Kinetic COF	Gloss Before	Gloss After	% Gloss Delta	Surface Appearance
<b>WB/PU-2K</b>	40B	0.452	0.485	77.8	73.0	-6.2%	Lots of craters
	40C	0.369	0.295	65.9	59.2	-10.3%	Lots of craters
	40A	0.347	0.265	86.9	78.7	-9.5%	Few craters
	COMP	0.343	0.193	69.2	61.8	-10.7%	Smooth, no crater
	CONTROL	1.227	1.609	91.9	81.0	-12.0%	Smooth, no crater

# SB PU 2K

	Sample	Static COF	Kinetic COF	Gloss Before	Gloss After	% Gloss Delta	Surface Appearance
SB/PU-2K	40B	0.389	0.314	37.5	31.8	-15.2%	Orange peel
	40C	0.265	0.184	66.0	56.2	-14.8%	Orange peel
	40A	0.255	0.194	55.9	47.8	-14.5%	Orange peel
	COMP	0.264	0.165	66.9	58.3	-12.9%	Rough surface
	CONTROL	1.198	1.527	98.5	81.3	-17.4%	Few craters

# 40 D-F

- 40A,B,C not compatible enough
- 40A,C close in performance
- 40B not performing

## Next Variations:

- 40 D–F silicone phase is high viscosity
- Silicone polyether emulsifier
- 40F has silica added



# WB Acrylic

	<b>Sample</b>	<b>Static COF</b>	<b>Kinetic COF</b>	<b>% Gloss Delta</b>	<b>Mar Resist</b>	<b>Stain Resist</b>	<b>Surface Appearance</b>
WB Acrylic	40D	0.253	0.168	-27.4%	1.9	6.5	Droplets
	40E	0.263	0.167	-27.6%	1.9	5.5	Droplets
	40F	0.273	0.173	-25.8%	2.5	7.5	Droplets
	COMP	0.533	0.292	-26.4%	2.3	5	Smooth
	CONTROL	0.543	0.357	-28.8%	1.4	1.5	Smooth



# SB Acrylic

	<b>Sample</b>	<b>Static COF</b>	<b>Kinetic COF</b>	<b>% Gloss Delta</b>	<b>Mar Resist</b>	<b>Stain Resist</b>	<b>Surface Appearance</b>
SB Acrylic	40D	0.335	0.184	-27.1%	2.0	6.5	Smooth
	40E	0.319	0.186	-18.7%	5.1	7	Smooth
	40F	0.340	0.180	-20.0%	4.6	5.5	Smooth
	COMP	0.431	0.194	-17.9%	5.4	7.5	Smooth
	CONTROL	0.673	0.763	-32.8%	0.0	1.5	Smooth



# WP PU 1K

	<b>Sample</b>	<b>Static COF</b>	<b>Kinetic COF</b>	<b>% Gloss Delta</b>	<b>Mar Resist</b>	<b>Stain Resist</b>	<b>Surface Appearance</b>
WB 1K PU	40D	0.298	0.167	-10.8%	8.0	6.5	Droplets
	40E	0.304	0.148	-12.7%	7.3	5.5	Droplets
	40F	0.260	0.152	-10.2%	8.2	7.5	Droplets
	COMP	0.381	0.205	-11.8%	7.6	5	Smooth
	CONTROL	0.641	0.435	-14.7%	6.6	1.5	Smooth



# SB PU 1K

	<b>Sample</b>	<b>Static COF</b>	<b>Kinetic COF</b>	<b>% Gloss Delta</b>	<b>Mar Resist</b>	<b>Stain Resist</b>	<b>Surface Appearance</b>
SB 1K PU	40D	0.532	0.248	-27.5%	1.9	5.5	Smooth
	40E	0.610	0.258	-23.6%	3.3	5.5	Smooth
	40F	0.666	0.253	-17.6%	5.5	6.5	Smooth
	COMP	0.677	0.335	-18.8%	5.1	6.5	Smooth
	CONTROL	1.014	0.845	-28.4%	1.6	1.5	Smooth





# 40 G-J

- 40D-F are performing better and have better compatibility

## Next Variations:

- G-J silicone phase is a mix of high viscosity fluid and gum, with silicone and organic emulsification
- 40I added film former
- 40J added film former and silica



# WB Acrylic

	<b>Sample</b>	<b>Static COF</b>	<b>Kinetic COF</b>	<b>% Gloss Delta</b>	<b>Mar Resist.</b>	<b>Surface Appearance</b>
WB Acrylic	40G	0.854	0.322	-14.5%	3.2	Smooth
	40H	0.899	0.314	-15.0%	2.8	Smooth
	40I	0.889	0.326	-13.8%	3.5	Smooth
	40J	0.784	0.304	-14.6%	3.1	Smooth
	COMP	0.900	0.383	-13.2%	3.9	Smooth
	CONTROL	0.922	0.590	-15.1%	2.8	Smooth

# SB Acrylic

	Sample	Static COF	Kinetic COF	% Gloss Delta	Mar Resist.	Surface Appearance
SB Acrylic	40G	0.791	0.313	-12.1%	4.6	Smooth
	40H	0.669	0.282	-13.8%	3.6	Smooth
	40I	0.641	0.279	-10.2%	5.7	Smooth
	40J	0.714	0.294	-10.6%	5.5	Smooth
	COMP	0.592	0.242	-10.8%	5.4	Minor Lines
	CONTROL	0.994	0.752	-19.6%	0	Smooth



# WB PU 1K

	<b>Sample</b>	<b>Static COF</b>	<b>Kinetic COF</b>	<b>Gloss Before</b>	<b>% Gloss Delta</b>	<b>Mar Resist.</b>	<b>Surface Appearance</b>
1K WB PU	40G	0.686	0.304	19.0	-8.8%	6.6	Minor Lines
	40H	0.650	0.293	18.5	-7.8%	7.2	Smooth
	40I	0.729	0.324	20.0	-6.8%	7.8	Minor Lines
	40J	0.649	0.283	19.2	-7.7%	7.3	Smooth
	COMP	0.765	0.312	17.1	-8.7%	6.7	Craters
	CONTROL	0.948	0.678	20.8	-9.1%	6.4	Smooth



# SB PU 1K

	<b>Sample</b>	<b>Static COF</b>	<b>Kinetic COF</b>	<b>% Gloss Delta</b>	<b>Mar Resist.</b>	<b>Surface Appearance</b>
1K SB PU	40G	1.396	0.371	-4.9%	9	Mild Wave
	40H	1.355	0.364	-4.9%	9	Smooth
	40I	1.228	0.362	-8.7%	6.7	Smooth
	40J	1.063	0.355	-4.2%	9.4	Smooth
	COMP	1.266	0.393	-9.1%	6.5	Smooth
	CONTROL	1.427	0.653	-9.3%	6.3	Smooth

# WB PU 2K

	<b>Sample</b>	<b>Static COF</b>	<b>Kinetic COF</b>	<b>Gloss Before</b>	<b>% Gloss Delta</b>	<b>Mar Resist.</b>	<b>Surface Appearance</b>
2K WB PU	40G	1.182	1.249	85.4	-8.4%	6.9	Few Craters
	40H	1.293	1.420	86.5	-7.5%	7.4	Few Craters
	40I	1.390	1.353	88.1	-8.6%	6.7	Few Craters, Mild Wave
	40J	1.209	1.202	86.4	-8.7%	6.7	Few Craters, Mild Wave
	COMP	1.332	0.784	79.6	-6.1%	8.3	Few Craters, Mild Wave
	CONTROL	2.669	2.894	90.3	-13.3%	3.9	Few Craters



# SB PU 2K

	Sample	Static COF	Kinetic COF	Gloss Before	% Gloss Delta	Mar Resist.	Surface Appearance
2K SB PU	40G	1.361	1.343	94.8	-10.1%	5.8	Craters
	40H	1.437	1.278	93.2	-11.2%	5.2	Craters
	40I	1.302	1.181	86.9	-14.5%	3.1	Craters
	40J	1.203	1.021	90.4	-12.8%	4.2	Craters
	COMP	0.926	0.840	90.3	-9.0%	6.5	Wave
	CONTROL	2.853	2.751	96.5	-10.2%	5.7	Few Craters

# 35A, 45 A,B

- 40G-J weaker performance
- 40C,D, E are the best options

## Final Variations:

- No Tin, silicone gum, mixed dispersant
- 35A minimal dispersant
- 45 A,B contain more dispersant
- 45A doesn't have preservative, 45B does.



# SB HG Enamel

	Sample	Static COF	Kinetic COF	Mar Resist	Appearance
<b>SB HG Black Enamel</b>	35 A	1.198	0.355	7	Good leveling. No fish eyes.
	45 A	1.323	0.368	7	Good leveling. No fish eyes.
	45 B	1.520	0.337	7	Good leveling. No fish eyes.
	COMP	1.733	0.449	7.5	Fair leveling. No fish eyes.
	CONTROL	1.960	0.438	4	Poor leveling. No fish eyes.



# WB HG Enamel

	Sample	Static COF	Kinetic COF	Mar Resist	Appearance
<b>WB HG Black Enamel</b>	35 A	1.994	0.450	7.5	Good leveling. No fish eyes.
	45 A	1.731	0.468	7.5	Good leveling. No fish eyes.
	45 B	1.748	0.461	7.5	Good leveling. No fish eyes.
	COMP	1.733	0.445	7	Good leveling. No fish eyes.
	CONTROL	1.862	0.890	3	Good leveling. No fish eyes.

# WB PU 1K

	<b>Sample</b>	<b>Static COF</b>	<b>Kinetic COF</b>	<b>Mar Resist</b>	<b>Appearance</b>
<b>1K WB PU</b>	45 B	0.463	0.282	7	Good leveling. No fish eyes.
	45 A	0.526	0.300	7	Good leveling. No fish eyes.
	COMP	0.385	0.300	7	Good leveling. No fish eyes.
	CONTROL	1.353	1.684	4	Good leveling. No fish eyes.

# Conclusion

- We found it was straightforward to match the performance properties.
- The rub was to improve waterborne compatibility, which we accomplished by altering the dispersion packages.
- We found superior performance to the COMP product without Tin or solvents.



**One More Piece to the Puzzle.  
Thank you for your attention**

