Coatings Trends & Technologies SUMMIT

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Next-Generation Acrylic-Polyurethane Dispersion for High-Performance Architectural Primers and Topcoats

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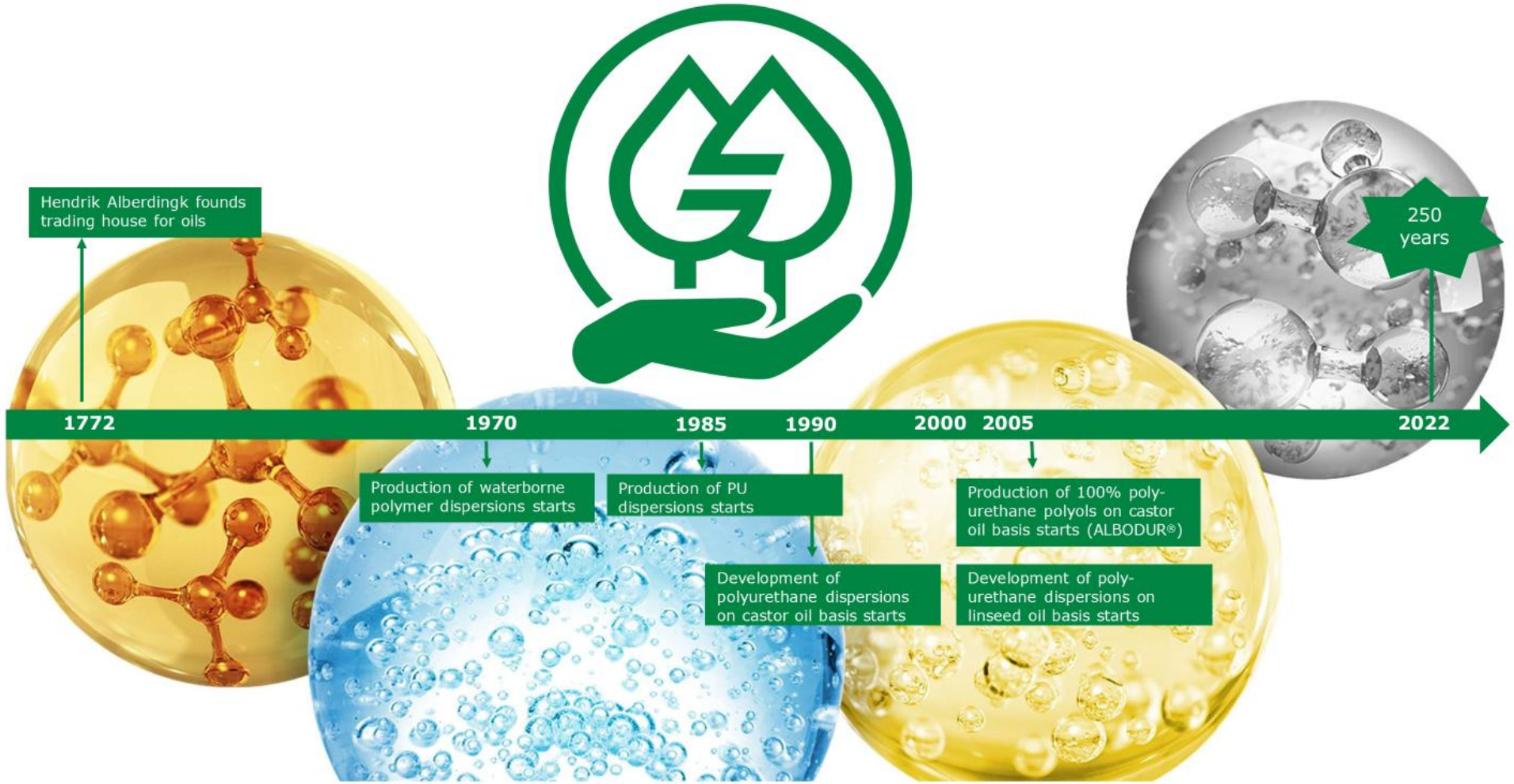
Alberdingk Boley Inc.

ALBERDINGK BOLEY - Green for 250 years



Where you can find us

All over the world: production sites and application development in Germany, the US and China, R & D centre in Krefeld (D) and multiple representatives on all continents

Agenda

- Introduction
- Market requirements
- Experimental plan
- Performance highlights
- Masonry coatings
- Conclusion
- Q&A

Bonding Enamel Requirements

- Excellent adhesion to multiple substrates
- High durability and hardness
- Chemical and stain resistance
- Environmental friendliness
- Fast drying enabling quick return to service
- Interior/Exterior applications

R&D Focus

Develop a high performing product with:

- Toughness >>> Polycarbonate PUD
- High resistance >>> Self-crosslinking
- Water resistance >>> Low surfactant
- Low VOC >>> Multi-phase & moderate MFFT
- Exterior durability >>> Monomer choice & flexibility

Acrylic-polyurethane (APU) polymer properties

Solids content [%]	38 - 40
Viscosity [mPas]	20 - 200
pH-value	8.0 – 9.0
MFFT [°C]	28
Polymer type	Acrylic-polycarbonate PUD
VOC capability	50 – 100 g/L

Commercial Benchmarking

Full Name	Price/gallon	VOC (g/L)	Volume solids	Resin Type	Dry time to topcoat/hr
Commercial 1	$64	<100	33.20%	Acrylic	1
Commercial 2	$66	<100	28.60%	Modified acrylic copolymer	3
Commercial 3	$30	<100	34.00%	Styrenated acrylic	1
Commercial 4	$67	87.6	40.00%	Urethane acrylic	4
Commercial 5	$82	148	40.50%	Acrylic urethane	1
Commercial 6	$34	<5	43.00%	Acrylic	1
Commercial 7	$51	<50	37.00%	Acrylic	1
Commercial 8	$30	<50	45.00%	Acrylic	1
Commercial 9		50	33.60%	Urethane acrylic	3

Formulation

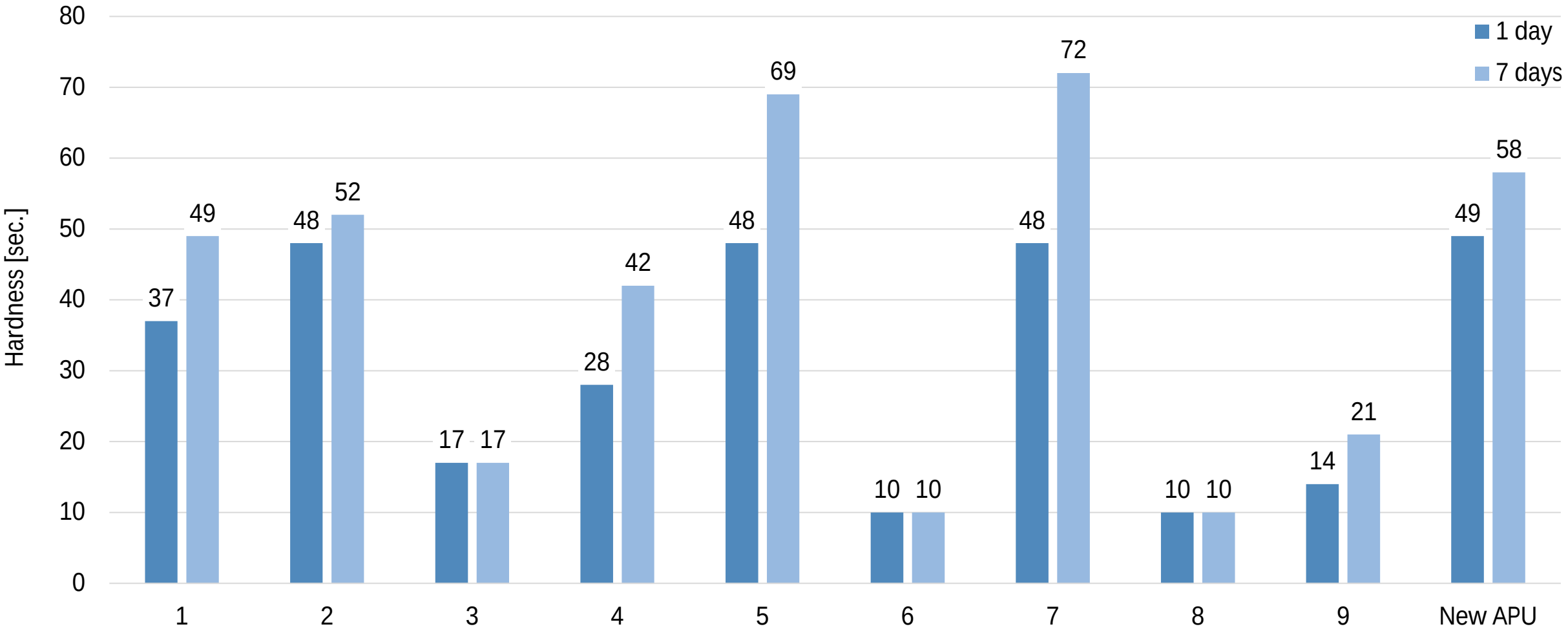
100 gallon formula	
Water	180.51
Dispersant	6.66
Defoamer	1.12
TiO2	242.71
Filler pigment	21.35
New APU resin	503.24
Wetting agent	4.43
Water	44.8
Coalescent 1	13.9
Coalescent 2	13.9
Flash rust inhibitor	5.71
Associative thickener	11.58
Defoamer	1.16
Anti settling agent	3.13
Total	1054.19

Properties	
Specific Gravity (SG)	1.263
Lb/Gal	10.54
% Weight Solids	45.51
% Volume Solids	30.38
PVC	28.5
% dispersant on Pigments	1.01
Grams VOC/liter less water	115.51
Lbs VOC/Gallon Less Water	0.96
Total Pounds	1054.19
Total Gallons	100

Commercial Benchmarking

Commercial Paints	1	2	3	4	5	6	7	8	9	New APU
Viscosity (KU)	97	102	122	99	97.2	119.7	124.5	106.3	101.7	80
Gloss (60 deg)	5.6	3.1	9.5	5.8	23	10.3	58	5.8	17	24
Dry Time (min):										
set to touch	13	11	9	11	10	17	8	13	10	10
tack free	18	12	10	13	15	18	10	14	15	12
Block resistance at 50◦C (0-10):										
after 1 day	9.5	10	9.5	9.5	10	0	9	10	0	10
4 days	10	10	9.5	10	10	0	9.5	10	0	10
7 days	10	10	10	10	10	0	10	10	0	10
Block resistance at room temperature:										
after 1 day	10	10	10	10	10	0	10	10	0	10
4 days	10	10	10	10	10	8	10	10	2	10
7 days	10	10	10	10	10	8.5	10	10	10	10

Commercial Benchmarking - Hardness



Commercial Benchmarking - Adhesion

19 substrates:

- Aluminum
- Cold Rolled Steel
- Polycarbonate
- ABS
- PVC
- Pine
- Unetched & Etched Concrete
- Quarry Tile
- Glazed Tile
- Glass
- VCT
- Epoxy coating
- Vinyl flooring
- Hardwood flooring
- Laminate flooring
- Exterior grade plywood
- FRP
- Chalky board

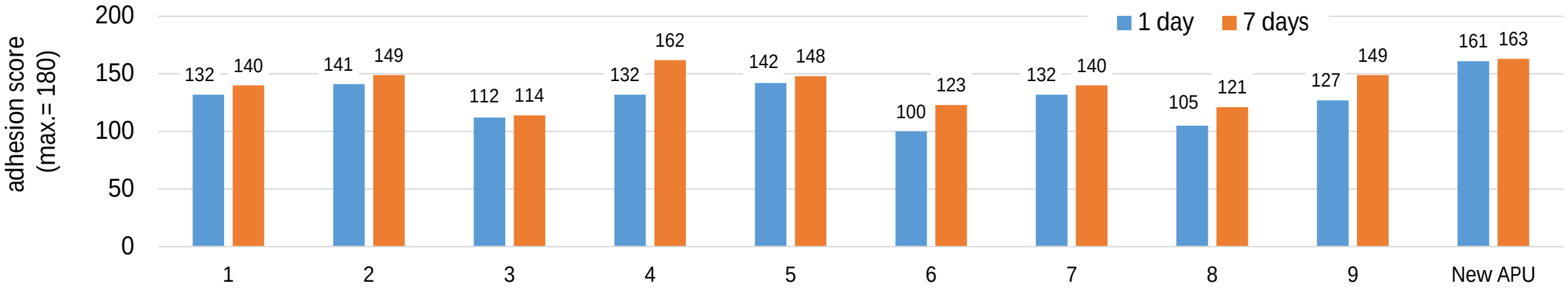
Test Parameters	
Substrate	Multiple
Film dry time	1 & 7 days
X-cut adhesion	Dry & Wet

Commercial Benchmarking - Adhesion

Classification		Surface of "X" - Cut from which flaking/peeling has occured
5A	No peeling or removal	None
4A	Trace peeling or removal along incisions or at their intersection	
3A	Jagged removal along incisions up to 1/16" on either side	
2A	Jagged removal along most of incisions up to 1/8" on either side	
1A	Removal from most of the area of the X under the tape	
0A	Removal beyond the area of the X	

Comprehensive adhesion:						
			1	2	3	...
Aluminum	1 day	Dry	4	0	0	...
		Wet	4	3	2	...
	7 day	Dry	5	0	0	...
		Wet	4	3	1	...
CRS	1 day	Dry	5	4	4	...
		Wet	4	4	4	...
	7 day	Dry	5	5	5	...
		Wet	5	5	5	...
PC	1 day	Dry	3	4	1	...
		Wet	2	4	3	...
	7 day	Dry	4	5	4	...
		Wet	2	4	4	...
...	...	...	...	...	...	...

1 vs 7-day adhesion change (dry + wet)

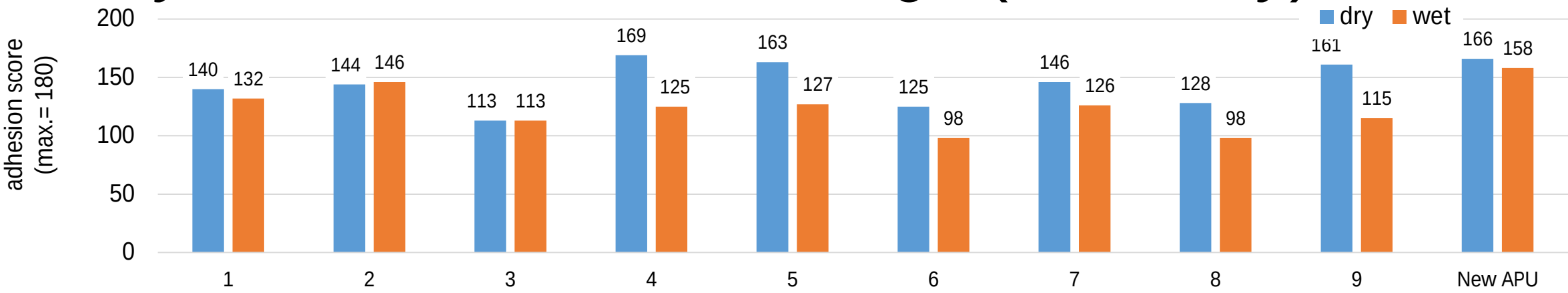


1 day Adhesion:					
		1	2	3	...
Aluminum	Dry	4	0	0	...
	Wet	4	3	2	...
CRS	Dry	5	4	4	...
	Wet	4	4	4	...
PC	Dry	3	4	1	...
	Wet	2	4	3	...
...	...	...	...	...	...
	TOTAL SCORE =	132	141	112	...

1-day score ranking:	
New APU	161
5	142
2	141
7	132
1	132
4	132
9	127
3	112
8	105
6	100

7-day score ranking:	
New APU	163
4	162
2	149
9	149
5	148
1	140
7	140
6	123
8	121
3	114

Dry vs Wet adhesion change (1 + 7 day)



Dry Adhesion:					
		1	2	3	...
Aluminum	1 day	4	0	0	...
	7 day	5	0	0	...
CRS	1 day	5	4	4	...
	7 day	5	5	5	...
PC	1 day	3	4	1	...
	7 day	4	5	4	...
...	...	...	...	...	...
	TOTAL SCORE =	140	144	113	...

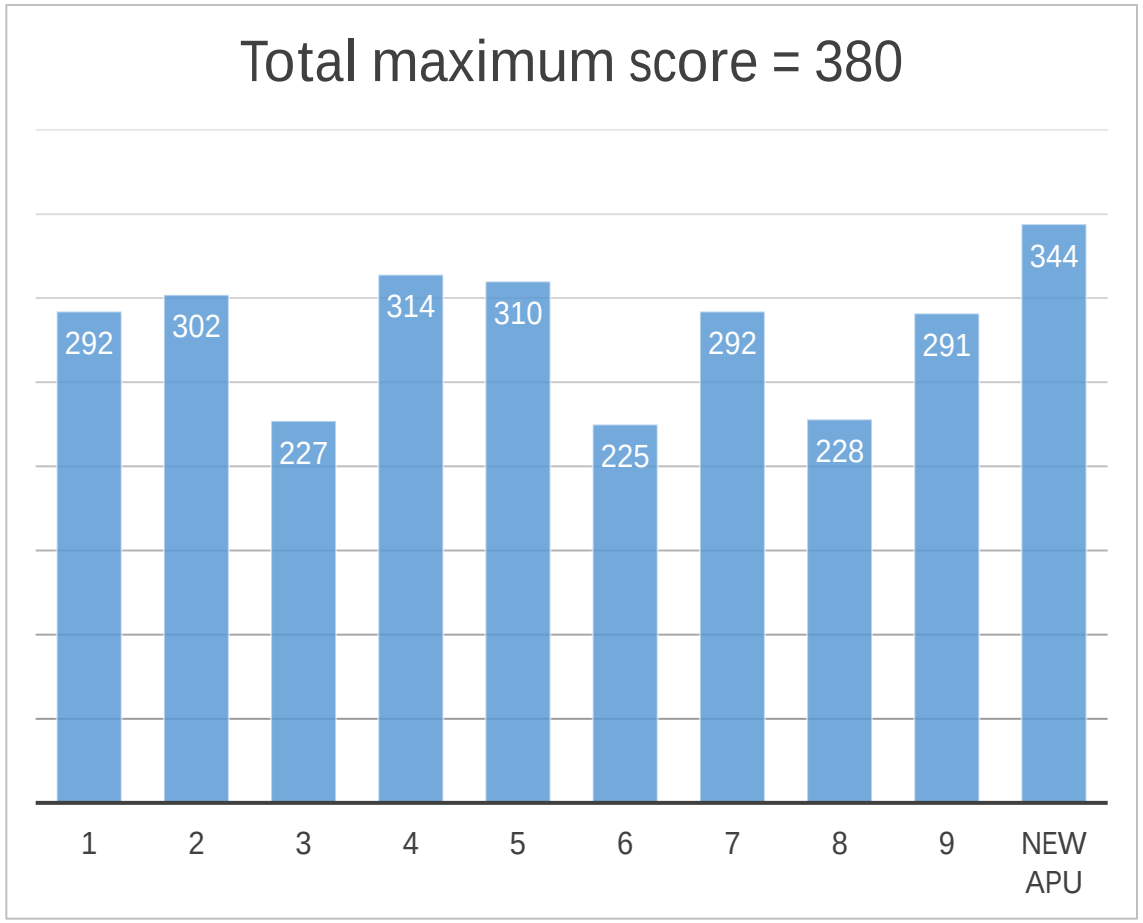
Dry score ranking:	
4	169
New APU	166
5	163
9	161
7	146
2	144
1	140
8	128
6	125
3	113

Wet score ranking:	
New APU	158
2	146
1	132
5	127
7	126
4	125
9	115
3	113
8	98
6	98

Comprehensive total adhesion score (dry/wet + 1/7 day)

Comprehensive:						
			1	2	3	...
Aluminum	1 day	Dry	4	0	0	...
		Wet	4	3	2	...
	7 day	Dry	5	0	0	...
		Wet	4	3	1	...
CRS	1 day	Dry	5	4	4	...
		Wet	4	4	4	...
	7 day	Dry	5	5	5	...
		Wet	5	5	5	...
PC	1 day	Dry	3	4	1	...
		Wet	2	4	3	...
	7 day	Dry	4	5	4	...
		Wet	2	4	4	...
...	...	...	...	...	...	...
	TOTAL SCORE=		292	302	227	...

Comprehensive total adhesion score (dry/wet + 1/7 day)



Ranking		Score	Cost/gallon
1	New APU	344	
2	Commercial 4	314	$67
3	Commercial 5	310	$82
4	Commercial 2	302	$66
5	Commercial 9	291	$95
6	Commercial 7	292	$51
7	Commercial 1	292	$64
9	Commercial 3	227	$30
10	Commercial 8	228	$30
11	Commercial 6	225	$34

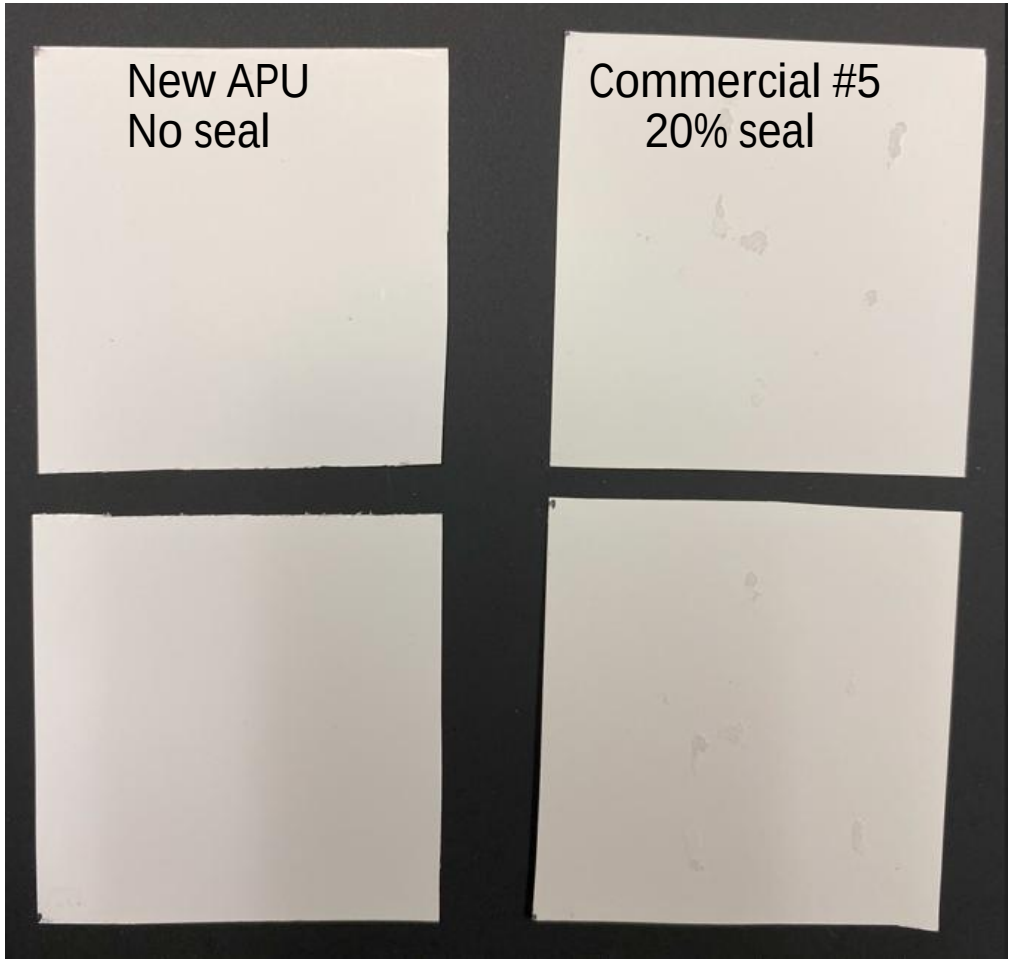
Block resistance

Commercial Primers	1	2	3	4	5	6	7	8	9	New APU
Block resistance at 50◦C (0-10):										
after 1 day	9.5	10	9.5	9.5	10	0	9	10	0	10
4 days	10	10	9.5	10	10	0	9.5	10	0	10
7 days	10	10	10	10	10	0	10	10	0	10
Block resistance at room temperature:										
after 1 day	10	10	10	10	10	0	10	10	0	10
4 days	10	10	10	10	10	8	10	10	2	10
7 days	10	10	10	10	10	8.5	10	10	10	10

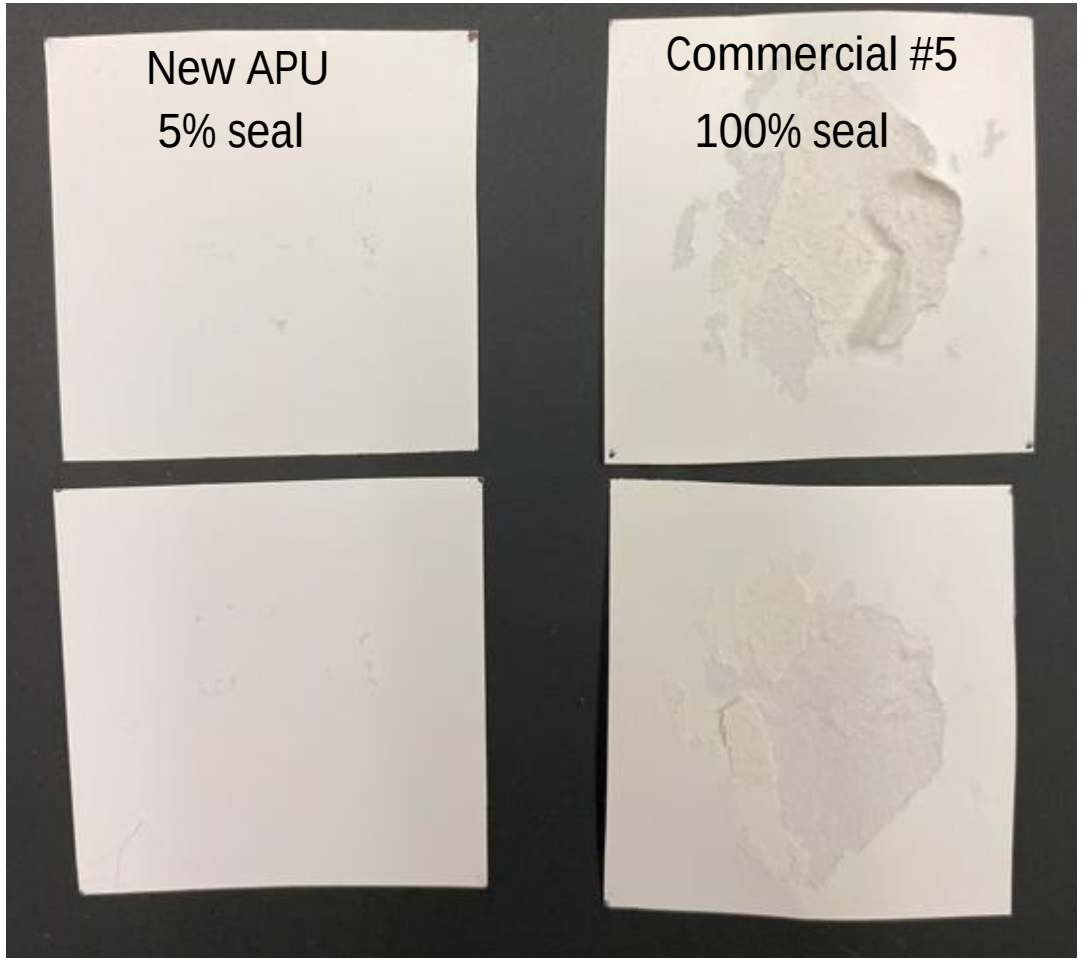
Test after 1 hour dry at room temperature

Early Block Resistance, 1h dry @ room temp

24 h test @ room temperature (500g weight)

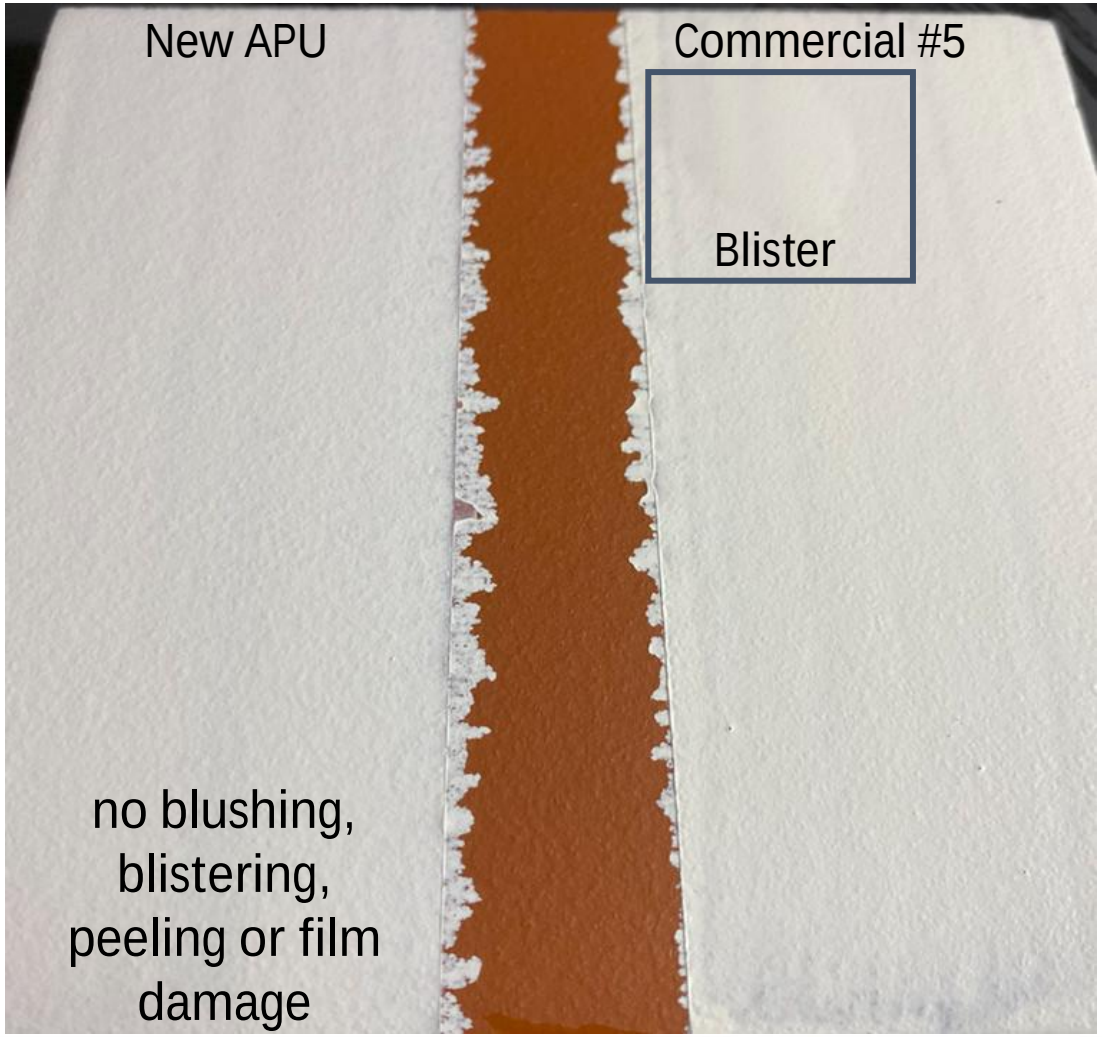


30 min test @ 50◦C (1000g weight)

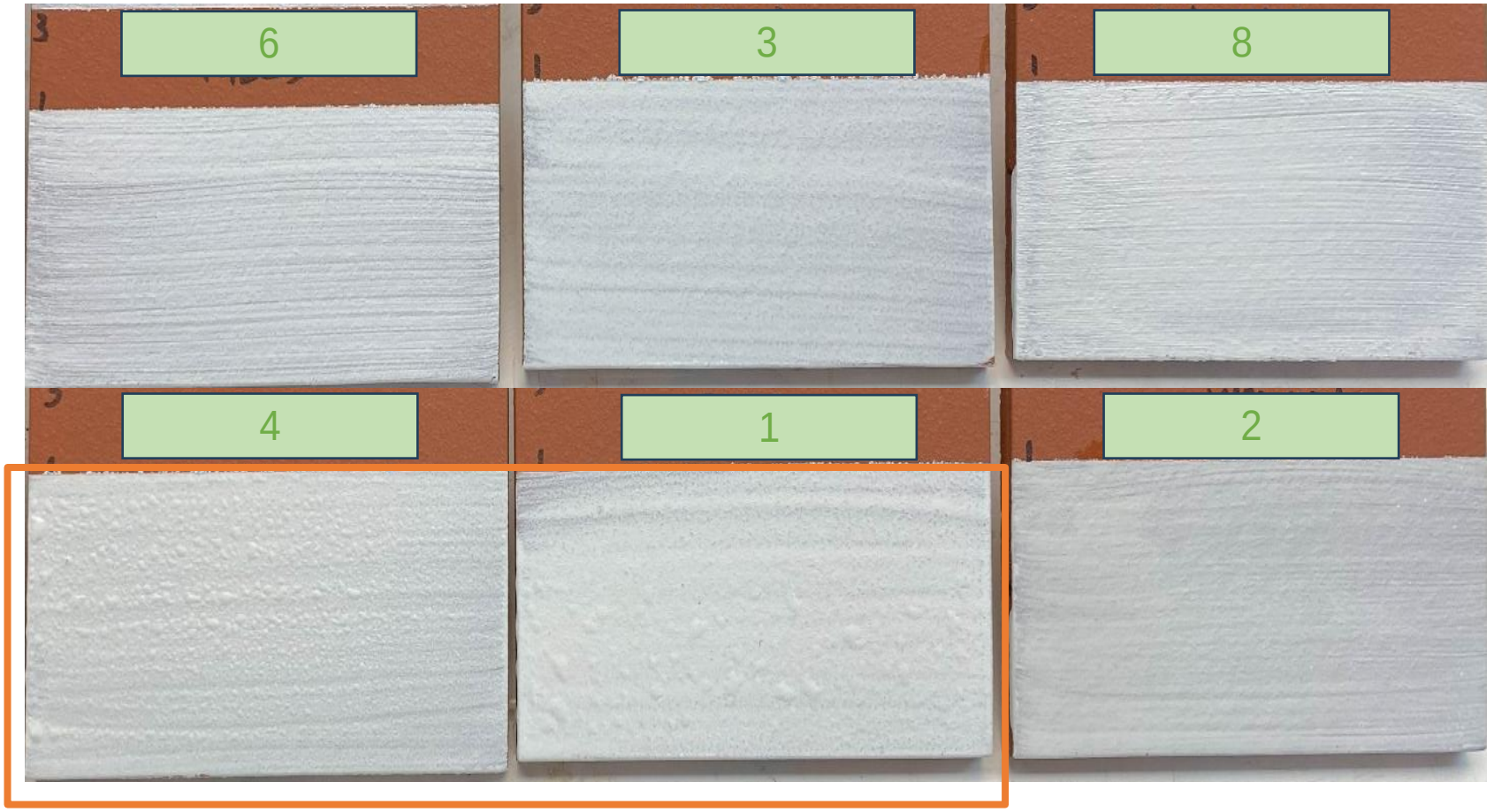


Quarry tile water immersion test

- Brushed on quarry tile and dried for 1 day
- Immersed in water overnight
- Next day, take tiles out of water and pat dry



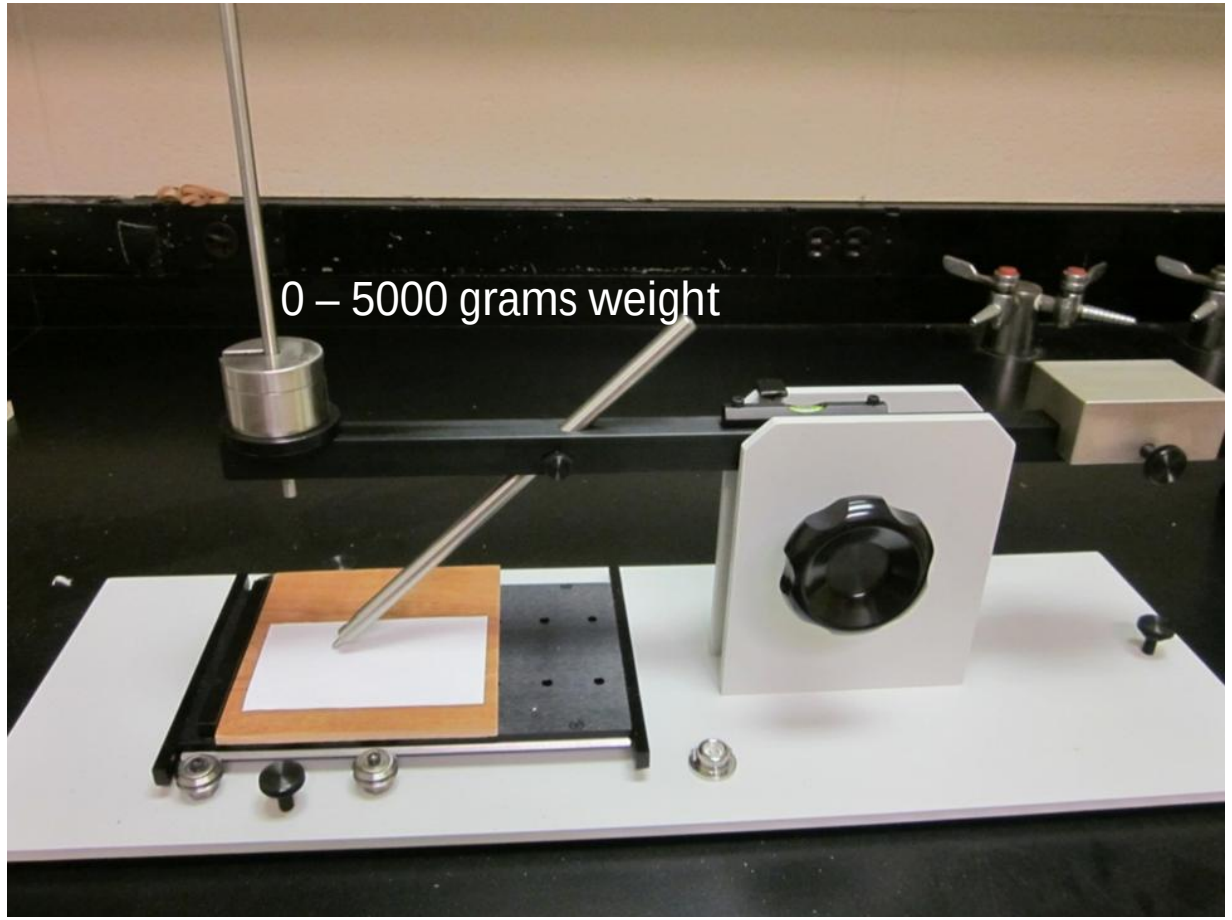
Quarry tile water immersion test – 1 day dry



Commercial paints 1 and 4 also showed severe blistering after overnight immersion

Hand fat resistance

- 8 mil coating applied to aluminum panel, 1 day dry
- Oil mixture dwell for 1h
- BYK Balanced Beam Scrape Adhesion and Mar Tester



Poor performance:

Hand fat resistance	1	2	3	4	5	6	7	8	9	New APU
1d/gram	5000	100	100	5000	4000	100	5000	100	100	5000

Good performance:

Tannin blocking

7 day dry at ambient:

ΔE = 2.45 ΔE = 0.97

Then overnight in a Cleveland Humidity chamber :

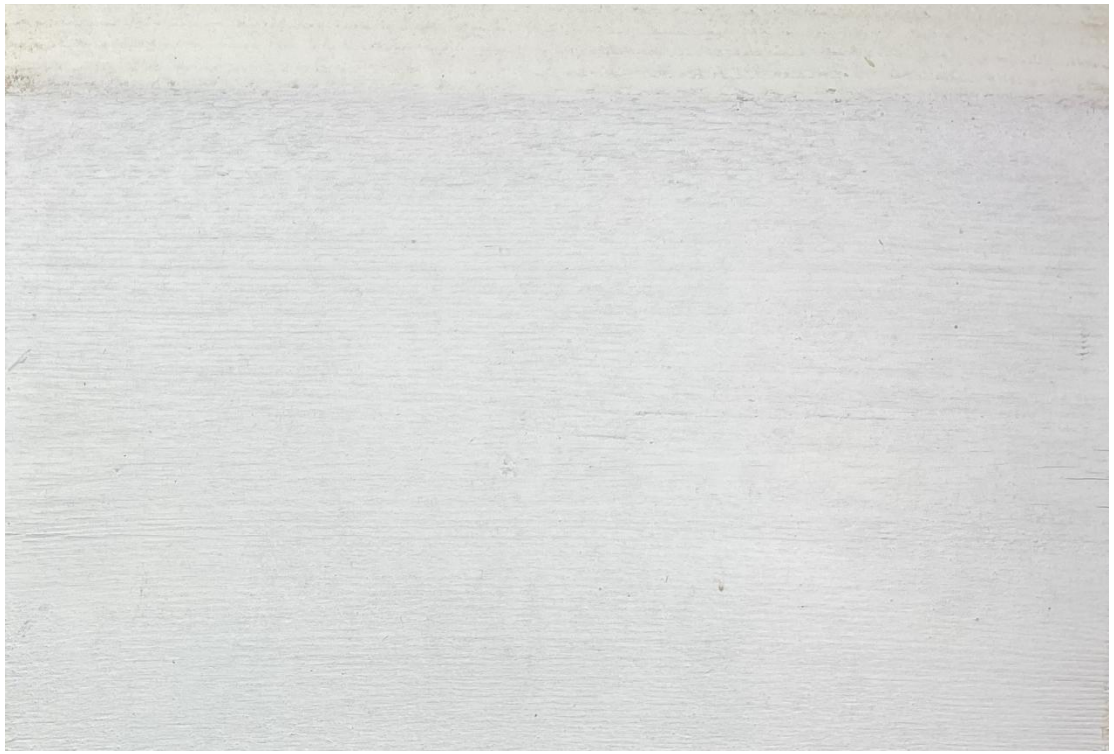
ΔE = 2.71 ΔE = 1.23

QUV, 3000 hours

New APU
ΔE = 0.28
Gloss changed from 20 to 15

Commercial #5
ΔE = 0.5
Gloss changed from 16 to 13

Site exposure, 6 months, Greensboro NC



New APU
ΔE = 3.59
Gloss no changed at 15

Commercial #5
ΔE = 3.86
Gloss changed from 12 to 11

Freeze-thaw stability and Mandrel bend

Passes 5 F/T cycles

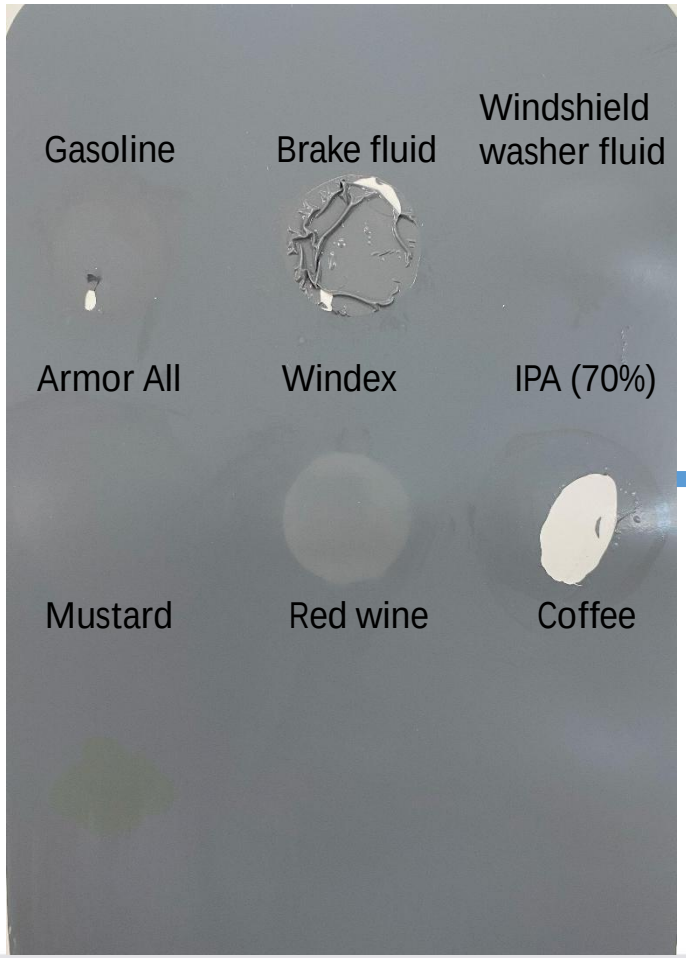
Flexible

Garage floor coating

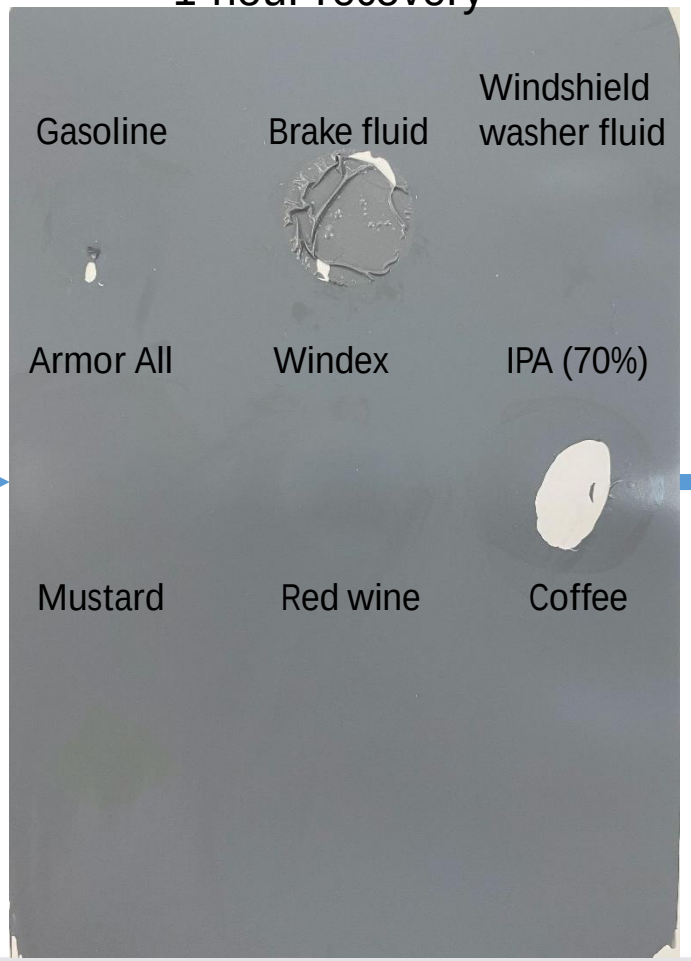
Formula:	
Water	34.28
Defoamer	1.33
Dispersant	2.68
TiO2	43.24
Filler pigment	14.41
New APU	171.38
Coalescent	0.68
Coalescent	1.54
Defoamer	0.54
Wetting agent	0.54
Surfactant	0.74
Black colorant	4.91
Associative thickener	2.69

Garage floor coating

Chemical resistance:



1-hour recovery



24-hour recovery

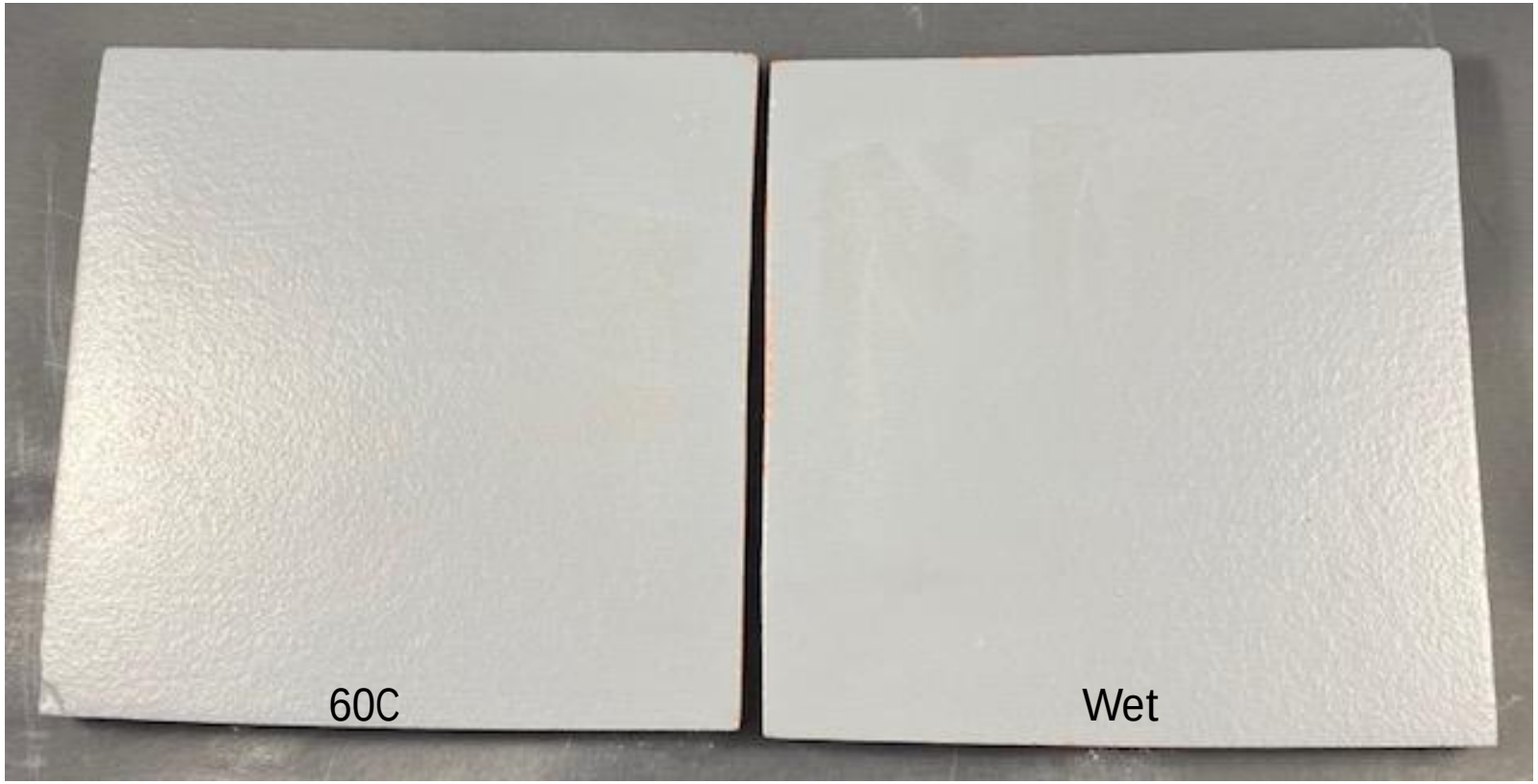
Garage floor coating

- Hot tire resistance

- The coatings are applied to red quarry tiles using a paint brush, then allowed to air dry for 7 days.
- Each coating is tested with two different preconditions:
  - Tile is placed in an oven at 60^{o}C for 30 minutes.
  - Tile is immersed in water at room temperature for 30 minutes.
- Two pieces of tires are preheated for 30 minutes at 60^{o}C then placed on each tile.
- Pressure is applied with a hydraulic press for 90 minutes, then tiles + tires are removed from the press.

Garage floor coating

- Hot tire resistance



Masonry results

Efflorescence

Alkali

Conclusion

A new acrylic-polyurethane resin produces durable enamels for demanding jobs:

- Dries to touch <15 minutes
- Ultra-block resistant in 1 hour
- Excellent adhesion in 24 hours
- Hand-fat and water resistant in 24 hours
- Tough enough to be used as garage floor coating

Thank you!

George Wang

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