



FUNCTIONAL SILICONES FOR EASY TO CLEAN COATINGS

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- **Common Stains for Architectural/Construction Coatings**
- **Functional Silicones Introduction**
- **Momentive Functional Silicones for Easy-to-Clean Coatings:**
 - Waterborne Acrylic
 - Solvent-borne Polyurethane
 - Water-borne Polyurethane





GRAFFITI



SURFACTANT LEACHING/WATER MARKS



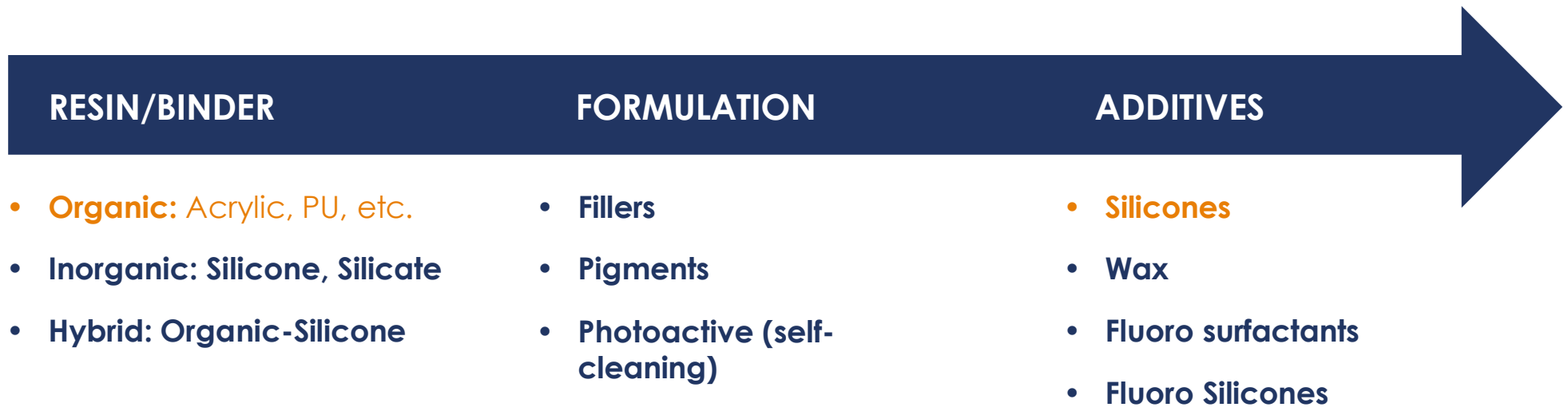
SCUFF



DIRT



MARKERS



- **Complete Formulation Optimization is Needed to Achieve Easy to Clean Coatings.**
- **Functionality of a Silicone can be Selected Based on Target Properties of a Target Formulation.**

Product formulations are included as illustrative examples only. Momentive makes no representation or warranty of any kind with respect to any such formulations, including, without limitations, concerning the efficacy or safety of any product manufactured using such formulations.

**MOMENTIVE SOLUTIONS FOR
WATERBORNE ACRYLIC PAINTS**



CoatOSil™ CLEAN Silicone

- Key Features
- How Does It Work
- Applications And Tests
- Summary



Key Features

- **Low viscosity emulsion of functional silicone**
- **Lower VOC; Lower cyclics**
 - < 7g/L VOC, ASTM D2369
 - < 1000 ppm D4, D5, D6
- **Typical properties**
 - White opaque liquid
 - ~45% solids
 - Low viscosity (< 400 cp at 25°C)
 - Particle Size: ~300 nm
- **Compatible with acrylic latex**

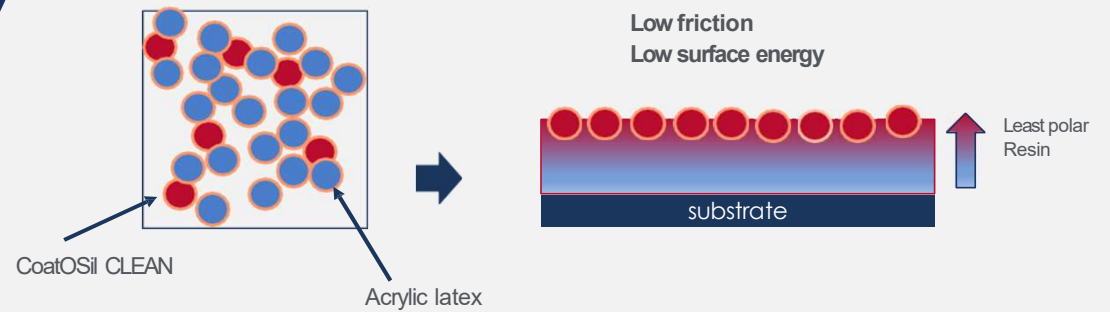


Unique molecular design to achieve optimal properties

- Compatibility
- Surface energy
- Coefficient of Friction
- Durability (anchoring groups)

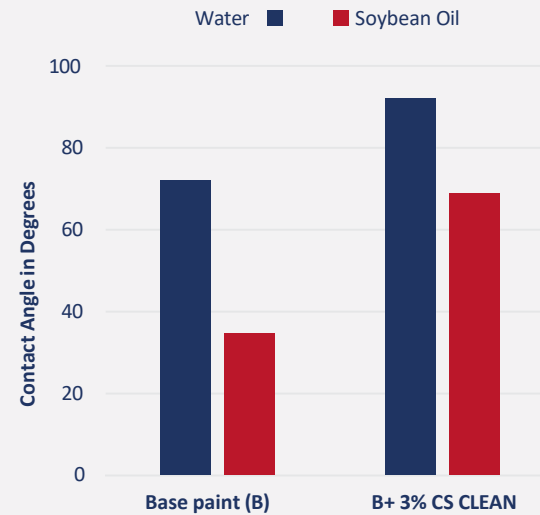
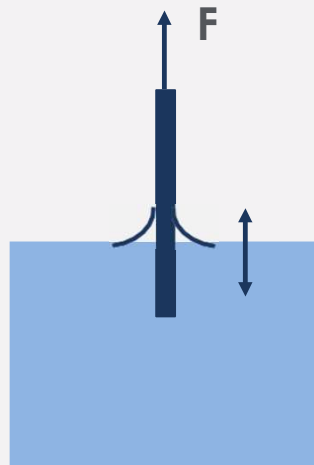


How does it work?



CoatOSil CLEAN increased both Hydrophobicity and Oleophobicity, and reduced Coefficient of Friction.

Dynamic Contact Angle Measurement



Coeff. Of Friction (CSM Tribometer):

Base paint (B)	B + 3% CS CLEAN
0.3	0.16

Typical properties are average data and are not to be used as or to develop specifications
 Note: Test data. Actual results may vary

Typical Benefits

- Scuff resistance
- Stain resistance
- Anti-blocking
- Reduced surfactant leaching
- Compatible with a wide range of latex systems



Interior Semi-Gloss 19 PVC	
Weight	100.00
Volume	80.82
% NV	46.31
% PVC	19.32
Density	1.24
Gloss, 60	63.0
Gloss, 85	92.0

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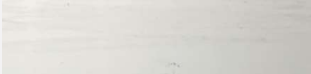

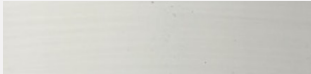





Ingredient	Function	Amount (wt%)
Water		18.80
Wetting agent (100% active, non-ionic)	Pigment wetting	0.20
Dispersing aid	Pigment dispersant	0.30
Defoamer	Defoaming	0.25
Ammonium Hydroxide (25%)	pH adjustment	0.45
Ti-Pure R-902	Opacity	22.00
Letdown		
100% acrylic latex	Binder	43.00
Butyl Glycol	Coalescent	1.00
Texanol	Coalescent	0.50
CoatOSil CLEAN		3.00
Defoamer	Defoaming	0.04
Biocide	Biocide	0.25
PU non-ionic thickener	Thickener	1.90
Water		7.3
TOTAL		100.00

CoatOSil CLEAN Improved Scuff Resistance

Interior Paint, Semi-Gloss, PVC 19

* Control was made using a commercial APEO free, zero-VOC capable, 100% acrylic latex.

INTERNAL TEST METHOD

CONTROL*	3% COATOSIL CLEAN	
		Plastic Pen Cap
		Metal (Spatula tip)
		Pen Cover
		Cork Stopper

Typical properties are average data and are not to be used as or to develop specifications
Note: Test data. Actual results may vary

Improved scuff resistance

CoatOSil CLEAN Improved Scuff Resistance

Interior Paint, Semi-Gloss, PVC 19

* Control was a commercial paint.

INTERNAL TEST METHOD

CONTROL*



3% COATOSIL CLEAN



Rubber stopper



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Note: Test data. Actual results may vary

Improved scuff resistance

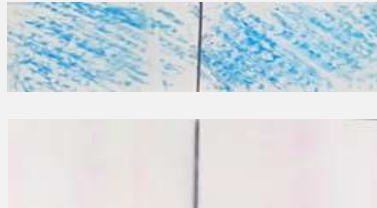
CoatOSil CLEAN Improved Stain Resistance

Interior Paint, Semi-Gloss, PVC 19

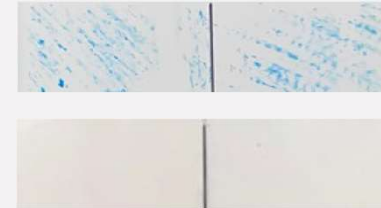
* Control was made using a commercial APEO free, zero-VOC capable, 100% acrylic latex.

ASTM D3450

CONTROL*



3% COATOSIL CLEAN



Crayon

Lipstick

Typical properties are average data and are not to be used as or to develop specifications
Note: Test data. Actual results may vary

Better crayon and lipstick resistance

CoatOSil CLEAN Provided Anti-Blocking

Interior Paint, Semi-Gloss, PVC 19

* Control was made using a commercial APEO free, zero-VOC capable, 100% acrylic latex.

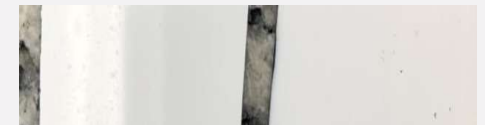
ASTM D4946

CONTROL*



Poor Tack

3% COATOSIL CLEAN



No Tack

Typical properties are average data and are not to be used as or to develop specifications
Note: Test data. Actual results may vary

Superior block resistance

CoatOSil CLEAN Reduced Surfactant Leaching

Interior Paint, Semi-Gloss, PVC 19

* Control was made using a commercial APEO free, zero-VOC capable, 100% acrylic latex.

ASTM 7190

CONTROL*



3% COATOSIL CLEAN



Typical properties are average data and are not to be used as or to develop specifications. Note: Test data. Actual results may vary

Reduced water streaks on paint surface

CoatOSil CLEAN Recoatability

Interior Paint, Semi-Gloss, PVC 19

* Control was made using a commercial APEO free, zero-VOC capable, 100% acrylic latex.

ASTM 3359

CONTROL*



3% COATOSIL CLEAN



- 2 coats of non-silicone containing coating over 2 coats of silicone containing coating tinted blue.
- 15-day cure time at RT between silicone and non-silicone coats

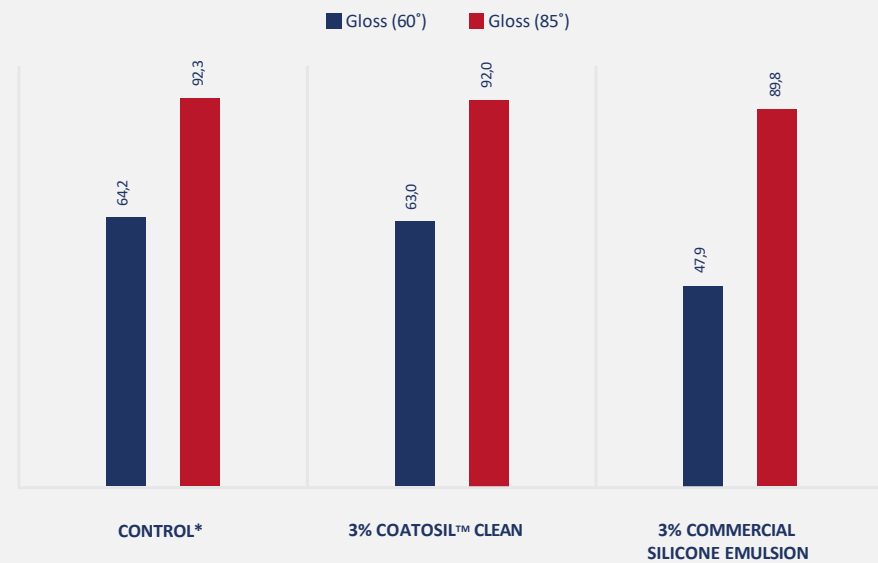
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No negative impact on recoatability

CoatOSil CLEAN Showed No Impact on Gloss

Interior Paint, Semi-Gloss, PVC 19

* Control was made using a commercial APEO free, zero-VOC capable, 100% acrylic latex.



No negative impact on gloss

Flat Model Interior Paint Formulation

Interior Flat 40 PVC

Weight	100.00
Volume	71.34
% NV	51.21
% PVC	38.51
Density	1.40
Gloss, 60	3.00
Gloss, 85	23.00

Product formulations are included as illustrative examples only. Momentive makes no representation or warranty of any kind with respect to any such formulations, including, without limitations, concerning the efficacy or safety of any product manufactured using such formulations.

Ingredient	Function	Amount (wt%)
Water		20.24
Wetting agent (100% active, non-ionic)	Pigment wetting	0.17
Dispersing aid	Pigment dispersant	0.25
Defoamer	Defoaming	0.20
Ammonium Hydroxide (25%)	pH adjustment	0.30
Ti-Pure R-902	Opacity	27.00
Calcium Carbonate	Filler	9.00
Letdown		
100% acrylic latex	Binder	28.00
Butyl Glycol	Coalescent	1.20
Texanol	Coalescent	0.60
CoatOSil CLEAN		3.00
Defoamer	Defoaming	0.04
Biocide	Biocide	0.25
PU non-ionic thickener	Thickener	1.00
Water		11.75
TOTAL		100.00

CoatOSil CLEAN Improved Scuff Resistance

Interior Paint, Flat, PVC 40

* Control was made using a commercial APEO free, zero-VOC capable, 100% acrylic latex.

INTERNAL TEST METHOD

CONTROL*



3% COATOSIL CLEAN



Plastic Pen Cap

Metal (Spatula tip)

Pen Cover

Cork Stopper

Typical properties are average data and are not to be used as or to develop specifications
Note: Test data. Actual results may vary

Improved scuff resistance

CoatOSil CLEAN Improved Stain Resistance

Interior Paint, Flat, PVC 40

* Control was made using a commercial APEO free, zero-VOC capable, 100% acrylic latex.

ASTM D3450

CONTROL*



3% COATOSIL CLEAN



Crayon

Lipstick

Typical properties are average data and are not to be used as or to develop specifications
Note: Test data. Actual results may vary

Better crayon and lipstick resistance

CoatOSil CLEAN Provided Anti-Blocking

Interior Paint, Semi-Gloss, Flat, PVC 40

* Control was made using a commercial APEO free, zero-VOC capable, 100% acrylic latex.

ASTM D3450

CONTROL*



Poor Tack

3% COATOSIL CLEAN



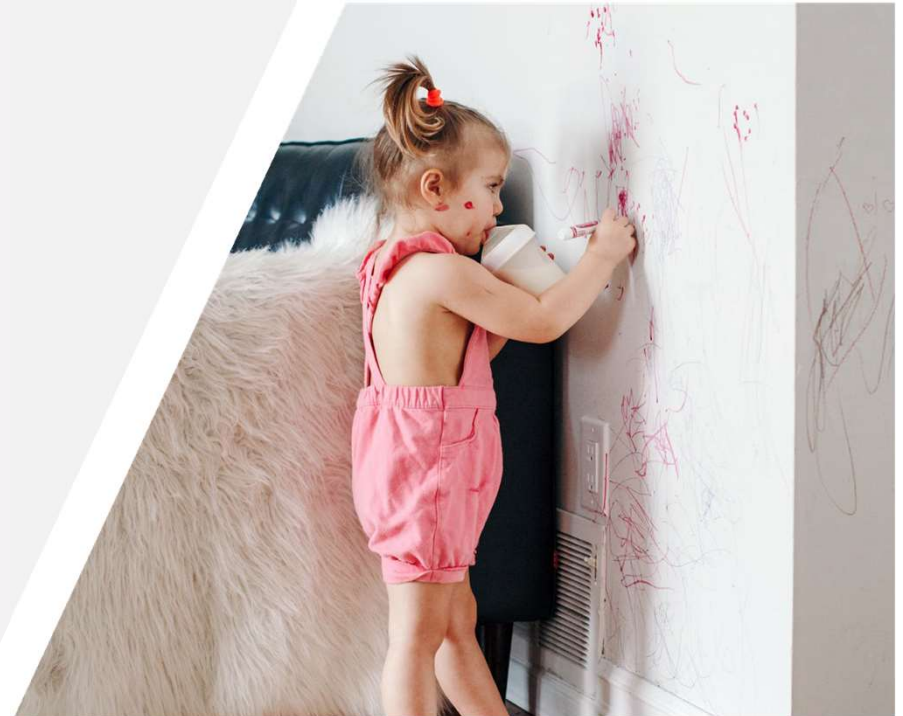
No Tack

Typical properties are average data and are not to be used as or to develop specifications
Note: Test data. Actual results may vary

Superior block resistance

Summary

- **Excellent Compatibility With Waterborne Coatings:**
 - Easy to use as a blend or post-add in most WB systems
 - < 1000 ppm D4, D5, D6
- **Typical Performance Benefits:**
 - Scuff resistance
 - Stain resistance
 - Anti-blocking
 - Reduced surfactant leaching
- **Virtually No Negative Effect on Adhesion, Recoatability, or Gloss**



MOMENTIVE SOLUTIONS FOR SOLVENT-BASED POLYURETHANE COATINGS

TSCA Registration In Progress



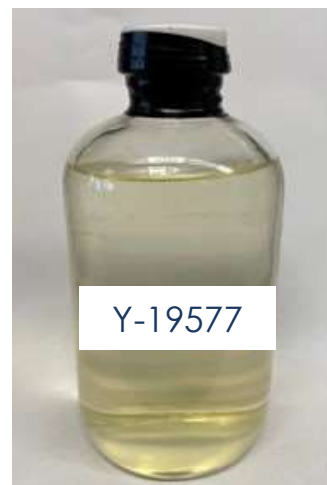
Introduction

Y-19577, a reactive silicone additive, is an excellent candidate for solvent-borne 2K Polyurethane/Polyaspartic coatings. It can help provide durable anti-graffiti properties (easy to remove).

Potential Applications and Benefits

As Anti-graffiti additive (1-10 wt%) in 2K SB PU coatings:

- Good compatibility
- Excellent graffiti removal property
- Excellent anti-sticker property
- Improved UV resistance
- Improved flexibility



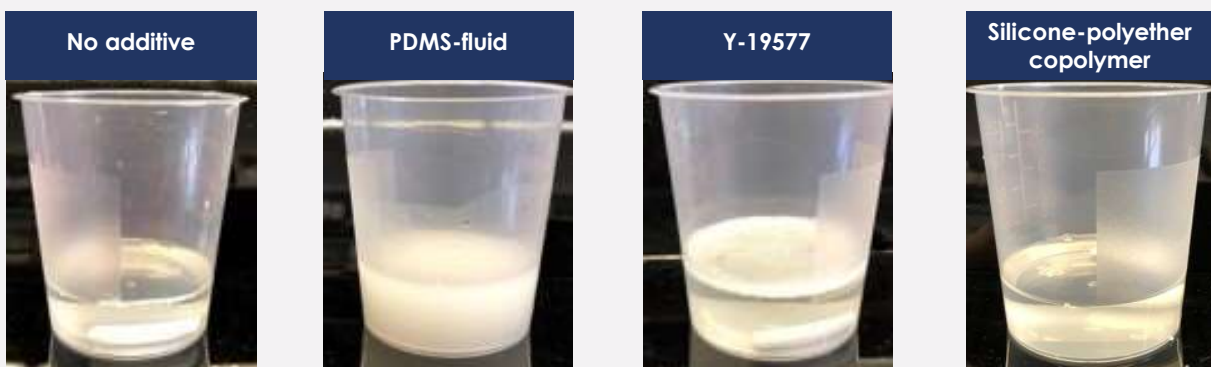
Typical Physical Properties

Property	Value
Active content	~100 wt%
Appearance	Pale yellow liquid
Viscosity, 25°C	70 cp
Density, 25°C	1.01 g/ml
Solvent pH, 25°C	11

Typical properties are average data and are not to be used as or to develop specifications

TSCA Registration In Progress

Various silicone additives (3 wt.%) mixed with acrylic polyol solution (w/o pigments)



Transparency/haze of silicone modified polyacrylate polyols cured with polyisocyanate activator



- Silicone fluid modified acrylic polyols are typically hazy/ opaque liquids
- Y-19577 is miscible with acrylic polyol up to 5 wt.% loading
- Y-19577 modified polyacrylates yield transparent films upon crosslinking with aliphatic polyisocyanates

Typical Physical Properties

Ingredient	Amount (wt%)	
	Control	With Additive
PART A:		
Commercial white topcoat	66.7	61.2
Silicone Additive	-	5.5
PART B:		
Polyisocyanate crosslinker	33.3	33.3
Total	100	33.3

Product formulations are included as illustrative examples only. Momentive makes no representation or warranty of any kind with respect to any such formulations, including, without limitations, concerning the efficacy or safety of any product manufactured using such formulations.

Coating Application

- Metal substrates cleaned by wiping with paper cloth and immersed in Xylene and IPA.
- Coatings spray applied at 2.5 bar pressure using 1.4 mm nozzle.
- Target dry film thickness ~60-70 microns.
- Coatings cured for 14 days at room temperature.

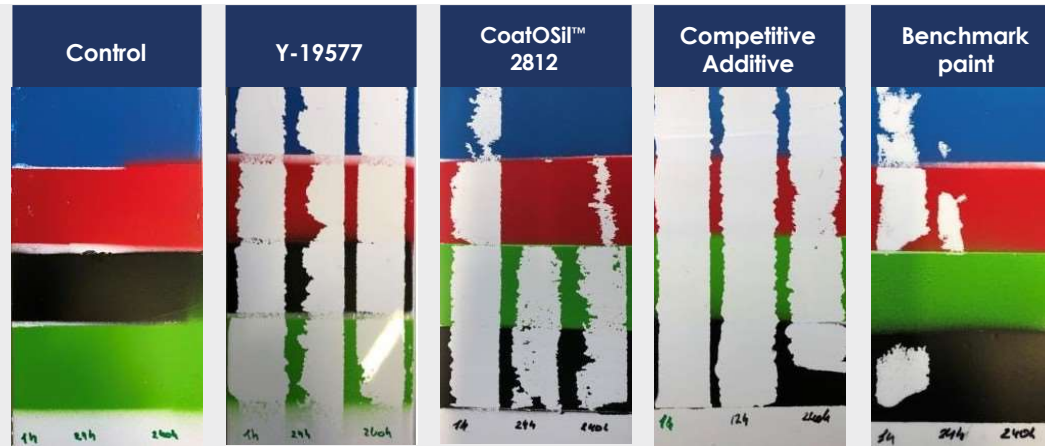
Graffiti Type and Application

- Single pass of graffiti applied on coated panels
- Graffiti removal tested after 24, 120 and 240 hrs



Nitrocellulose based graffiti spray paint

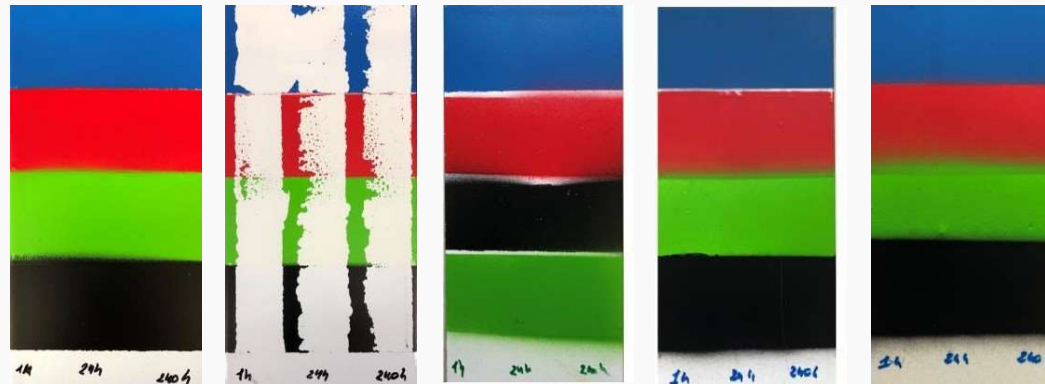
BEFORE WEATHERING



Tape application and single pull

AFTER WEATHERING
(1000 hr QUV-B, 8 hr UV, 4 hr water cycle)

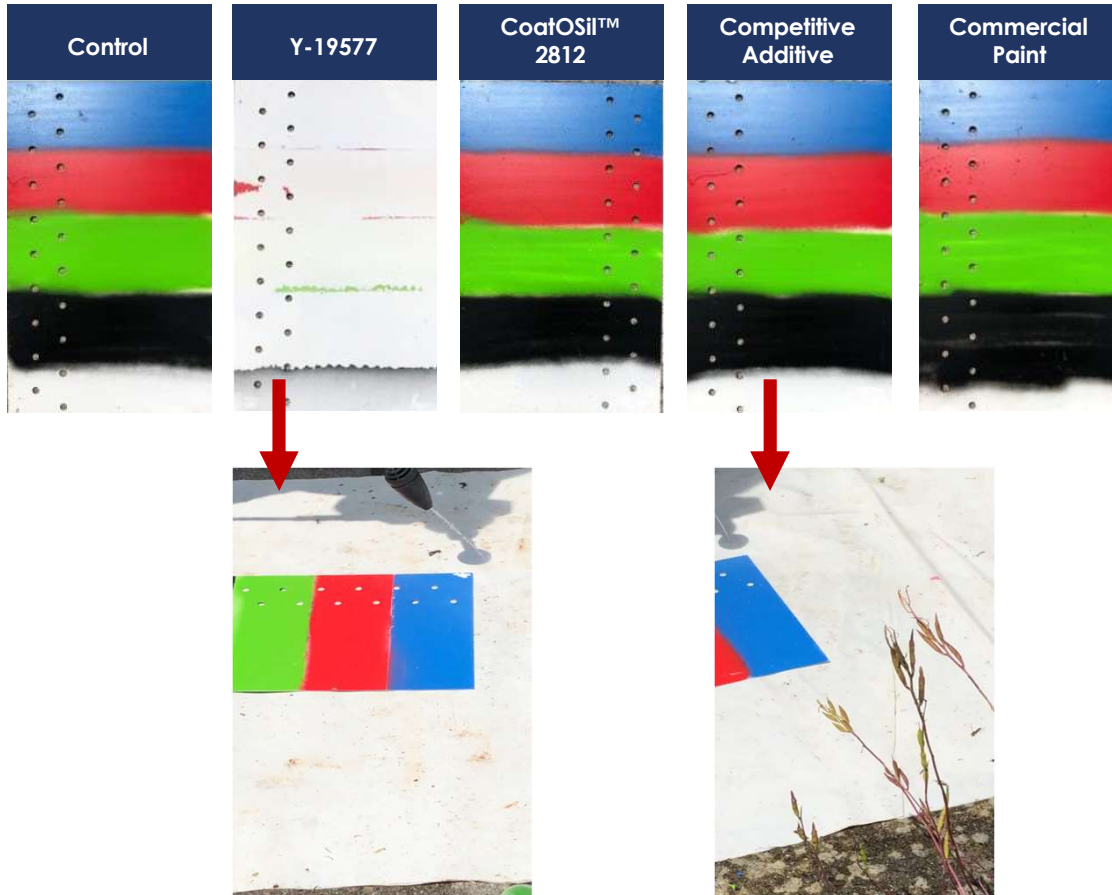
Only Y-19577
Showed Graffiti
Removal after
Weathering



Note: Test data. Actual results may vary.

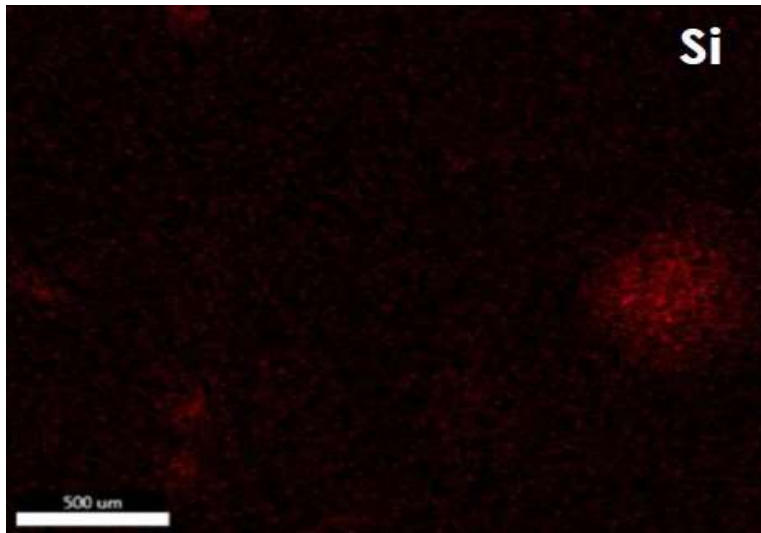
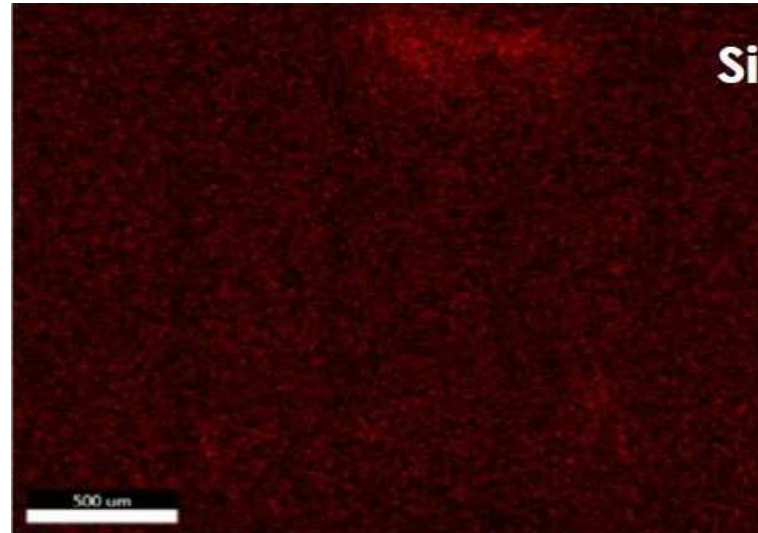


Only Y-19577 Retained Water Contact Angle after Weathering



Karcher High Pressure Cleaner
(60-80 bar, no detergent)

Only Y-19577 showed Complete Removal of Graffiti

Control**Y-19577**

Excellent Distribution
of Si throughout the
Surface of Film

Scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDS)

SEM-EDS analysis was done using Zeiss EVO-18 Scanning Electron Microscope, fitted with EDAX Element Z2e system from Ametek. SEM imaging was done in high vacuum with 15 kV accelerating voltage, working distance of 8.5-9.5 mm and probe current of 100-300 Pa. Samples were prepared by cutting the coated metal plates into 1X1' squares and attaching to the stage using carbon adhesive tape. Samples were sputter coated with gold at 10 mA for 90 sec to obtain a conductive surface to prevent charging of the sample. EDS elemental maps were acquired at a magnification of 10,000X.

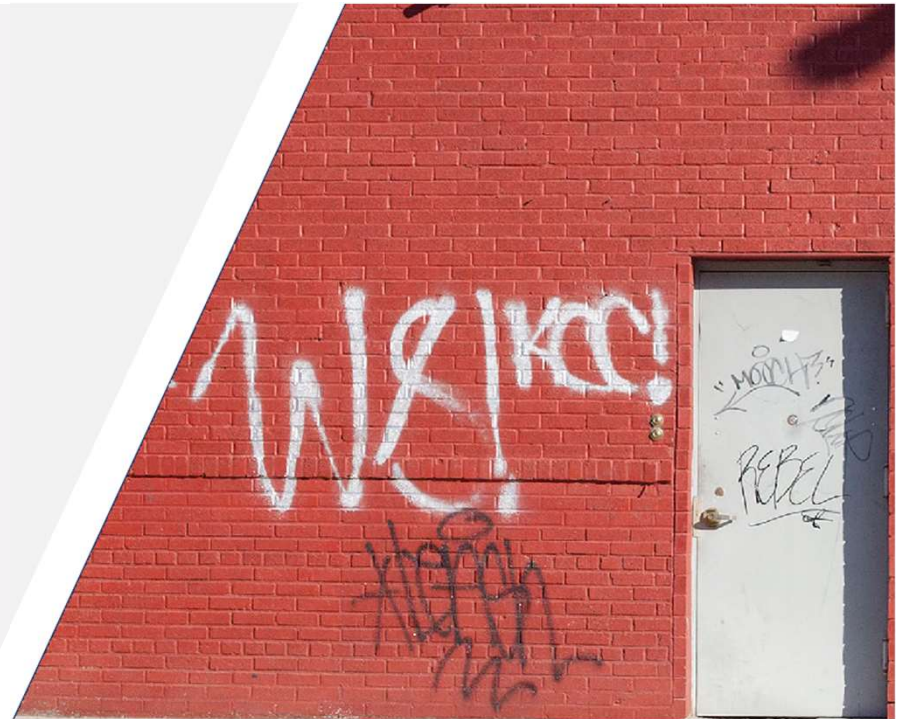
Note: Test data. Actual results may vary.

Properties	Test Method	Control	Y-19577	CoatOSil™ 2812 copolymer	Competitive Additive
Impact Resistance (front)	2 Kg, 1 m.	Severe damage	Pass	Pass	Pass
Impact Resistance (reverse)		Slight damage	Pass	Slight damage	Pass
Flexibility	DIN EN ISO 1250	Good	Good	Good	Good
	DIN EN ISO 6860	Good	Good	Good	Slight damage
Adhesion (cross-hatch)	DIN EN ISO 2409	Gt 3-4	Gt 0	Gt 5	Gt 0
Chemical Resistance (THF, Heptane, Fluid Oil, 10% KOH, Cleaner, Gear box oil)	In house	THF: Poor Rest: Good	THF: Better Rest: Good	THF: Poor Rest: Good	THF: Better Rest: Good
Water Contact Angle (initial)	Kruss instrument	83.2	93.5	88.9	98.7
Surface Energy, mN/m (initial)	Kruss instrument	35.4	23.8	25.3	29.4
Water Contact Angle (after QUV)	Kruss instrument	55.2	92.3	49.8	60.1
Surface Energy, mN/m (after QUV)	Kruss instrument	54.8	22.9	54.3	46.1
Gloss at 20° (initial)	DIN 67 530	86	80	72	87
Gloss at 20° (after QUV)	DIN 67 530	19	66	18	73

Y-19577 also improved Impact Resistance, Adhesion, Chemical resistance and UV Stability (gloss and surface energy retention)
VERSATILE FUNCTIONAL ADDITIVE TO IMPROVE SURFACE AND BULK PROPERTIES

Y-19577 Silicone

- Y-19577 silicone provides 2K solvent based polyurethane coatings with low surface energy and strong antigraffiti effect;
- Y-19577 silicone enables polyurethane coatings with improved release properties even after weathering;
- Y-19577 silicone allows formulation of polyurethane coatings with improved compatibility, mechanical properties, adhesion, chemical resistance and good shelf-life stability.



MOMENTIVE SOLUTIONS FOR WATER-BASED POLYURETHANE COATINGS

TSCA Registration In Progress



Introduction

Y-19644 silicone is a reactive silicone additive. It is compatible with water-based 2K Polyurethane coating systems and can enhance durable anti-graffiti properties (easy to remove).

Potential Applications and Benefits

As Anti-graffiti additive (1-5 wt%) in 2K WB PU coatings:

- Good compatibility with WB resins
- Excellent graffiti removal of various paints
- Improved UV durability for outdoor applications
- Improved chemical resistance



Property	Value
Active content	~100 wt%
Appearance	Pale yellow liquid
Viscosity, 25°C	125 cp
Density, 25°C	1.02 g/ml
Solvent pH, 25°C	10.8
Refractive Index	1.42

Typical properties are average data and are not to be used as or to develop specifications

TSCA Registration In Progress

Note: Test data. Actual results may vary.

PART A**WHITE TOPCOAT**

Bayhydrol A145, resin	16.7
Edaplan 490, dispersant	1.2
Butyl glycol, co-solvent	1.4
Water	2.3
CoatOSil™7210 defoamer	0.1
R902+ titanium dioxide	25.4
Bentonite EV, rheology modifier	0.5

mixing with cowless blades disperser milling
with Zr-beads, 1000rpm, 45 min, at RT.
Grinding fineness less 15 micron

water	2.4
Bayhydrol A145, resin	42.1
Butyl glycol, co-solvent	2.3
water	5.3
CoatOSil 7001 flow & levelling agent	0.048
CoatOSil 2812 flow & levelling agent	0.048
Tinuvin 292, HALS	0.2

TOTAL TOPCOAT 100.0

PART B**POLYISOCYANATE CROSSLINKER**

Desmodur N3900, crosslinker	10.2
Butylglycol acetate, solvent	5.95
Ethyl-3-ethoxypropionate, solvent	0.85

TOTAL CROSSLINKER 17.0

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TEST SYSTEM

- Release agents were incorporated by cold blending with the PART A of the topcoat paint and mixing for **48h** before application.
- Standard concentration of release agent in the TOTAL RFU paint formulation was **1.5 wt.%**.

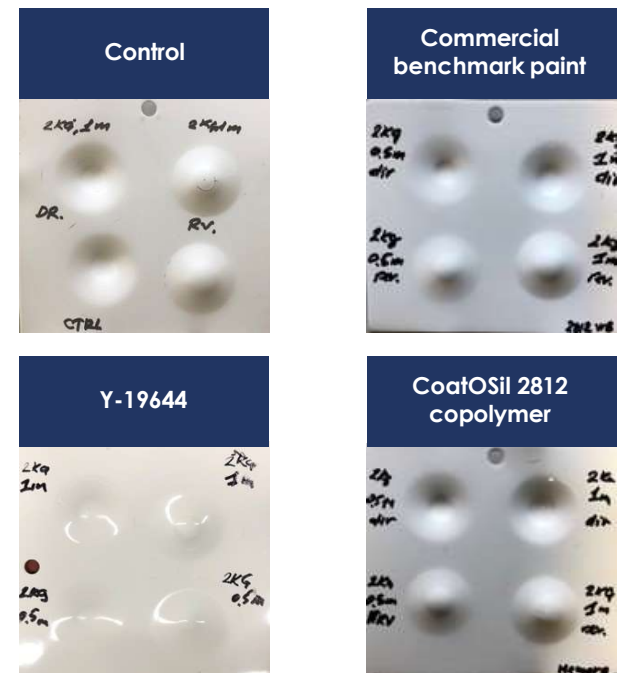
APPLICATION and DRYING

- Substrates: CRS (Gardebond OC), HDG, (Gardebond OE), E-coat primed panels, Epoxy primed panels (appearance panels).
- Cleaned by wiping with paper cloth immersed in Xylene and IPA.
- Applied by spraying, 2.5 bar, 1,4mm nz. DFT=60-70 mic.
- Dried at RT for 14 days before testing.



- Good compatibility of with 2K WB polyurethane paint
- No craters or orange peel
- Induction time of 48h is required to enable good compatibility of silicones with the WB paint

- All experimental systems showed good impact resistance – on PAR with the control 2K PUR topcoat and commercial 2K PU benchmark (commercial anti-graffiti paint)



Note: Test data. Actual results may vary.

Dry/Wet Cross-hatch Adhesion



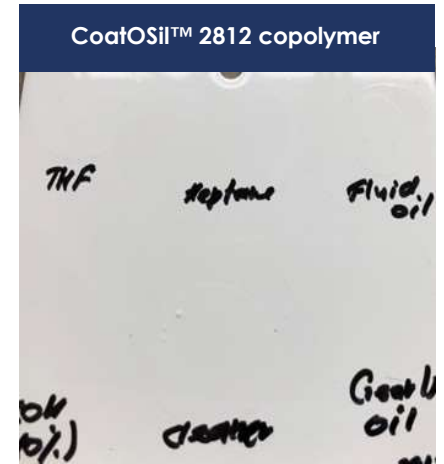
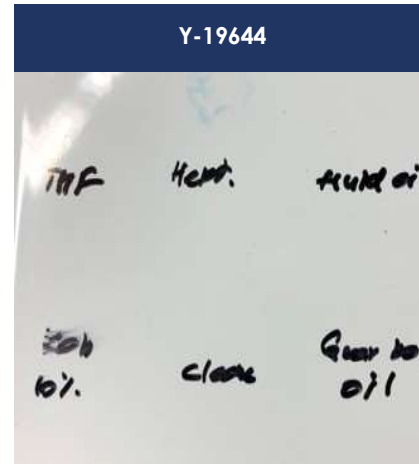
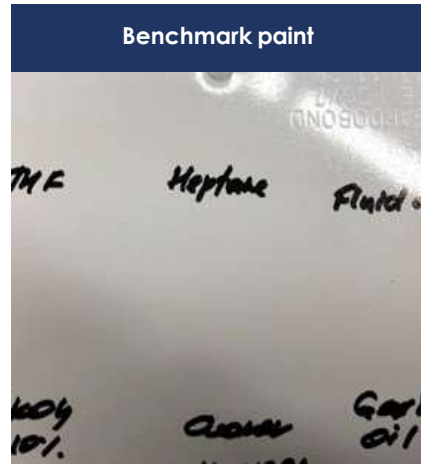
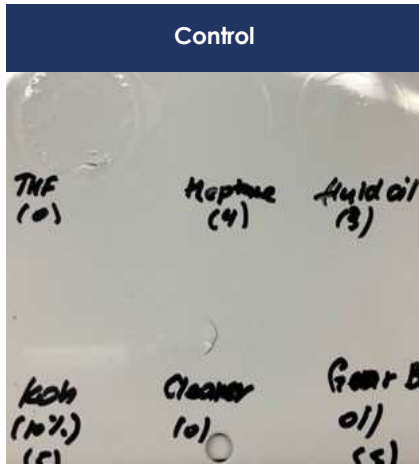
Conical Mandrel Bend Test



Note: Test data. Actual results may vary.

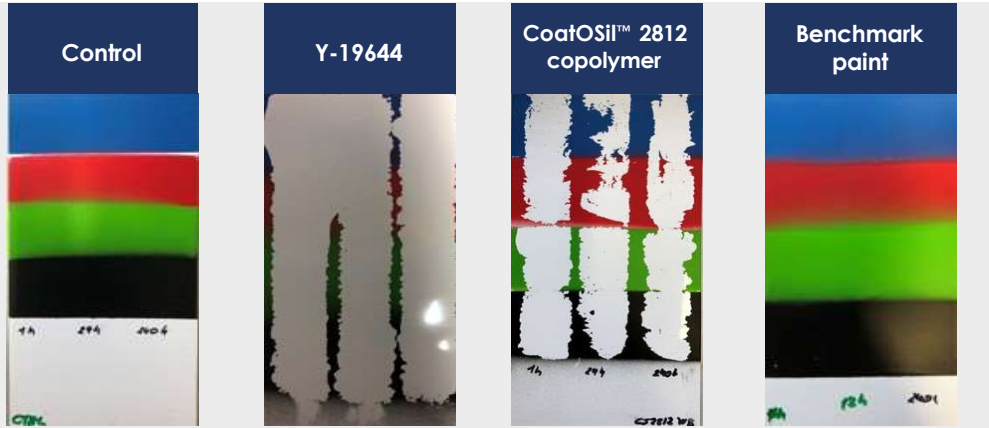
- All systems showed good bending flexibility except the 2K commercial benchmark
- Both silicone additives provide good dry adhesion.
- None of the tested systems affected wet adhesion

Y-19644 showed excellent chemical resistance



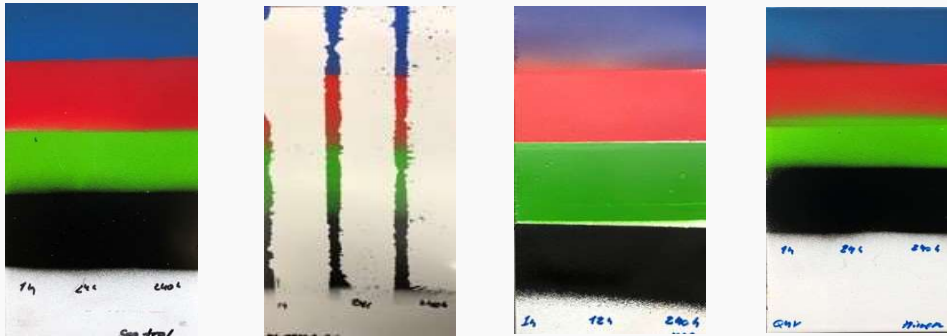
Chemical resistance test was carried out by direct exposure of test surface to various chemicals including: THF, Heptane, Fluid oil, KOH (10%), Cleaner, Gear Box oil. Exposure time: 2h; temperature: RT.

BEFORE WEATHERING

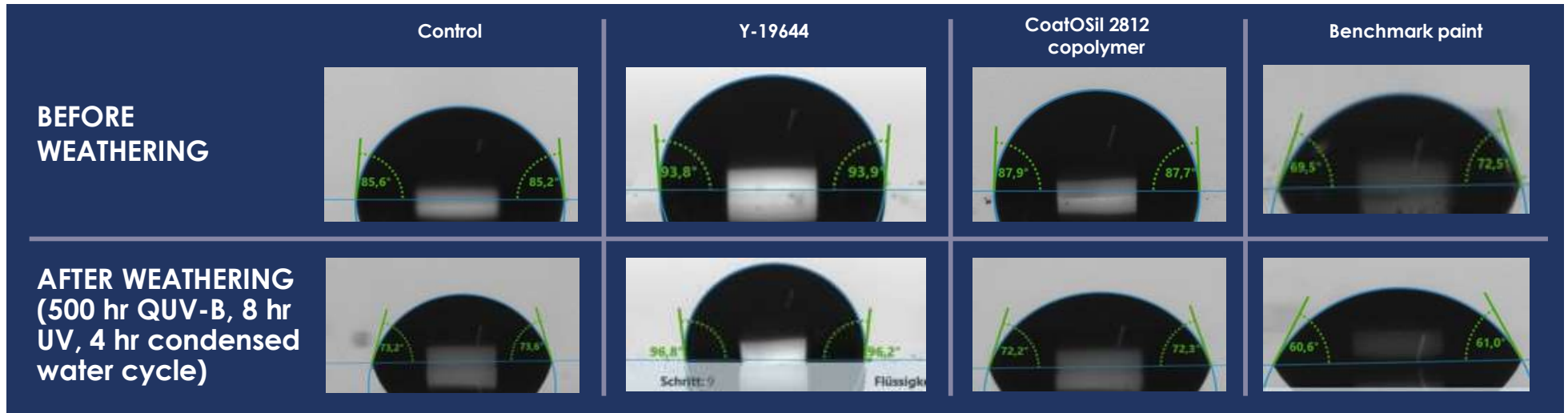


**AFTER WEATHERING
(500 hr QUV-B, 8 hr
UV, 4 hr condensed
water cycle)**

Only Y-19644
Showed Graffiti
Removal after
Weathering



Note: Test data. Actual results may vary.

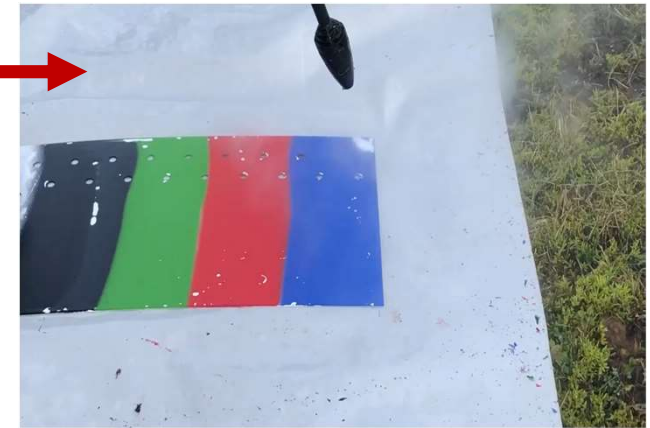
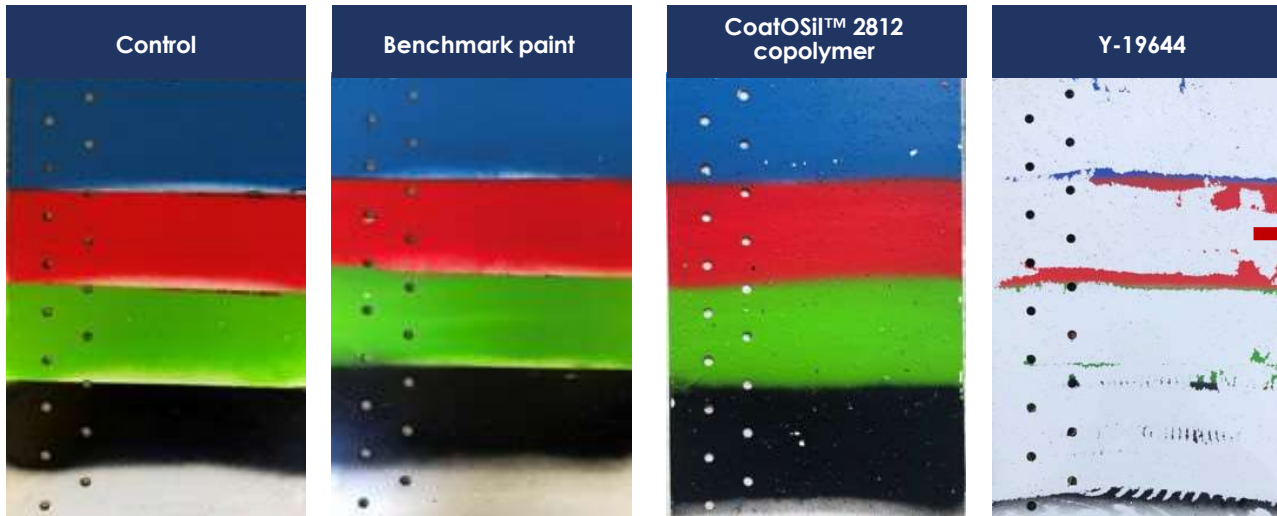


RESULTS	CONTROL	Y-19644	Benchmark paint	CoatOSil 2812 copolymer
Total surface energy before QUV(mN/m)	33.6	25.1	45.2	31.6
Total surface energy after QUV(mN/m)	43.0	23.6	50.3	44.8
Delta	9.4	-1.5	5.1	13.2

Only Y-19644
Retained Water
Contact Angle
after Weathering

Introduction

- Application of NITRO-Anti-graffiti paint on a clean white TOPCOAT panel (60X80 cm)
- cleaning pass with Kercher high-pressure cleaner (ca.60-80 bar), no detergents



Y-19644 showed the best antigraffiti performances vs. other technologies

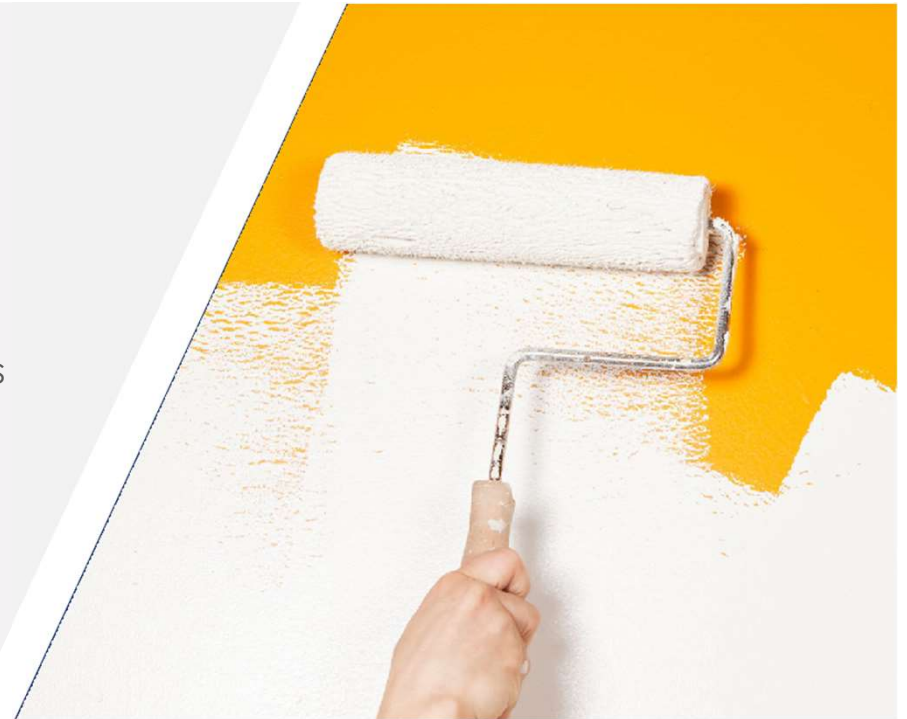
Y-19644 Silicone

- Y-19644 silicone is an excellent candidate for durable water-based anti-graffiti polyurethane applications
- Y-19644 silicone has good compatibility with water-based 2K Polyurethane combined with good shelf-life stability
- Y-19644 silicone modified polyurethanes are characterized by high water contact angle, low surface energy, excellent mechanical properties and chemical resistance



Momentive Functional Silicones for Easy-to-Clean Coatings:

- CoatOSil Clean Silicone for Waterborne Acrylic Systems
- Y-19577 Silicone* for Solvent-borne Polyurethane Systems
- Y-19644 Silicone* for Waterborne Polyurethane Systems



*Y-19577 and Y-19644 TSCA registration are in progress



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