Novel Silicones for Higher Solids Coatings

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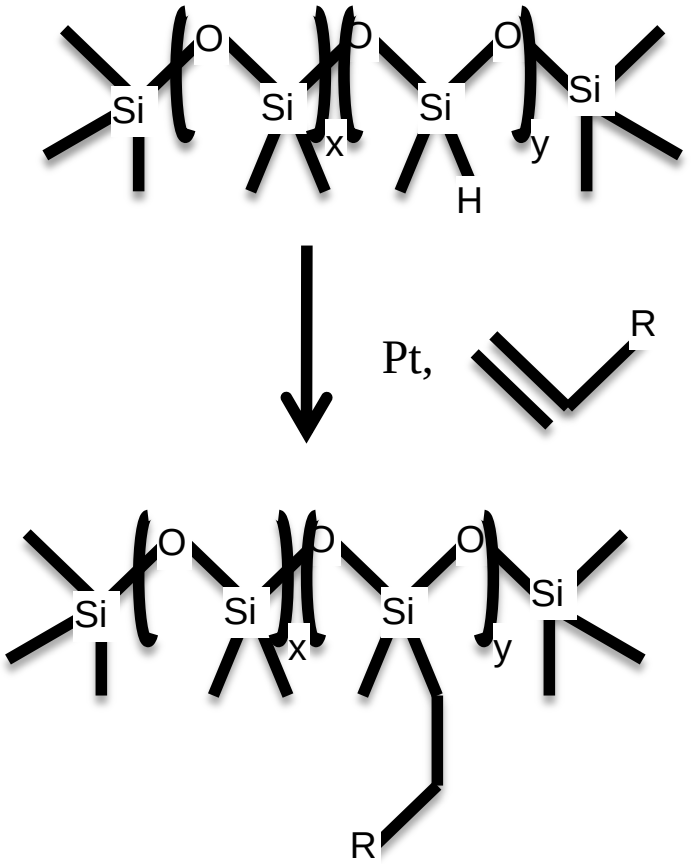
Alkyl Silicones

Structural Variables

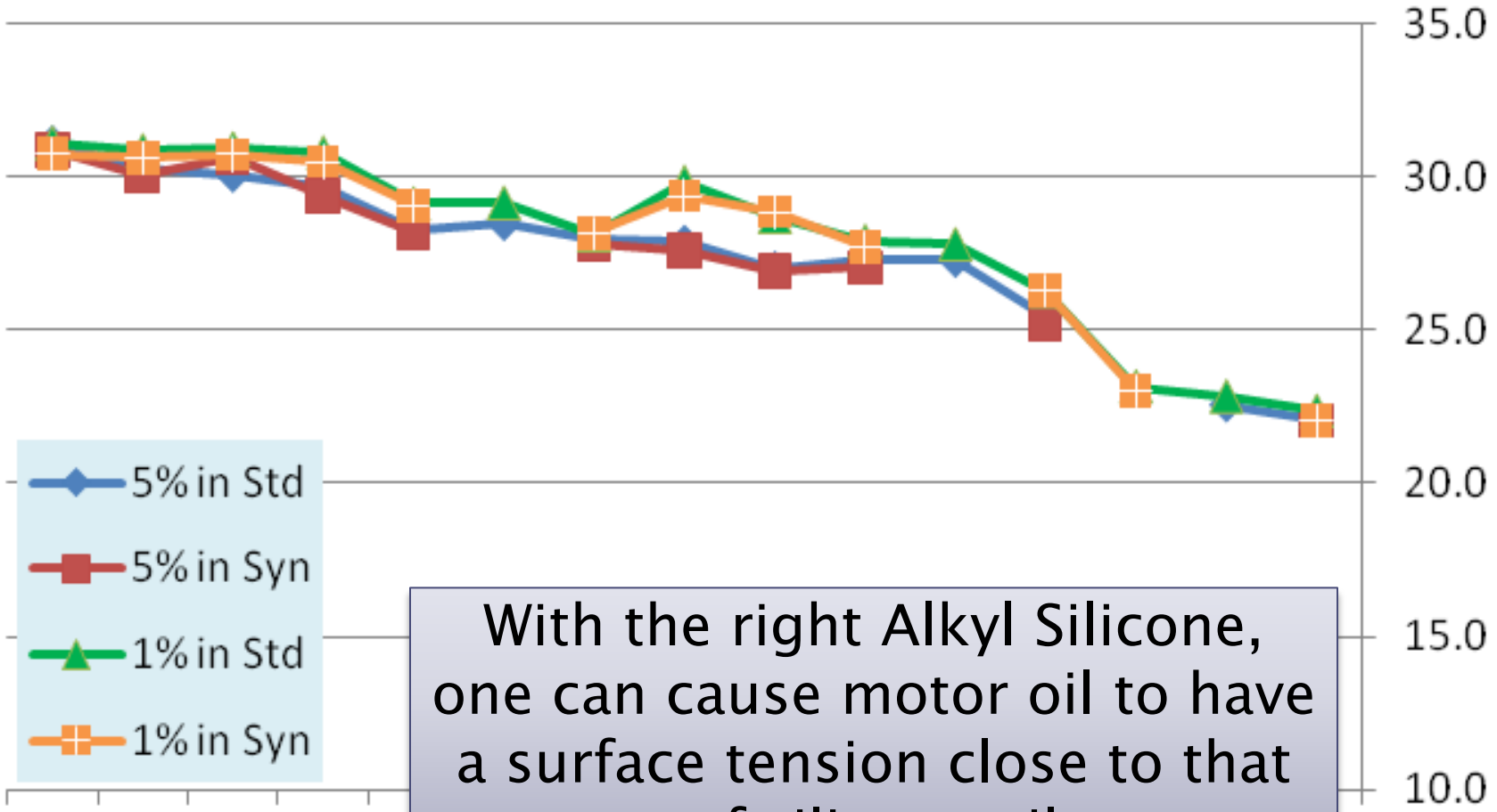
- CH_2=CH–R can vary from Ethyl to $C_{32}H_{65}$
- Variables include molecular weight, weight percent silicone, chain length of hydrocarbon
- Additional proprietary treatments



Alkyl Silicones in PC

- Alkyl silicones are widely used in personal care products. These have better solubility in oils and esters than pure silicone fluid and lower the surface tension of these oils providing many unique properties, such as softness, lubricity, gloss and emolliency in skin care applications.
- Recently some specific alkyl silicones have been found to dramatically reduce surface tension of hydrocarbon oils at very low use levels.

Surface Tension Reduction of 10W-30 Motor Oil



With the right Alkyl Silicone, one can cause motor oil to have a surface tension close to that of silicone oil

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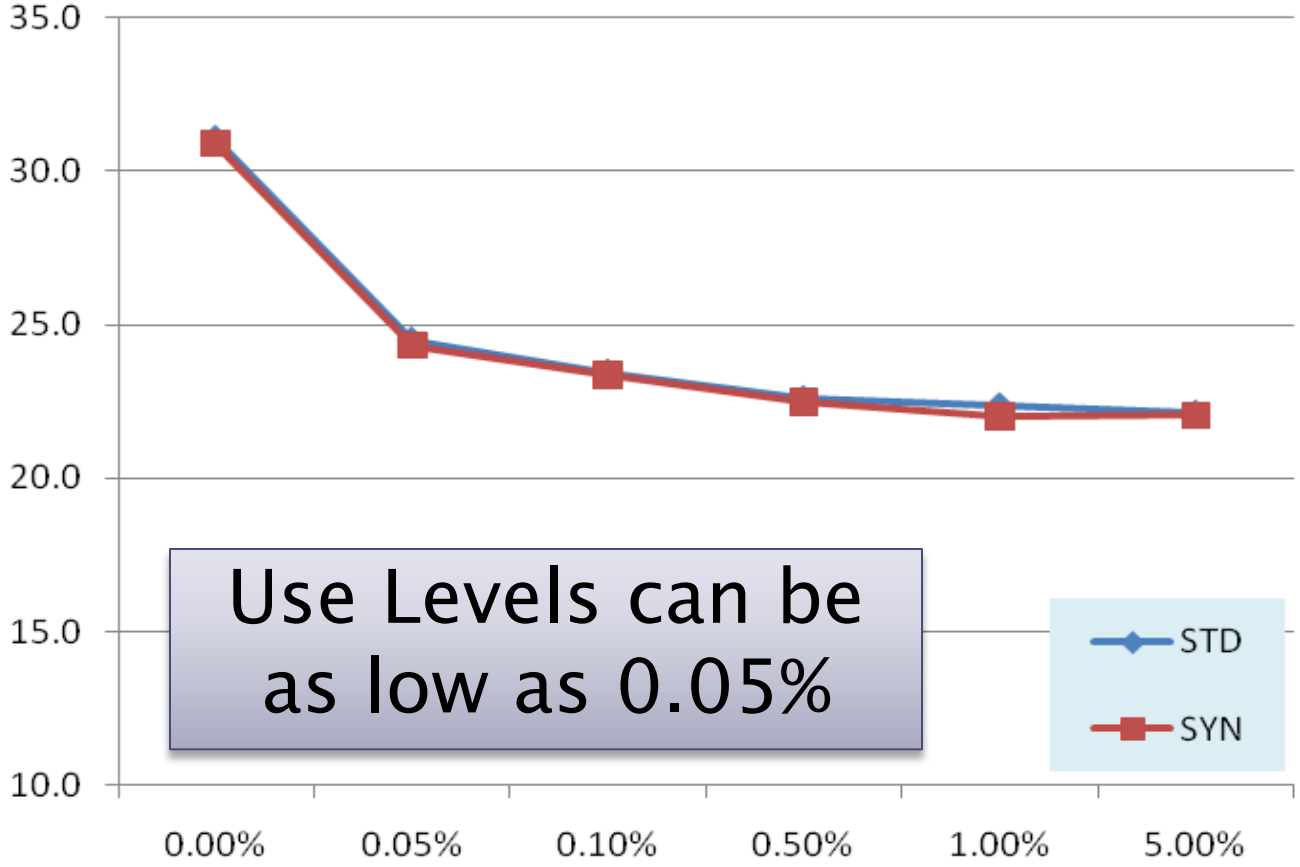
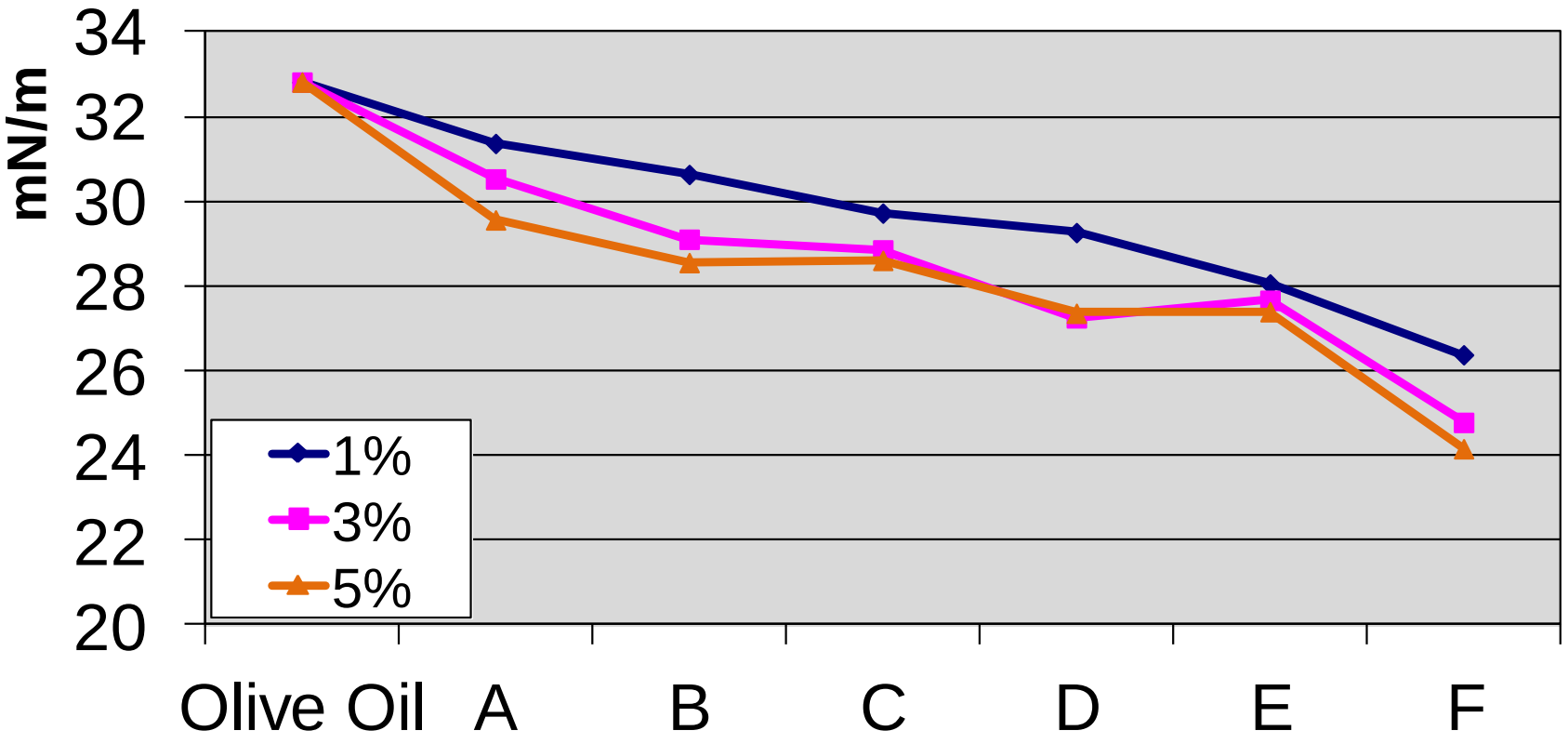
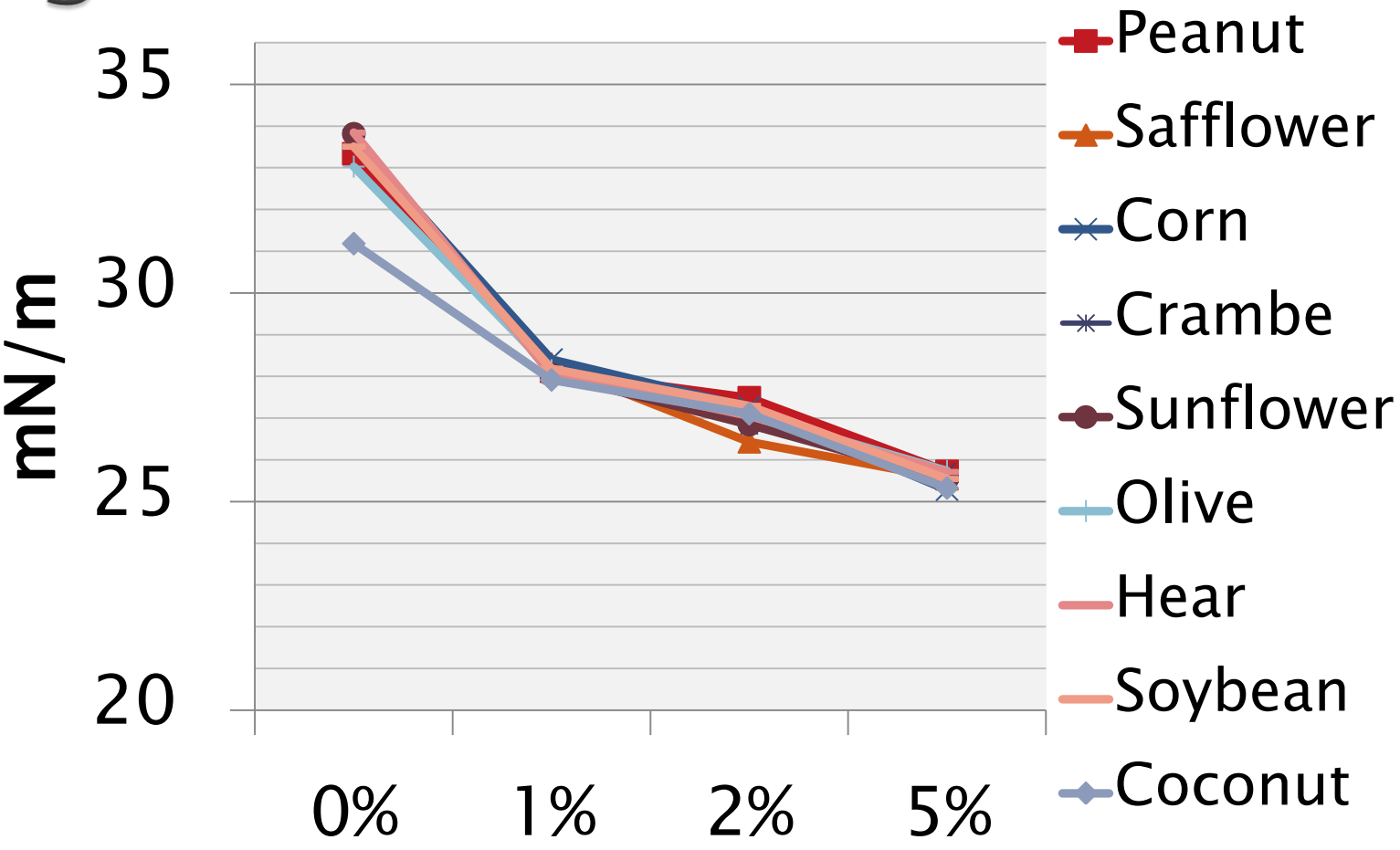
Concentration Study: ST Reduction of 10W-30 Oil



Surface Tension Reduction in Olive Oil



Surface Tension Reduction of Vegetable Oils



Hypothesis

- The effect of using these alkyl silicones in solvent-borne coating systems will be to lower surface tension, improve viscosity, flow and film forming properties.
- It is expected that effect will allow for higher solids and lower VOC's in the coating.

Protocol

- Alkyl silicones at 0.5% will be evaluated in three formulas at recommended and higher solids levels
- Standard tests will be run
  - Visual defects
  - Surface Tension
  - Flow
  - COF
  - Gloss
  - Abrasion Resistance

- Black High Gloss Enamel
  - 60% (315 g/l)
  - 65% (259 g/l)
- Nutshell Resin White
  - 89% (153 g/l)
  - 94% (87 g/l)
- Acrylic Melamine
  - 83% (224 g/l)
  - 92% (93 g/l)

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Alkyl Silicones Used

Silicone	Description
C-16 CR	Modified Siloxane: $C_{16}H_{33}$ Groups
C-22 CR	Modified Siloxane: $C_{22}H_{45}$ Groups
C-8 CR	Modified Siloxane: C_8H_{17} Groups
C-2 Si	Low MW Siloxane: C_2H_5 Groups
C-4 Si-a	Low MW Siloxane: C_4H_9 Groups
C-4 Si-b	Low MW Siloxane: C_4H_9 Groups
C-6 Si	Low MW Siloxane: C_6H_{13} Groups

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Black Enamel Formula

	High Solids	Higher Solids
High Solids Alkyd Resin	39.53%	42.75%
Glycol Ether/Solvent Mix	**28.35%**	**22.51%**
Special Black 4A	13.95%	15.09%
Filler Blend	16.61%	17.96%
Siltech Additives	0%	0 or 0.5%
Anti-settling Agent	S.Q.	S.Q.
Dispersing Agent	S.Q.	S.Q.
Dryer blend	S.Q.	S.Q.
Stabilizer	S.Q.	S.Q.
Anti-skinning Agent	S.Q.	S.Q.
VOC	**315 g/l**	**259 g/l**
Solid	**60%**	**65%**

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Black Enamel

Appearance

Black Enamel	Finish
Control (315 g/l)	Smooth with 10 small fisheyes
Control (259 g/l)	Smooth with 10 small craters
C-16 CR	Smooth with 2 small craters
C-22 CR	Smooth with 2 small craters
C-8 CR	Smooth with no craters
C-2 Si	Smooth with 4 small craters
C-4 Si-a	Smooth with 4 small craters
C-4 Si-b	Smooth with 4 small craters
C-6 Si	Smooth with 4 small craters

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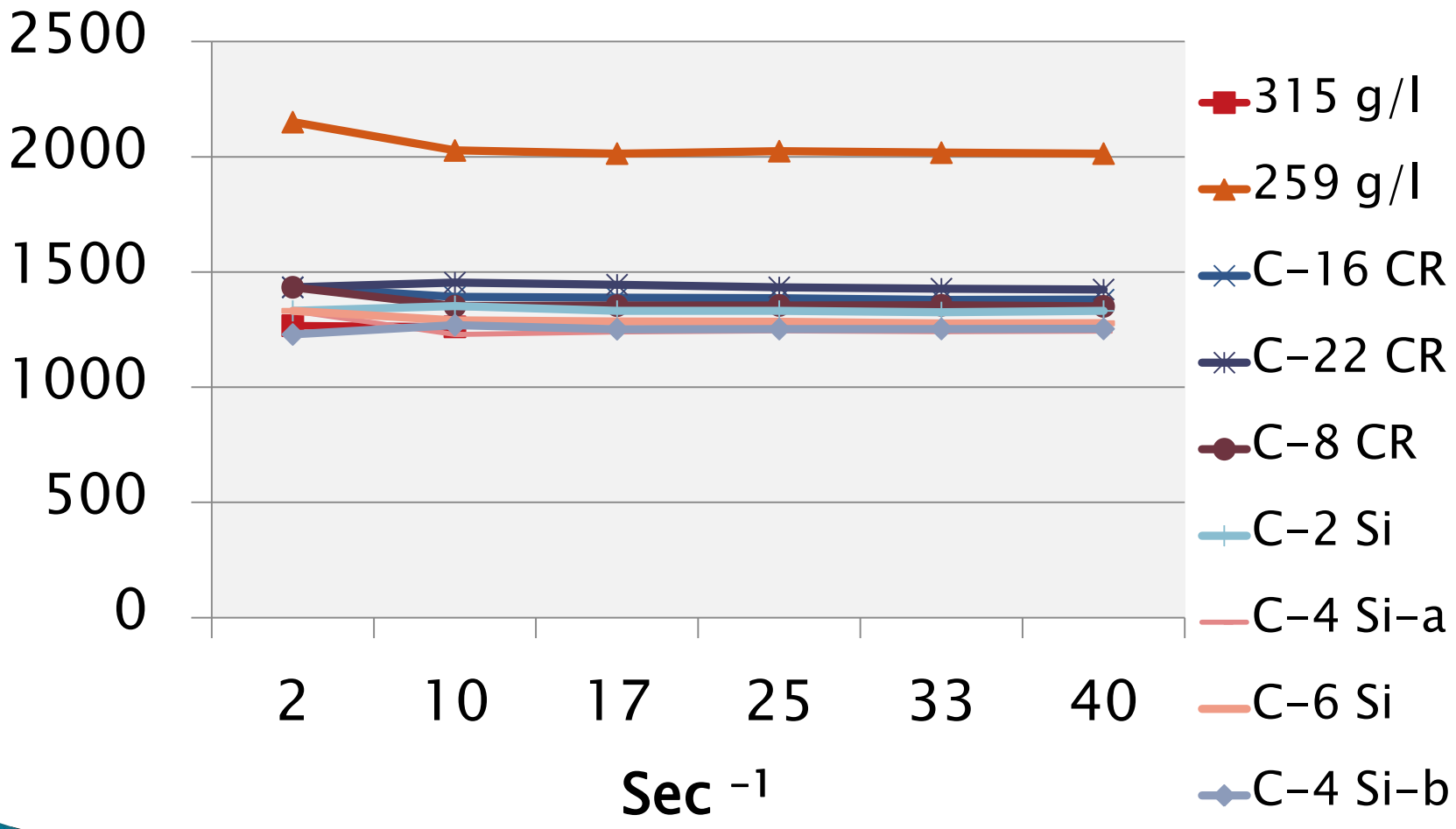
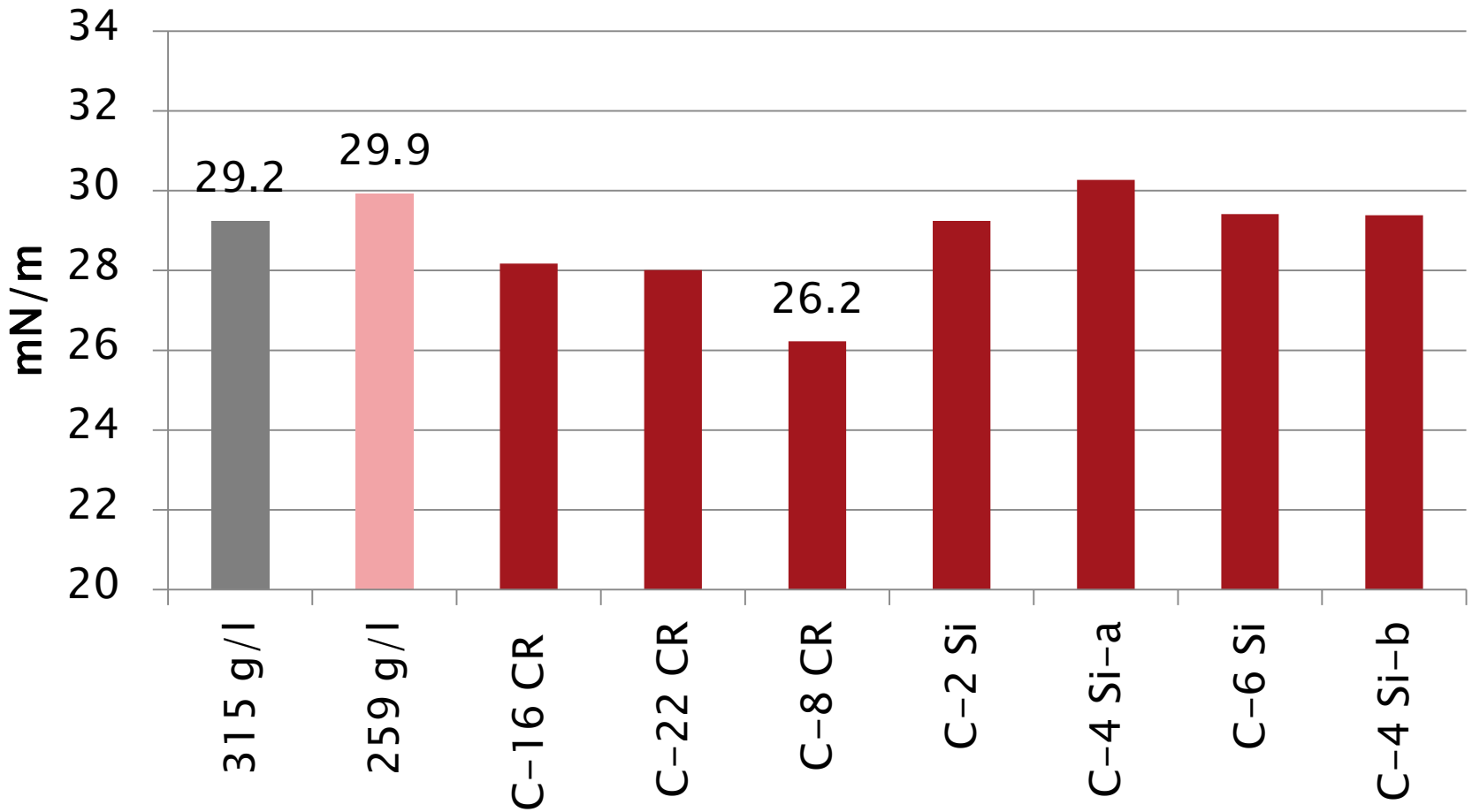
Black Enamel

Viscosity



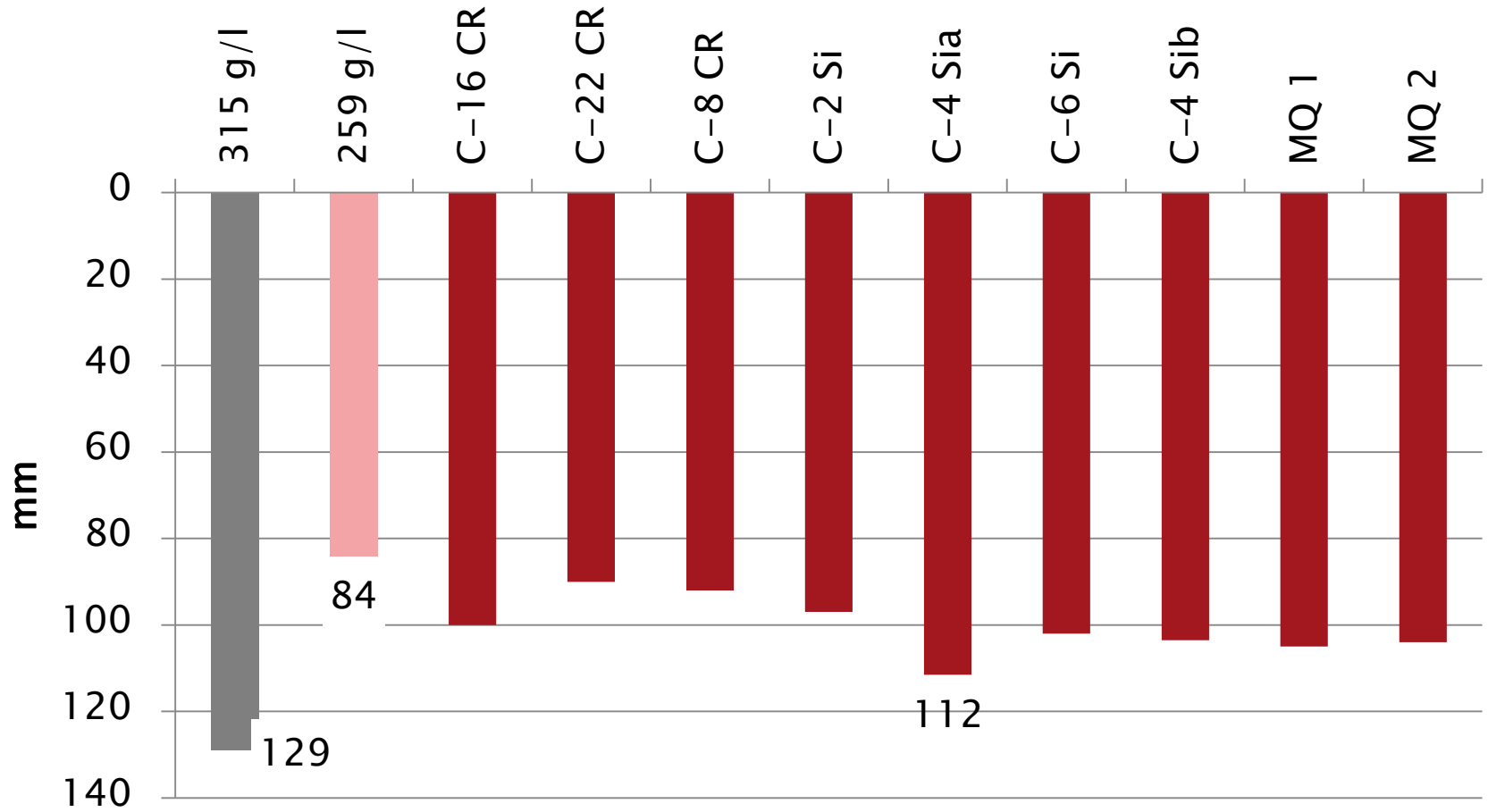
Black Enamel

Surface Tension



Black Enamel

Flow @ 0.2 gm 45°, 2 min



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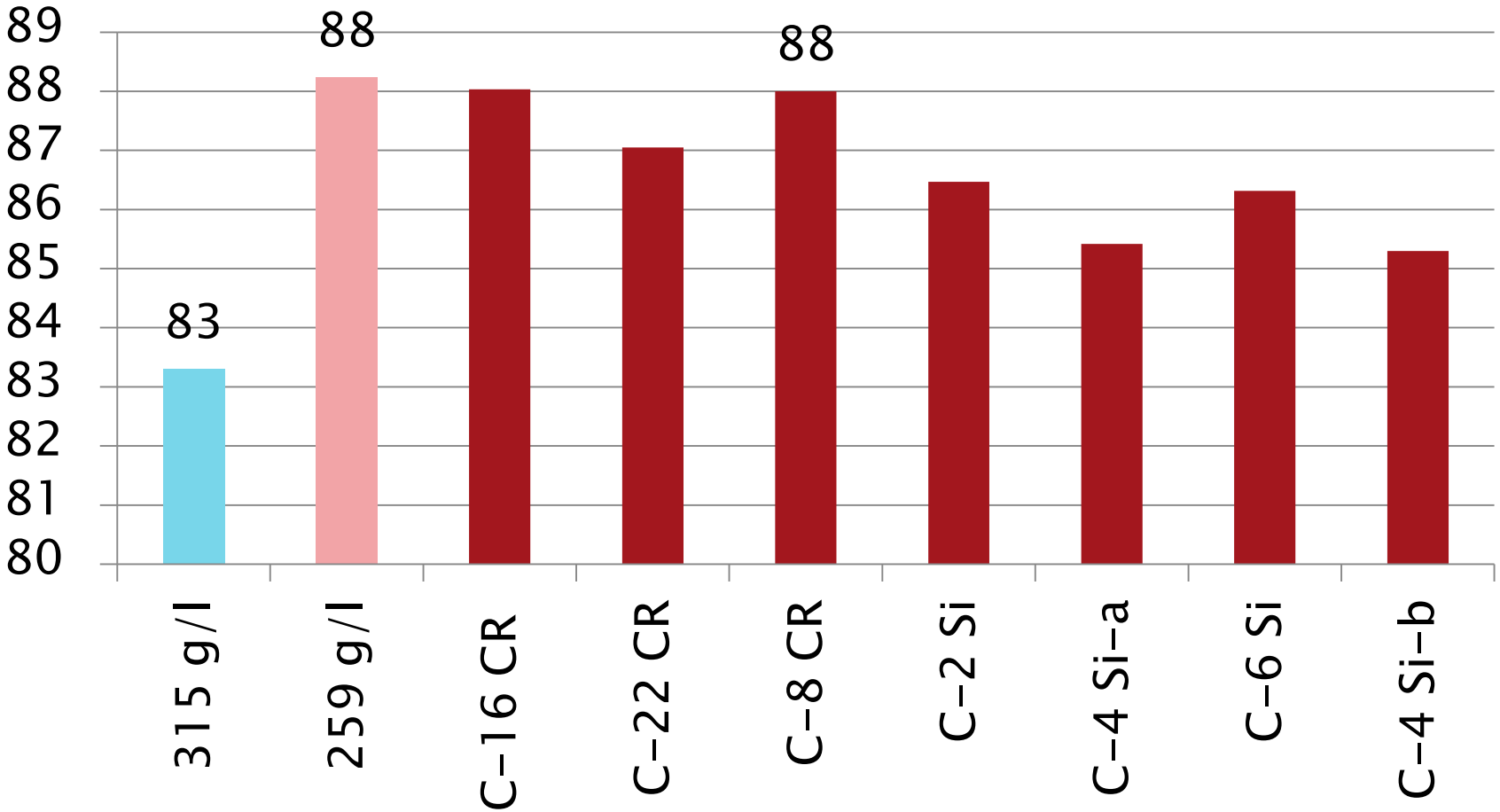
Black Enamel

Gloss



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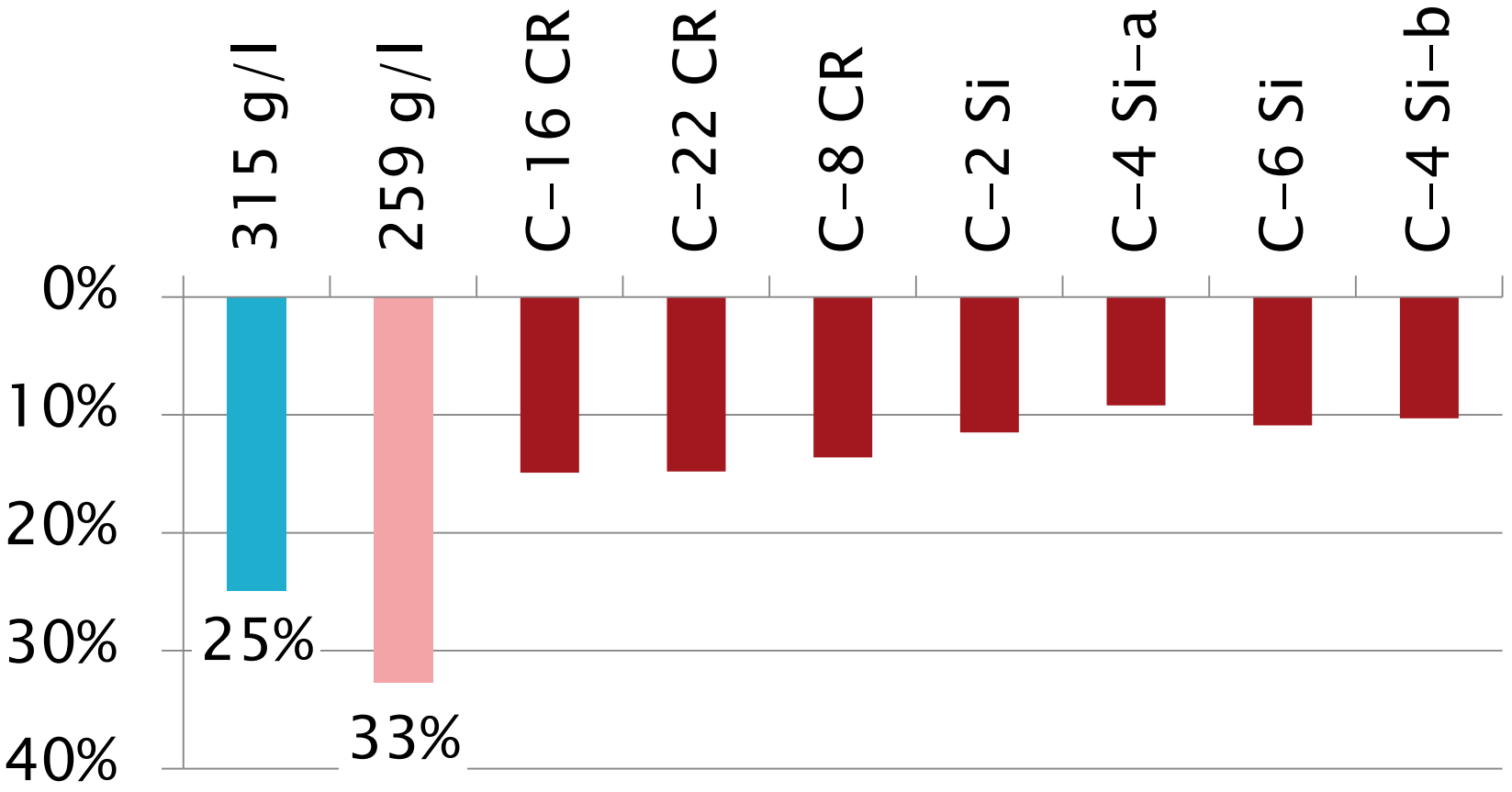
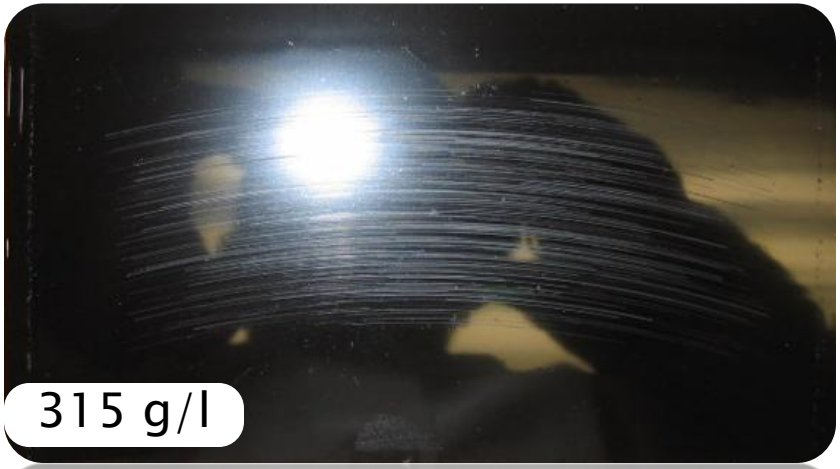
Black Enamel

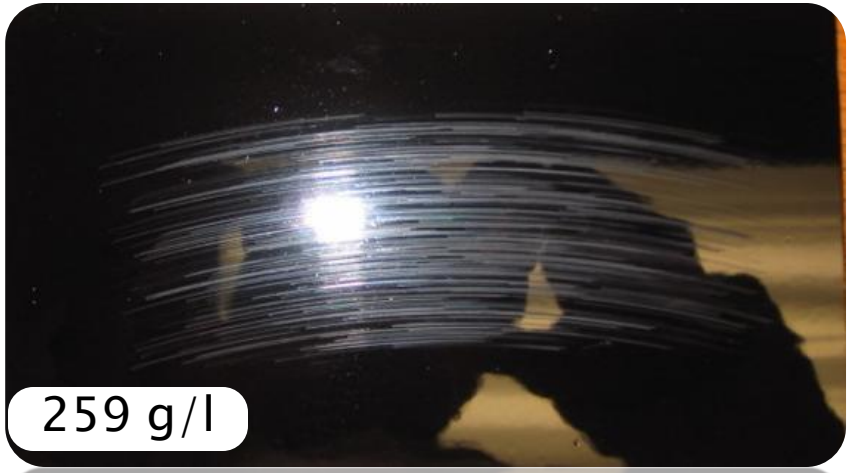
Abrasion Resistance via % Loss in Gloss

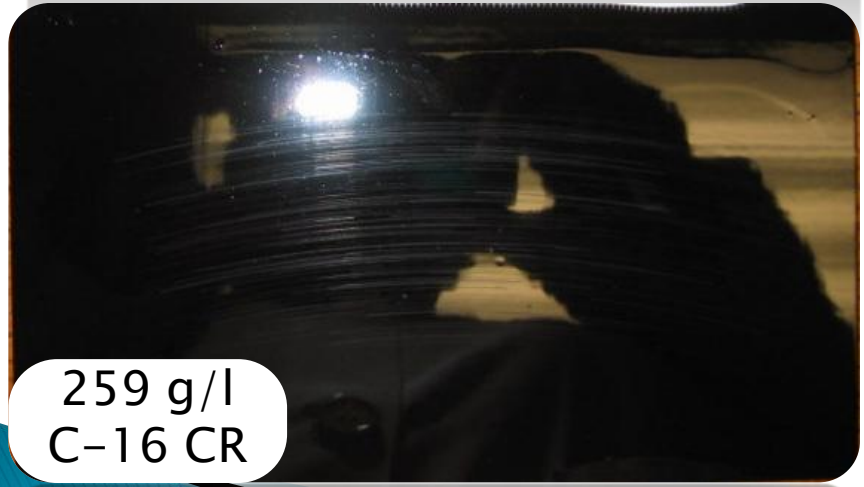


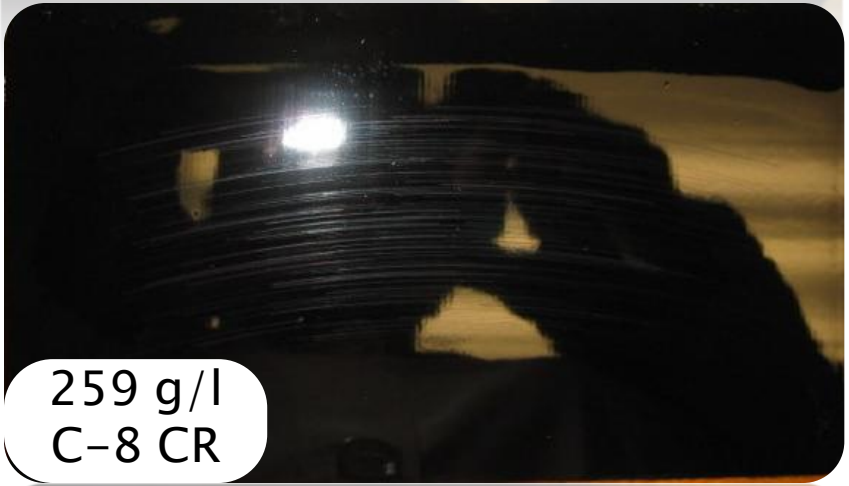
Black Enamel

Visual









Black Enamel Summary

17% Reduction in VOCs

Property	Result
Appearance	Higher solids has more defects; additives improve it to better than high solids control
ST	Returned to or below high solids control
Viscosity	Returned to high solids control
Flow	Improved directionally but not to control
Gloss	Higher solids control is better
Abrasion Resistance	Lost in higher solids; regained and more with additives

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White Nutshell Topcoat

	High Solids	Higher Solids
Cashewthane 1611-1Resin	43.74%	45.96%
Siltech C-442	0.86%	0.91%
CE-2000	0.55%	0.58%
Xylene	**10.74%**	**5.74%**
Ti-Pure R900	43.74%	45.96%
Siltech Additives	0%	0 or 0.5%
6% Manganese NAP-ALL	0.20%	0.20%
12% Cobalt HEX-CEM	0.06%	0.06%
Dri-RX HF	0.06%	0.06%
Skino #2	0.06%	0.06%
Total	100.0%	100.0%
VOC (g/l)	**153.2**	**86.7**
%Solids	**89%**	**94%**

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White Nutshell Topcoat

Appearance

White Nutshell	Finish
Control (153 g/l)	Smooth
Control (87 g/l)	Smooth
C-16 CR	Smooth
C-22 CR	Smooth
C-8 CR	Smooth
C-2 Si	Smooth
C-4 Si-a	Smooth
C-6 Si	Smooth
C-4 Si-b	Smooth

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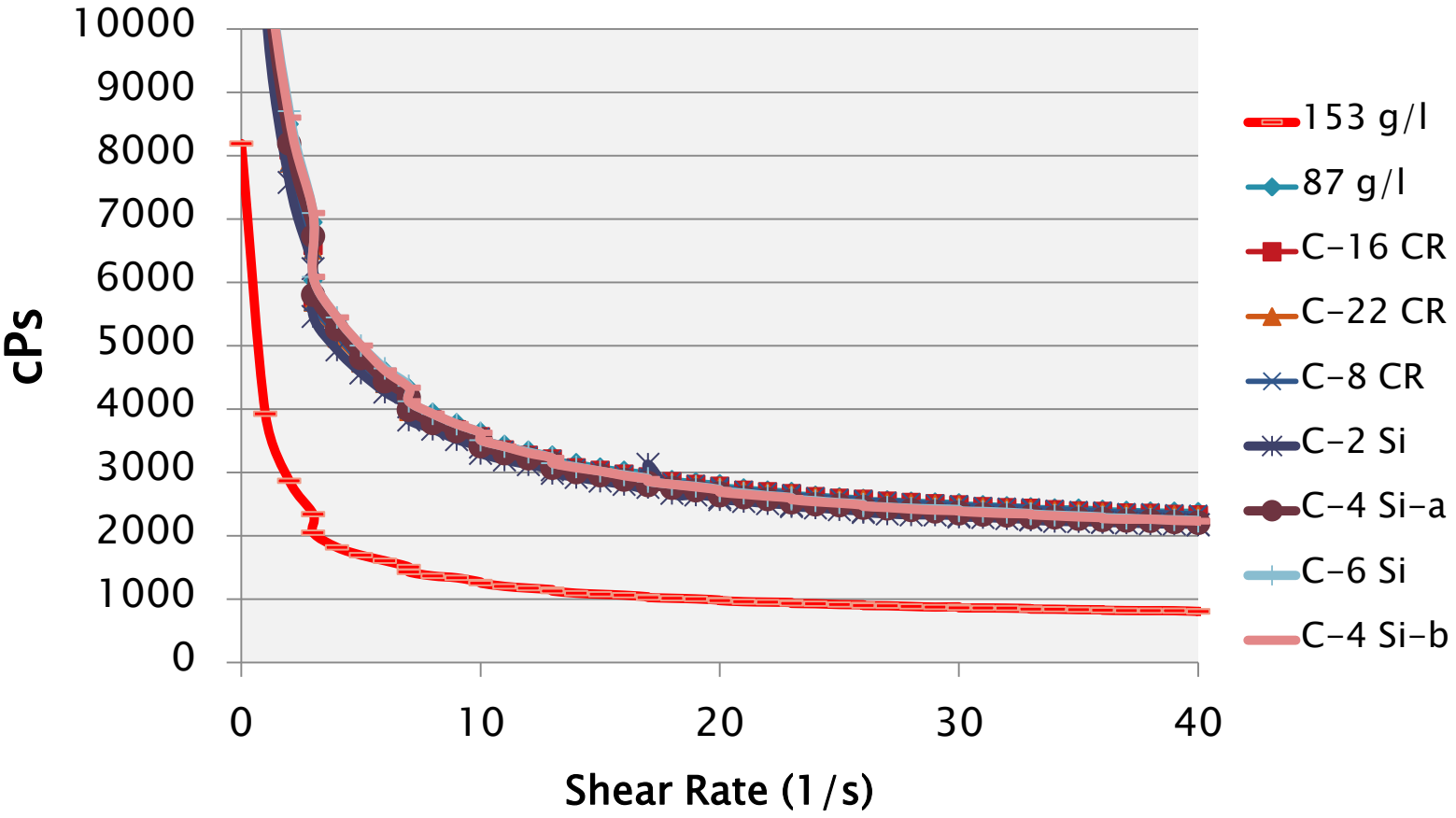
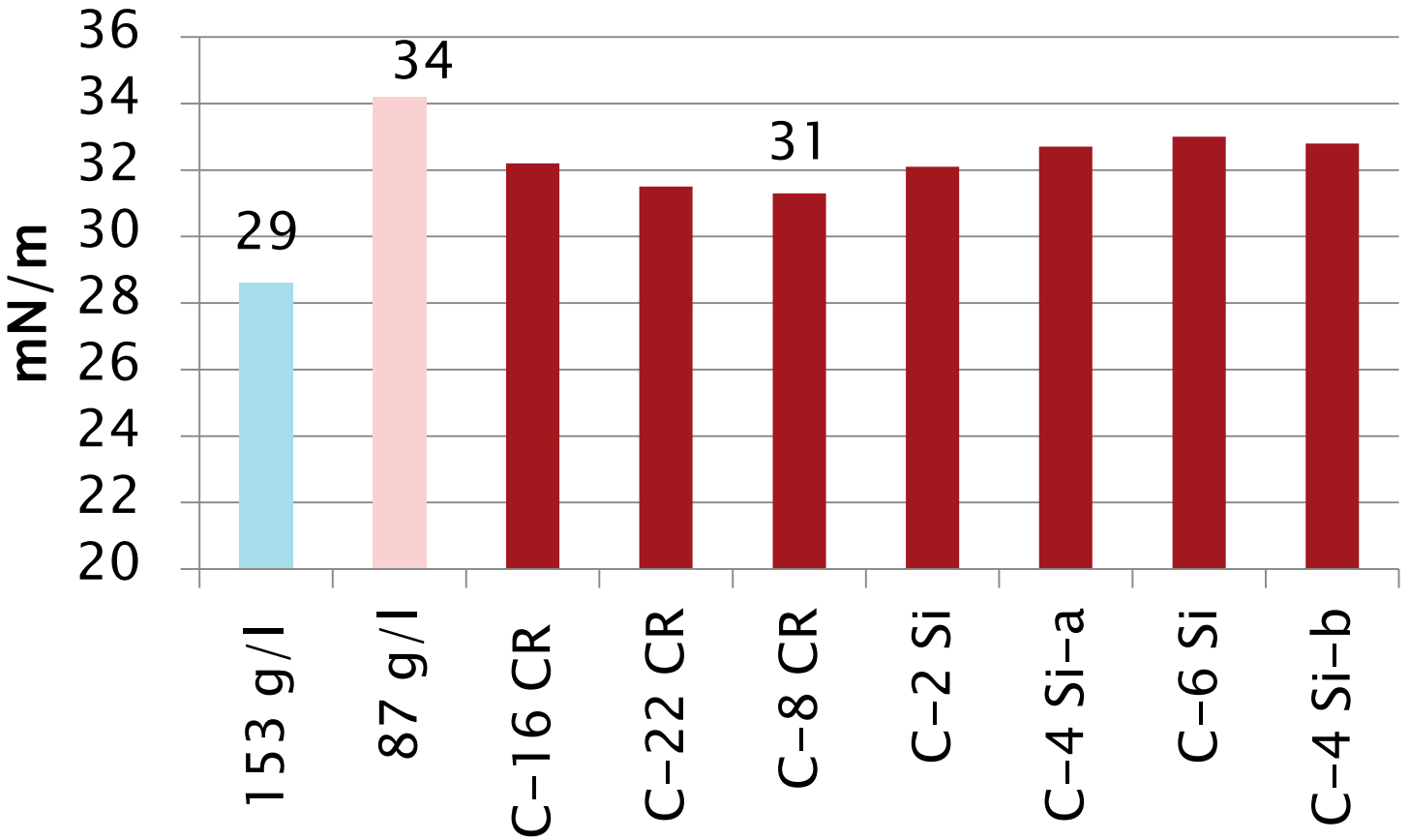
White Nutshell Topcoat

Viscosity



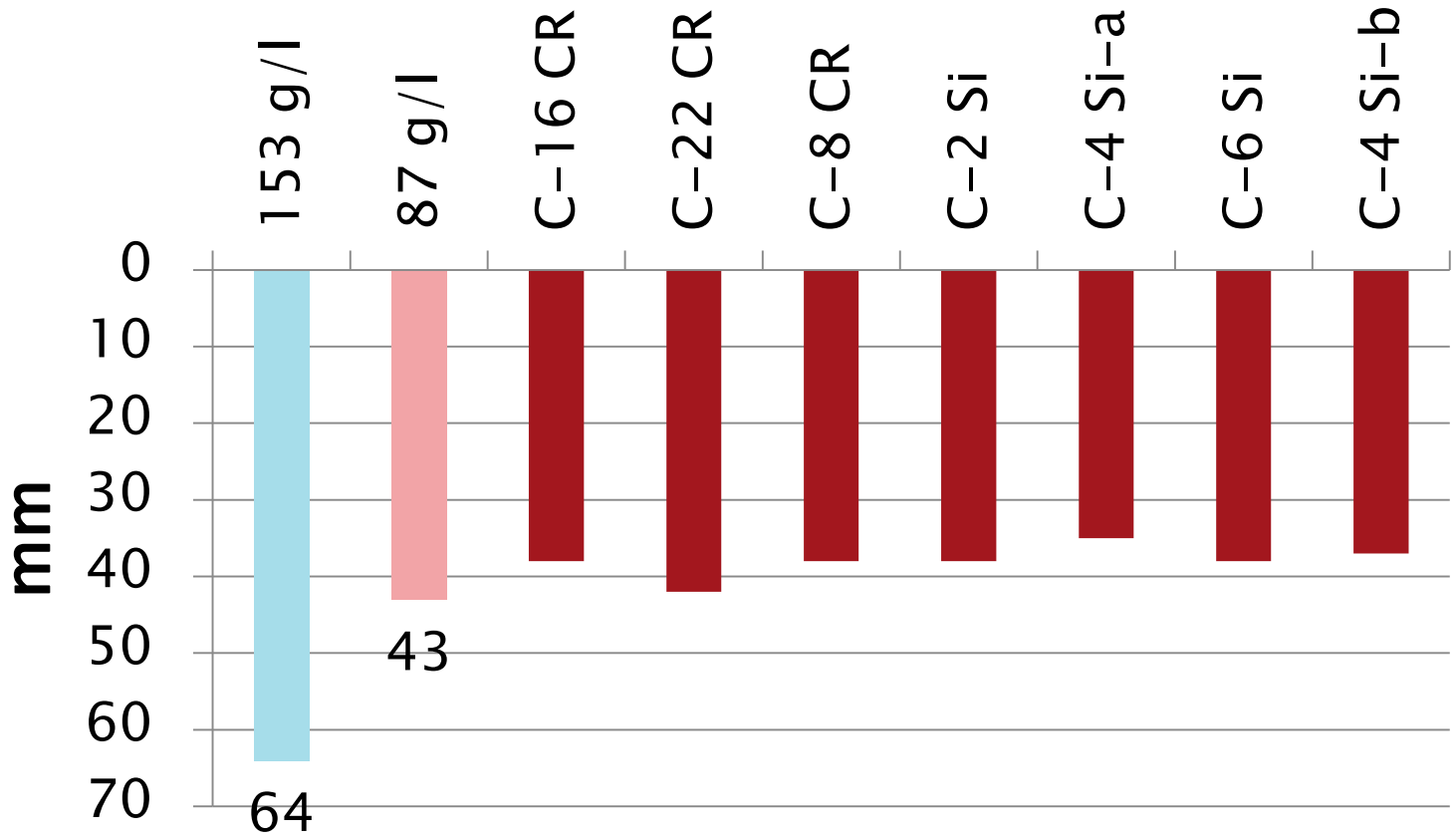
White Nutshell Topcoat

Surface Tension



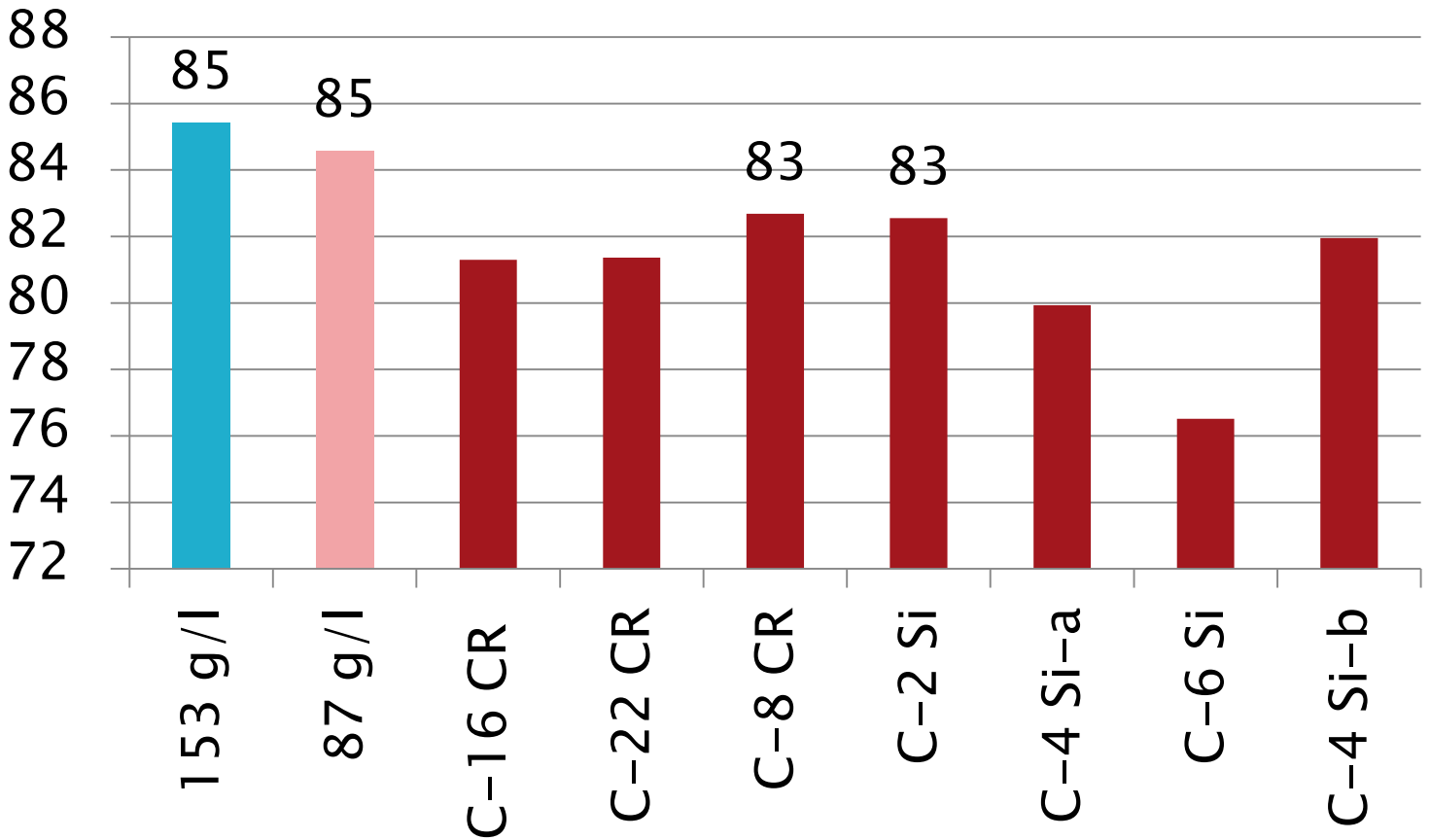
White Nutshell Topcoat

Flow @ 0.2 gm 45°, 2 min



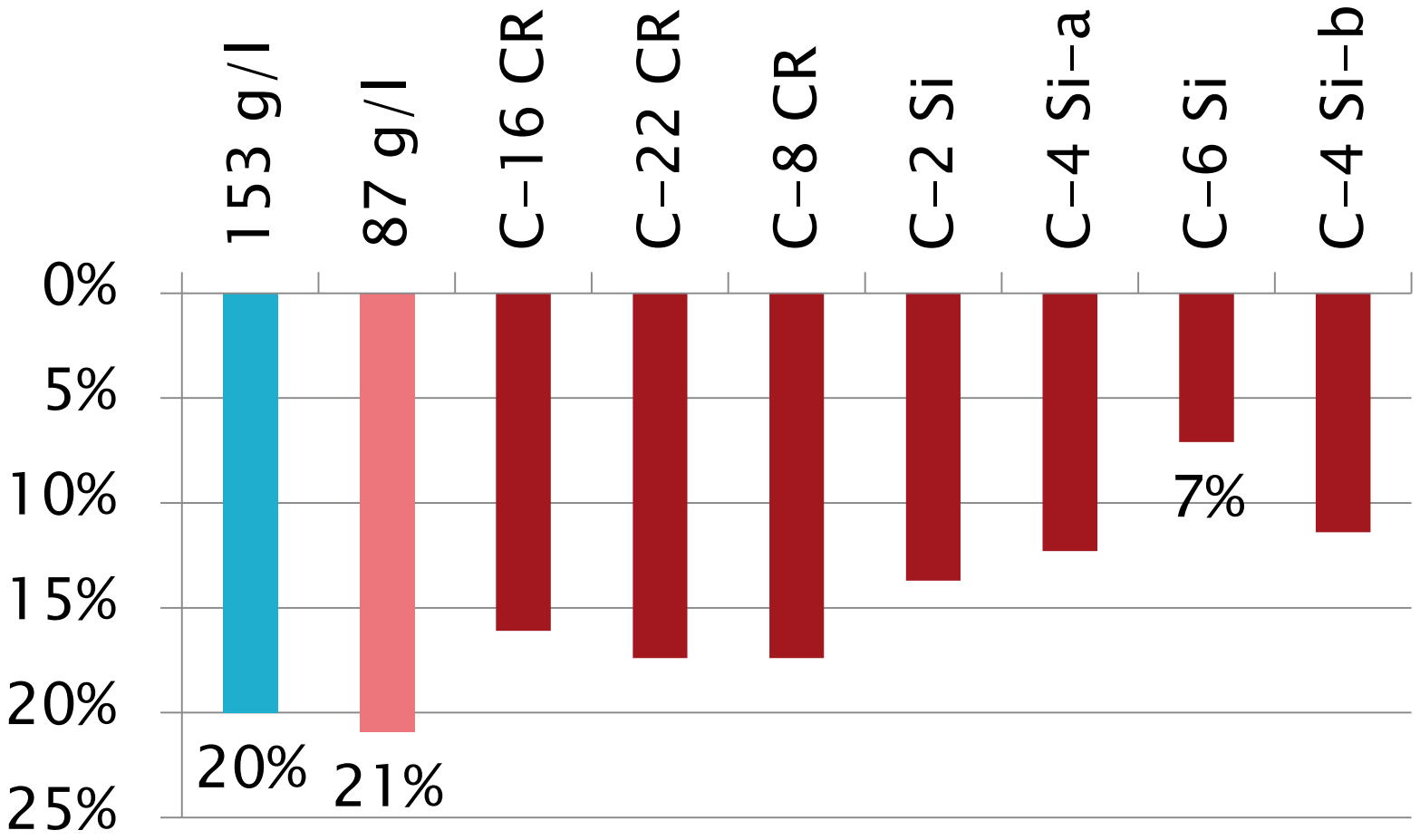
White Nutshell Topcoat

Gloss



White Nutshell Topcoat

Abrasion Resistance via % Loss in Gloss



White Nutshell Topcoat

Visual

White Nutshell Summary

43% Reduction in VOCs

Property	Result
Appearance	All have no defects
ST	Improved directionally but not to control
Viscosity	Increased; additives have no effect
Flow	Reduced; additives do not return it
Gloss	Reduced; additives do not return it
Abrasion Resistance	Lost in higher solids; regained and more with additives

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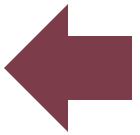
Acrylic Melamine

	High Solids	Higher Solids
Joncryl 504	19.94%	21.60%
Solvent mix	**17.04%**	**6.56%**
CE-2000	0.50%	0.22%
Siltech Additives	0%	0 or 0.5%
Ti-Pure R-900	32.41%	35.10%
Joncryl 504	16.94%	18.45%
Luwipal 066	12.67%	17.12%
Nacure 2500	0.50%	0.54%
Total	100.0%	100.0%
VOC (g/l)	**224.3**	**91.7**
%Solids	**83%**	**92%**



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Acrylic Melamine

Appearance

Gloss White	Finish (92 g/l)
Control (224 g/l)	Smooth with 5 small fish eyes
Control (92 g/l)	Smooth with 10 fisheyes
C-16 CR	Smooth with 50 fisheyes
C-22 CR	Smooth with 20 fisheyes
C-8 CR	Smooth with no fisheye
C-2 Si	Smooth with 5 fisheyes
C-4 Si-a	Smooth with 15 fisheyes
C-6 Si	Smooth with 50 fisheyes
C-4 Si-b	Smooth with 3 fisheyes

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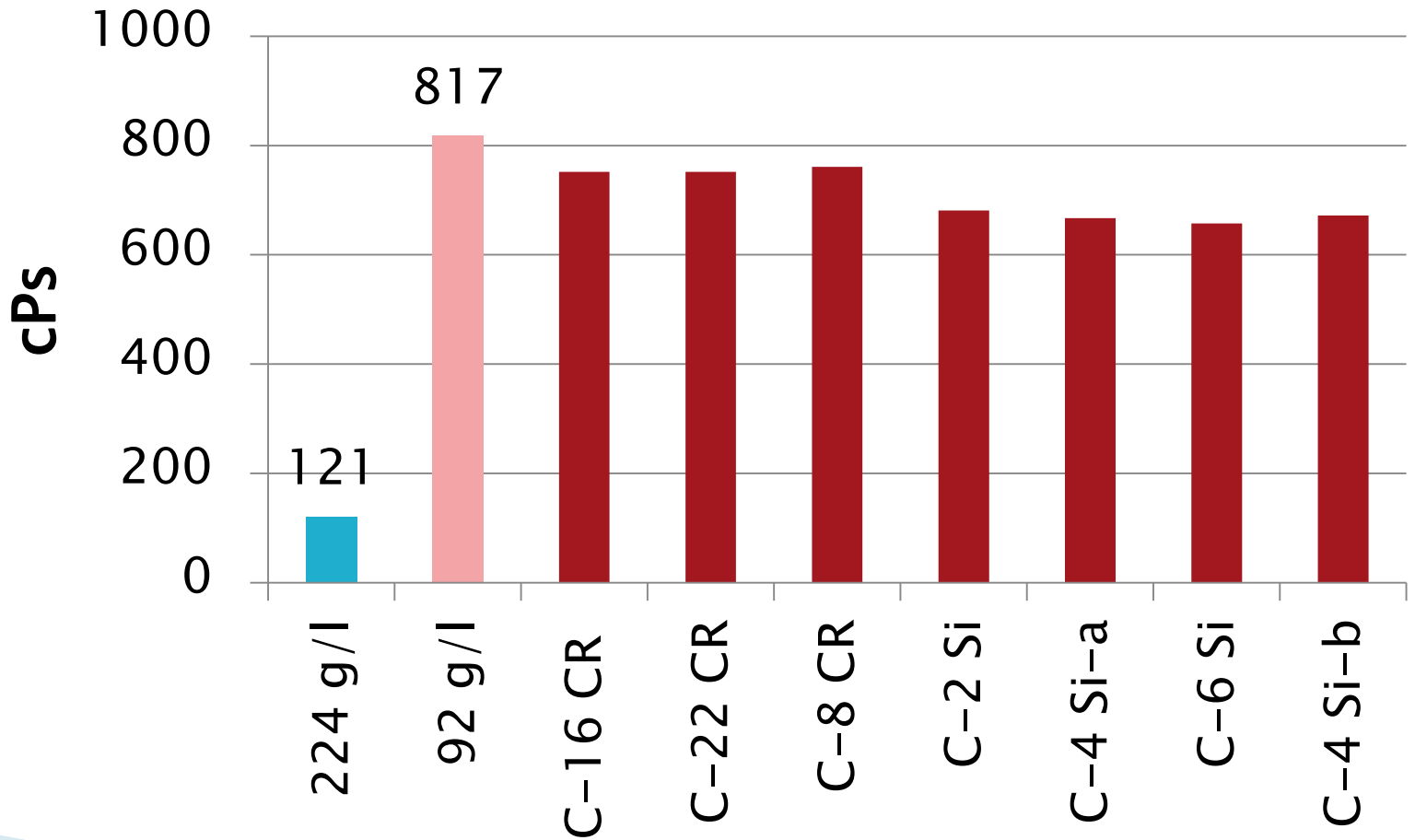
Acrylic Melamine

Viscosity



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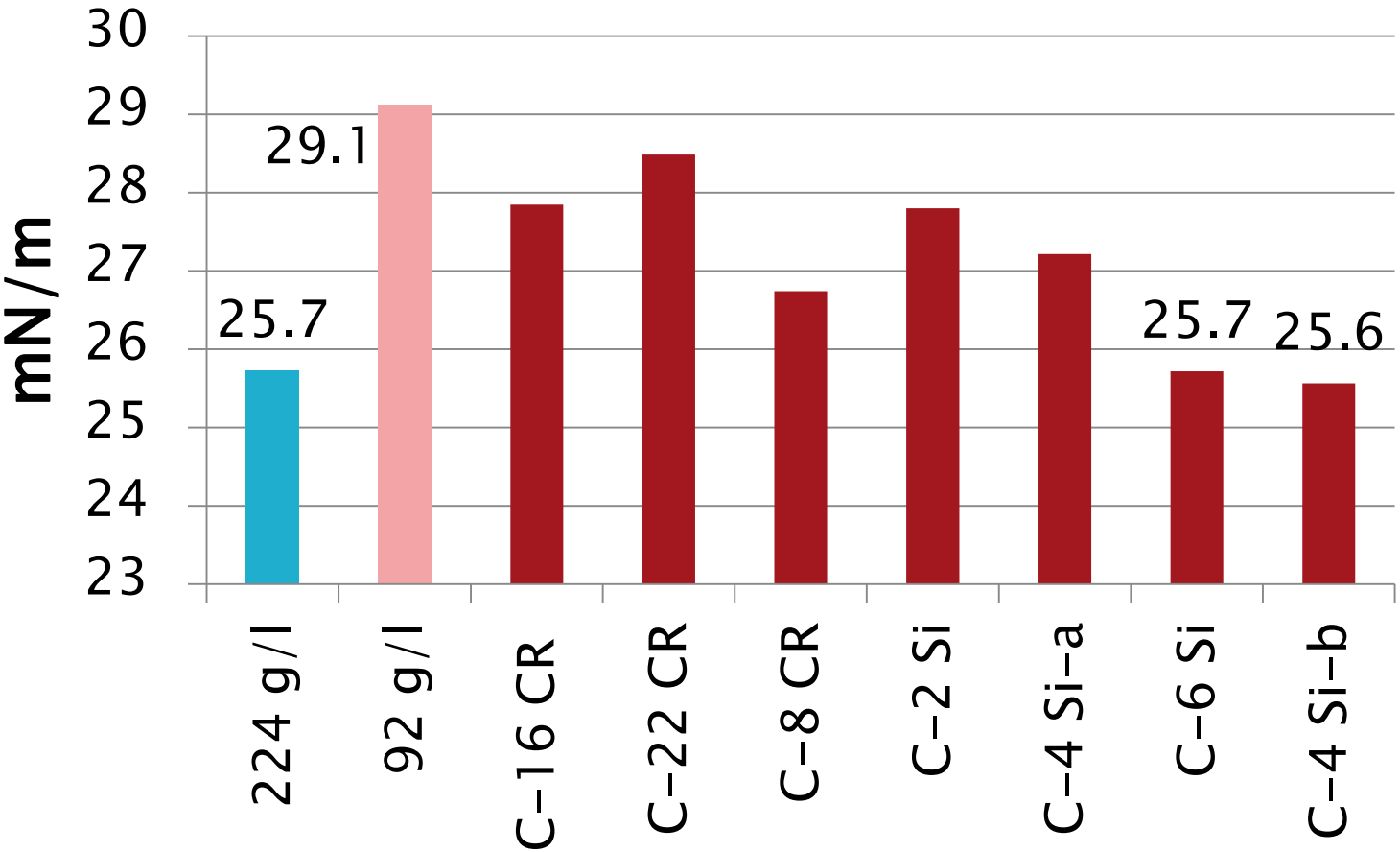
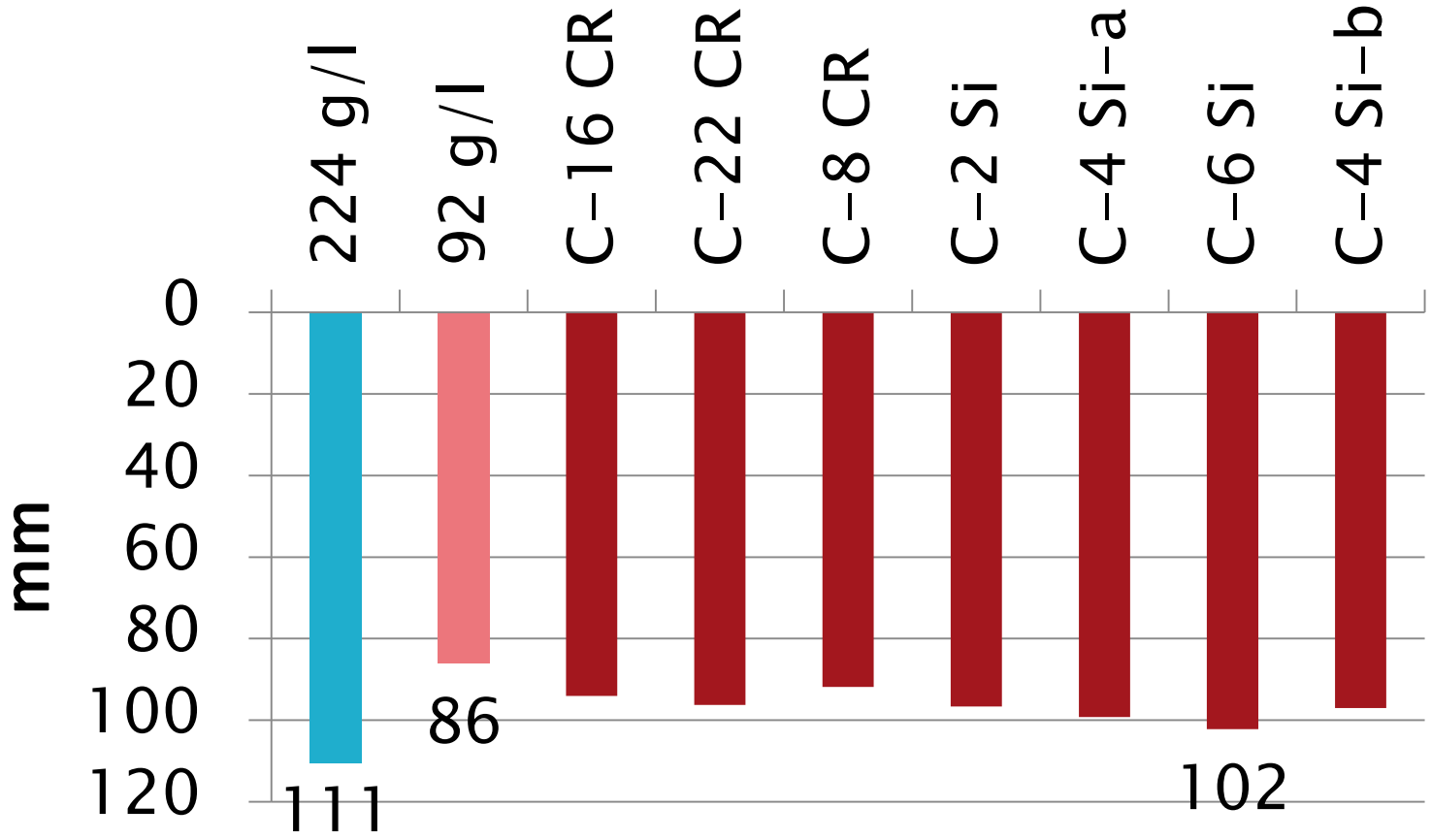
Acrylic Melamine

Surface Tension



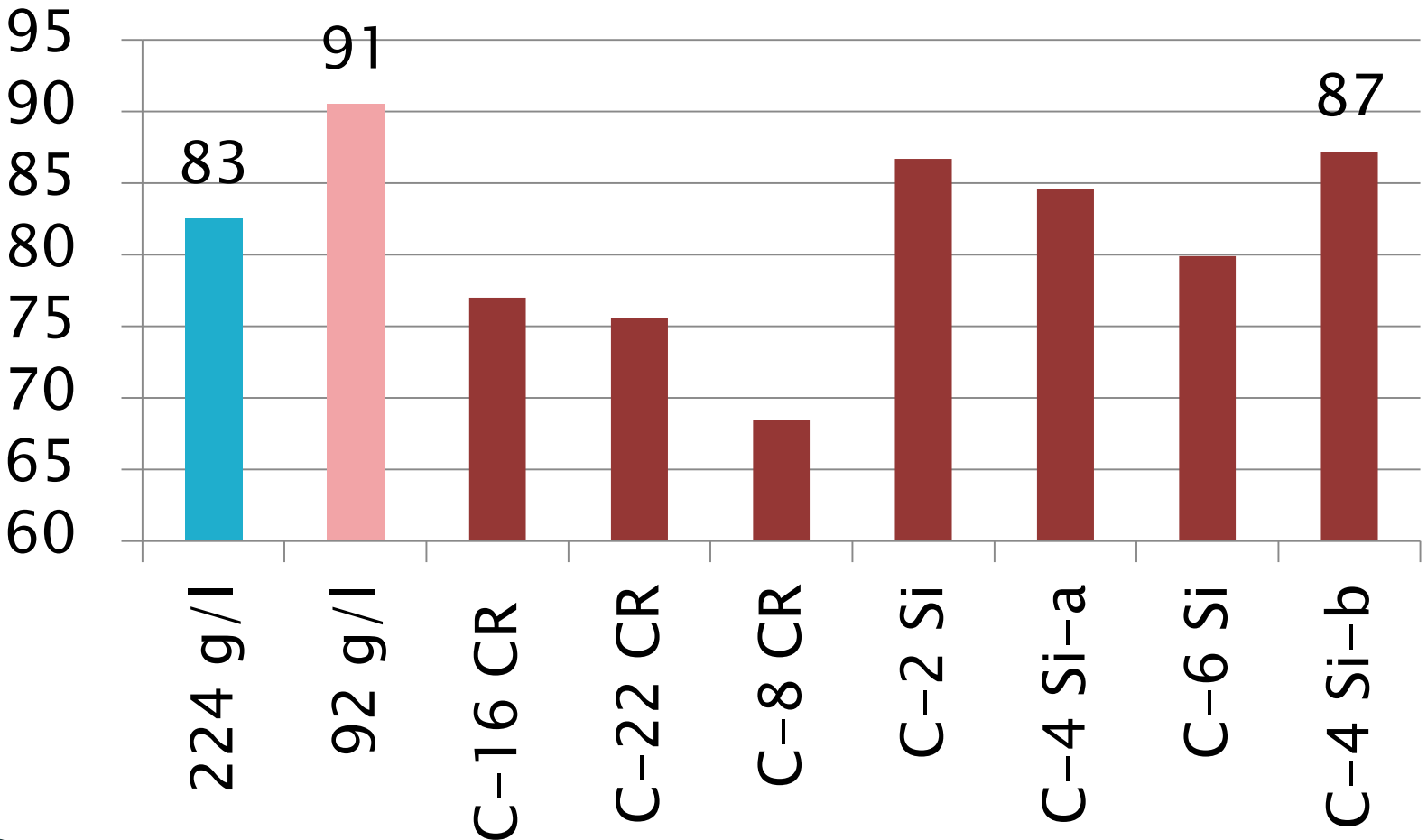
Acrylic Melamine

Flow



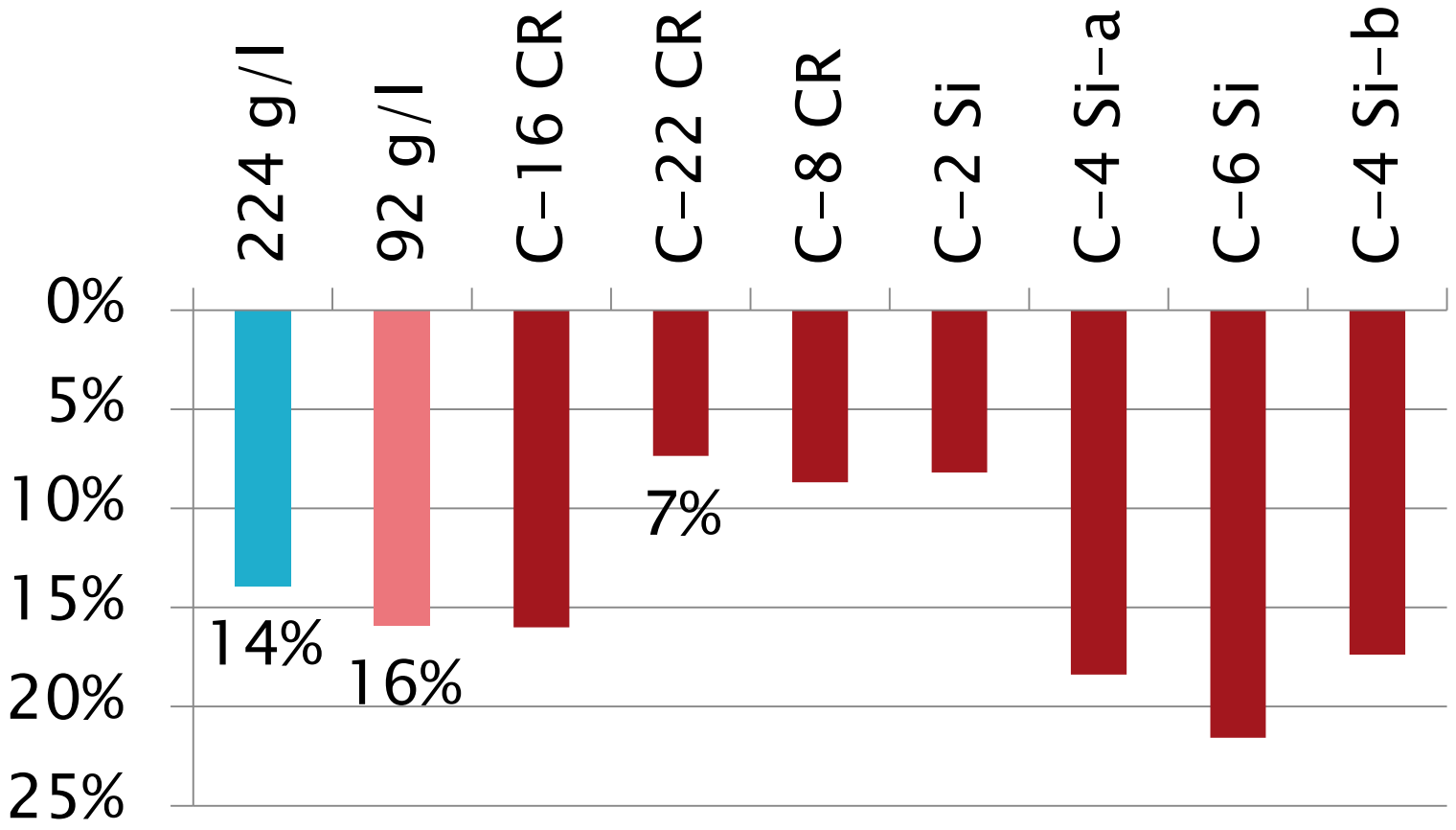
Acrylic Melamine

Gloss



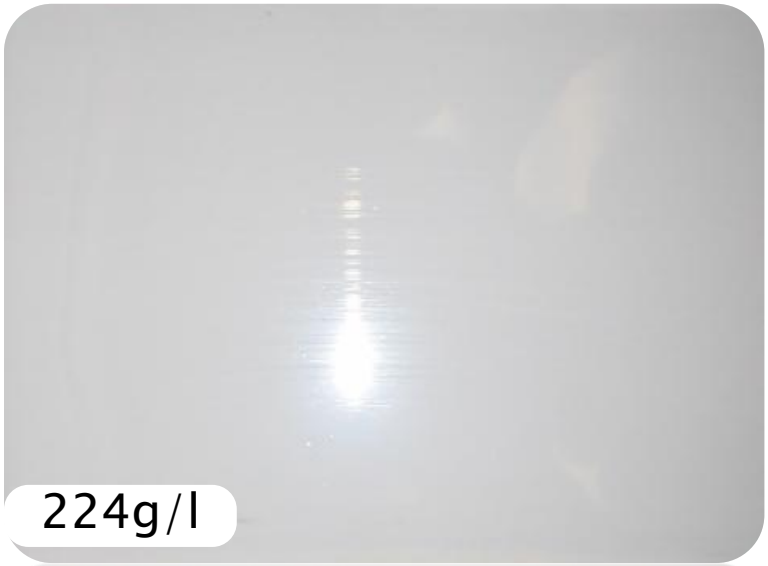
Acrylic Melamine

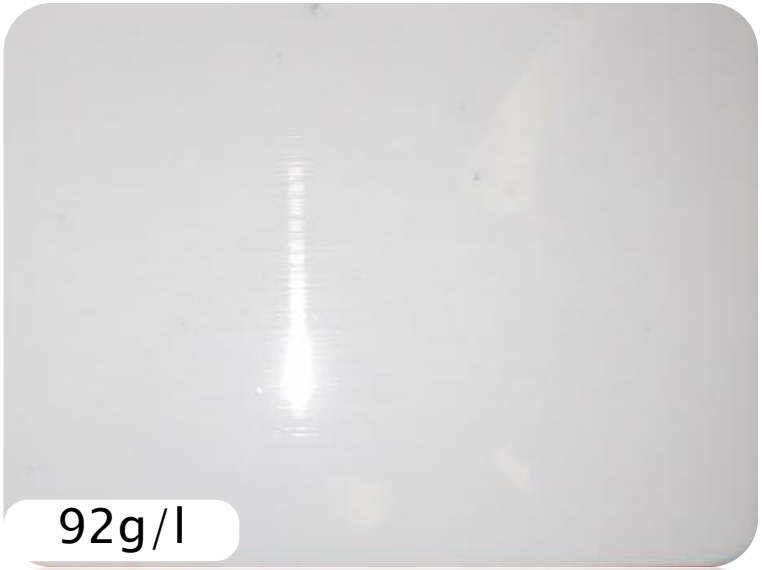
Abrasion Resistance by % Loss in Gloss

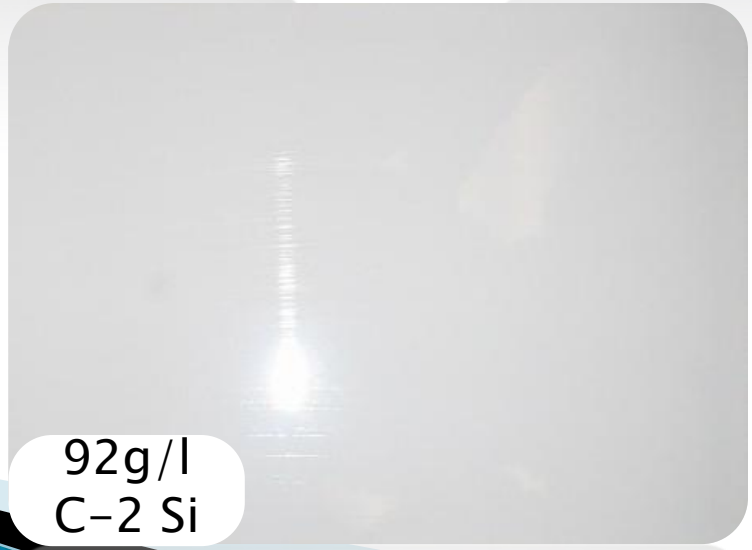


Acrylic Melamine

Visual







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Acrylic Melamine

58% Reduction in VOCs

Property	Result
Appearance	Higher solids has more defects; additives improve it to better than high solids control
ST	Improved to control
Viscosity	Improved directionally but not to control
Flow	Improved directionally but not to control
Gloss	Higher solids control is better
Abrasion Resistance	Lost in higher solids; regained and more with additives

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Conclusions

- Abrasion Resistance is improved over the high solids control in 3/3 cases.
- Surface tension of the higher solids formula is returned to that of the high solids control in 2/3 cases and improved directionally in the 3rd.
- Flow is completely returned in one formula and is improved directionally in another.

Conclusions

- Viscosity of the higher solids formula is returned in only the black enamel case.
- In most cases, the additives provide directional improvement in properties and appearance is better.
- The 48% and 58% reduction systems may simply be too much reduction.
- More work is needed to be conclusive but these early results are encouraging.

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