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A Family of Waterbased Acrylics based on a Unique Self-Crosslinking Mechanism

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Wood Symposium
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Overview of the Presentation

- History of Interpolymer Acrylic Development
- Self-Crosslinking Theory, Monomers, Backbone & Mechanism
- Film Formation Overview
- Acrylics & Starting Point Formulation Details
- Application Information
- Physical Testing Results
- Summary
- Thank You & Questions

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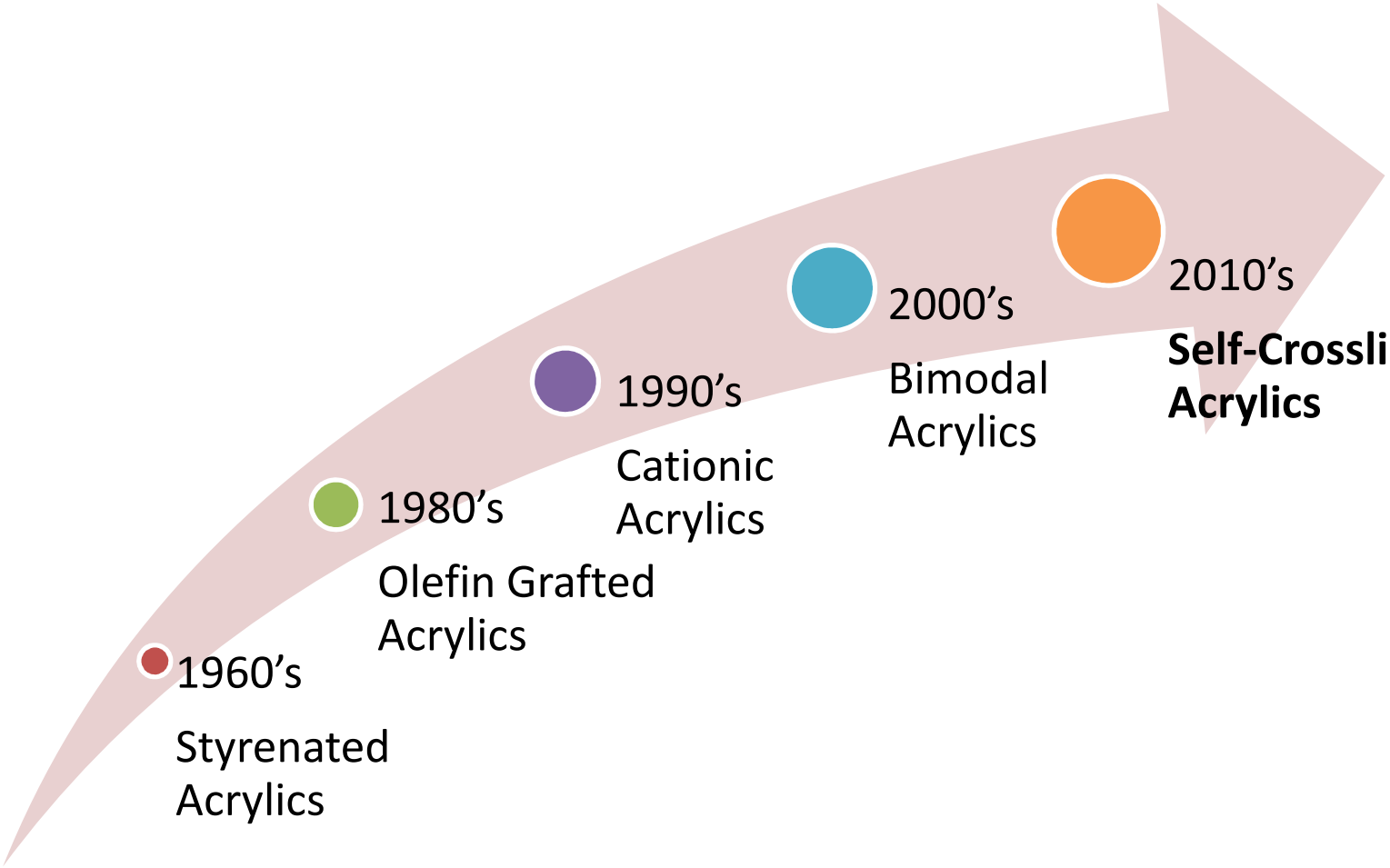
Timeline of Acrylic Development at Interpolymer



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Developmental Model for the Self-Crosslinking Acrylic

Development Theory (what potential product should have)

- Ease of use (1K instead of 2K system potential).
- Health and Safety benefits.
- Improved economics of coating.
- Properties need to be similar to traditional post-addition crosslinkers.

Development Target (what Interpolymer wants beyond Theory)

- Crosslinking needs to react at room temperature.
- Stability profile needs to be same as traditional acrylic technology.
- Robust enough to be usable in multiple technologies & markets.
- Needs to be “Unique” mechanism that adds value to our product line.

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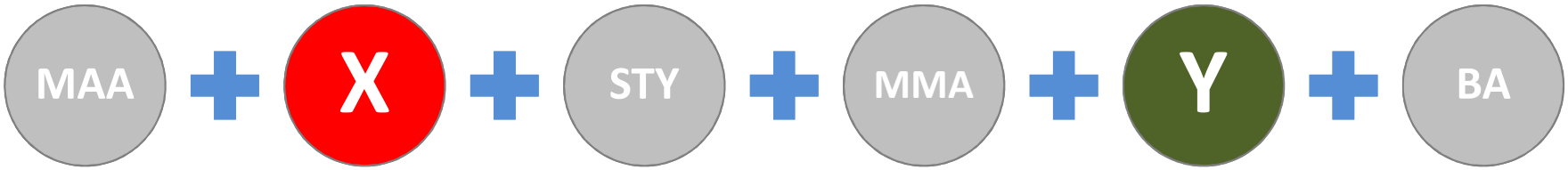
Monomers used in Self-Crosslinking Acrylics



MAA = Methacrylic Acid Monomer, H2C=C(CH3)-COOH

X = Schiff Monomer blend, H2C=CH-R-Z & H2C=CH-R'-Z'

STY = Styrene Monomer, H2C=CH-C6H5

MMA = Methyl Methacrylate Monomer, H2C=C(CH3)-CO-O-CH3

Y = Self-Condensing Monomer, H2C=CH-R''-Z''

BA = Butyl Acrylate Monomer, H2C=CH-CO-O-CH2-CH2-CH2-CH3

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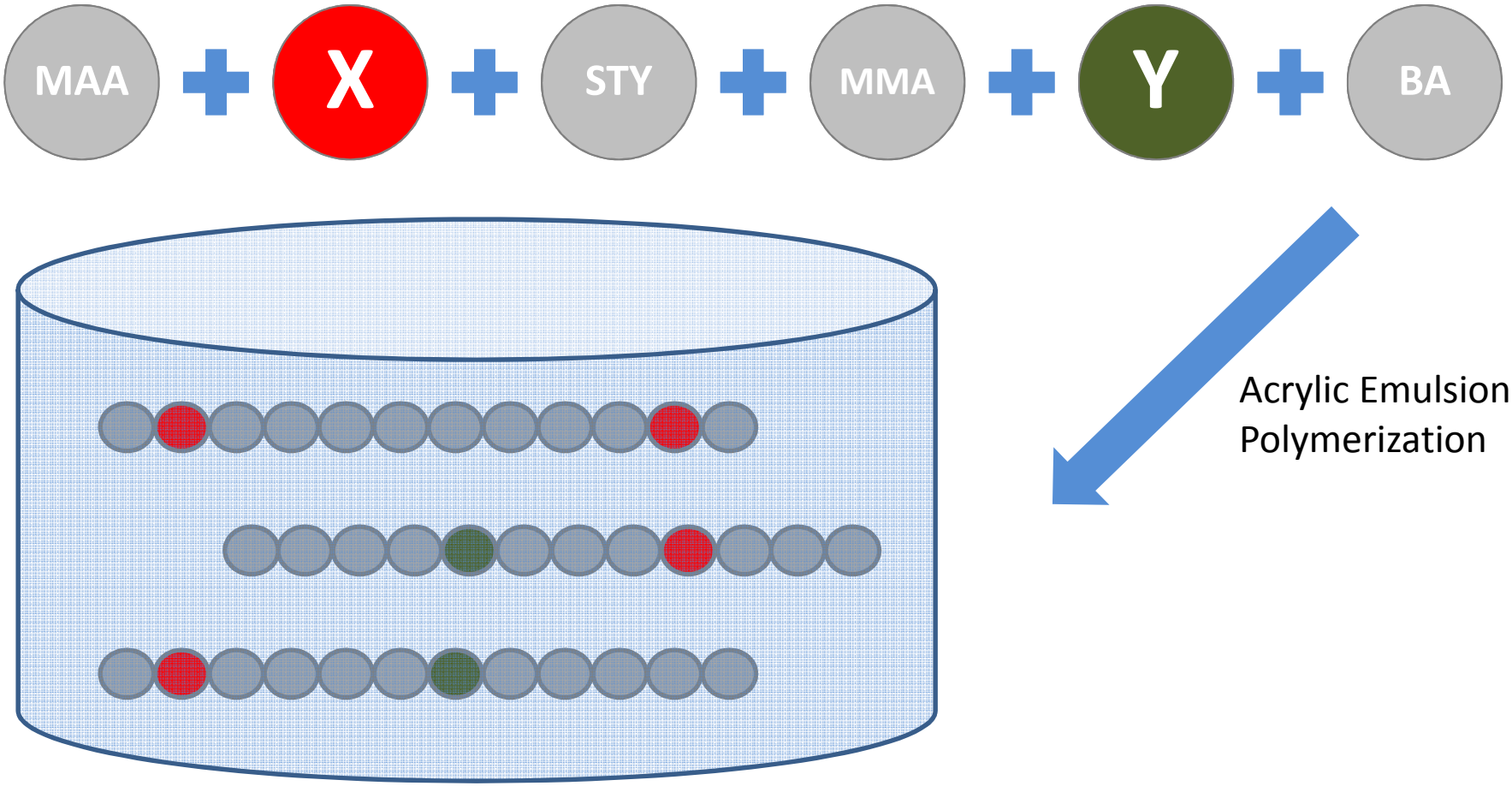
Backbone Formation of Self-Crosslinking Acrylics



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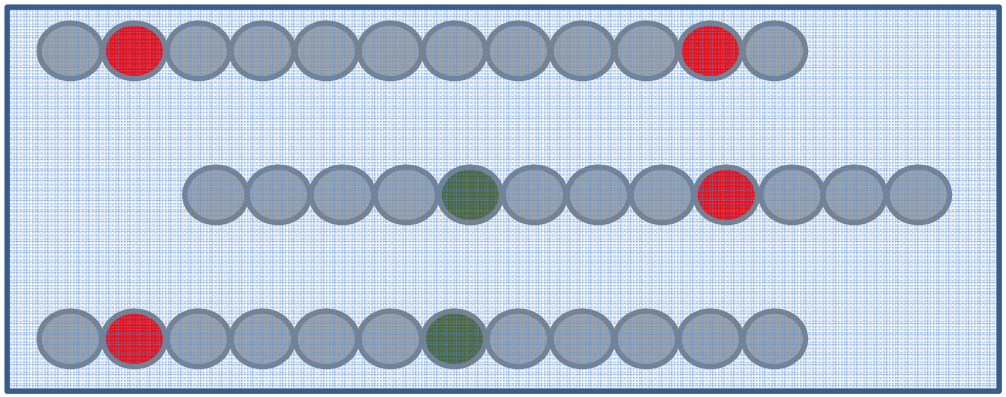
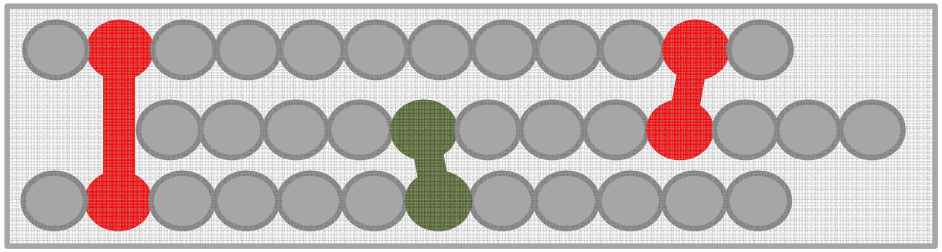
Mechanism of Self-Crosslinking Acrylics



Aqueous Emulsion

1. Apply formulated polymer to substrate
2. Remove the Water & Coalescing Solvents
3. Crosslinking network develops during film formation.



Self-Crosslinked Polymer Film

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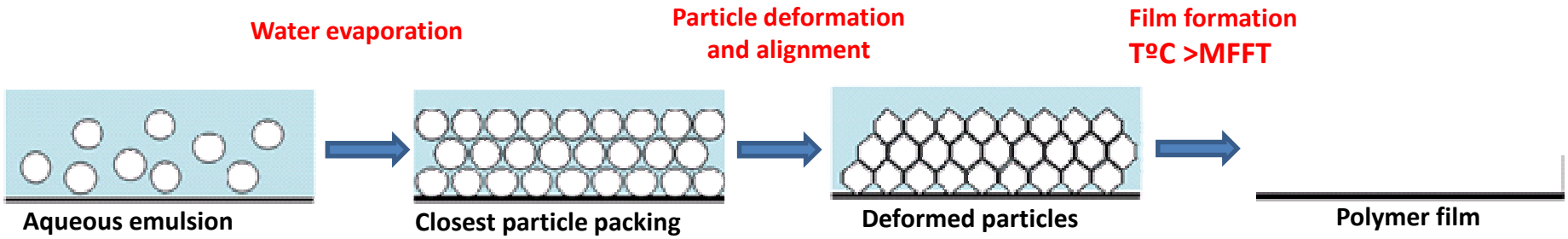
Film Formation of Waterbased Polymers

MFFT = Minimum Film Formation Temperature

Factors that Influence the Film Formation:

- Backbone configuration and composition
- Atmospheric conditions
- Ingredients of the formula
- Substrate porosity and composition



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Information on Acrylics used in this Presentation

Code	% NV	Calc. Tg	Actual MFFT	X/Y Ratio	% X+Y of Polymer
SX Tg 5	42%	5°C (41°F)	15°C (59°F)	55/45	4.5%
Tg 5	42%	5°C (41°F)	10°C (50°F)	-	-
SX Tg 35	42%	35°C (95°F)	45°C (113°F)	55/45	5.2%
Tg 35	42%	35°C (95°F)	40°C (104°F)	-	-
SX Tg 65	40%	65°C (149°F)	75°C (167°F)	64/36	4.0%
Tg 65	40%	65°C (149°F)	68°C (155°F)	-	-

Note: all of the above acrylic backbones are the same, ratio's adjusted to hit targeted Tg.
X & Y levels chosen to optimize Tg and physical property targets.

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Information on Application Formulas used in this Presentation*

Ingredients	Tg 5 Polymers	Tg 35 Polymers	Tg 65 Polymers
Water	27.60%	28.99%	29.22%
Plasticizer	-	2.89%	5.67%
Coalescing Solvent	-	2.71%	3.24%
Leveler	0.90%	0.90%	0.90%
Acrylic Resin	71.50%	64.51%	60.97%
Total Solids	30%	30%	30%
pH	7-9	7-9	7-9
Viscosity	< 100 cps	< 100 cps	< 100 cps
VOC Content	< 10 g/L	79.5 g/L	94.3 g/L

Note: all of the above formulas were designed for room temperature film formation.

** This slide does not include the white paint formula based on Tg 5 polymers used in some examples.*

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Information on Application Data used in this Presentation

- This Evaluation took place over a 10 month period (February 2016 – December 2016).
- The purpose was to evaluate our Self-Crosslinking Mechanism over multiple substrates targeting multiple markets.
- 14 Substrate types used during evaluation (Concrete, Oak, Maple, Pine, Poplar, Red & Grey Quarry Tiles, PVC, VCT, Glass, Steel, Aluminum and Coated & non-Coated Leneta Cards)
- 6 Markets were targeted during evaluation (Flooring, Furniture, OPV for Labels, OPV for non-FDA Packaging, Paints and Kitchen Cabinets).
- All evaluations were repeated by the multiple members of Interpolymer's Massachusetts Laboratory Staff.
- The following is only the highlights of all the data & photographs recorded during the Self-Crosslinking Acrylic Study.

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Physical Testing - Bench Testing Results

	Tg 5	SX Tg 5	Tg 35	SX Tg 35	Tg 65	SX Tg 65
60° Gloss (3 wet mils, N2C Gloss Card) (3 wet mils, Oak) (3 wet mils, concrete)	86 71 76	88 72 78	84 73 65	86 74 80	84 74 67	85 74 75
Recoatablity (ASTM D 3153)	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Sward Hardness (ASTM D 2134)	18	24	28	30	30	34
Pencil Hardness (ASTM D 3363)	3B	2B	2B	HB	B	F
Wear Index (ASTM D 4060)	48	46	60	62	64	65

Note: Pencil Hardness Scale (softer to harder): 6B-5B-4B-3B-2B-B-HB-F-H-2H-3H-4H-5H-6H
Wear Index based on 1000 cycles using CX-17 wheels with 500 g weight

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Physical Testing – Chemical Spot (ASTM D 1308) Testing Results

	Tg 5	SX Tg 5	Tg 35	SX Tg 35	Tg 65	SX Tg 65
Rubbing Alcohol	4	1	2	0	5	1
100% Ethanol	4	1	5	0	5	1
Skydrol Fluid	5	5	5	4	4	0
Mustard	3	0	1	0	1	0
Red Wine	1	0	0	0	2	0
Betadine	4	3	3	0	4	3

Note: Chemical resistance is reported subjectively on a scale from 0 to 5 where "0" indicates no change to the film and "5" indicates complete film removal.

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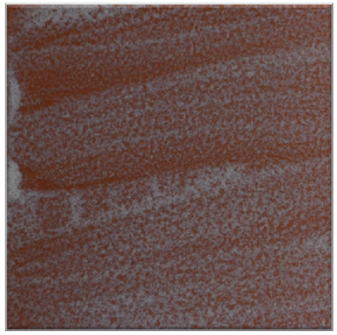
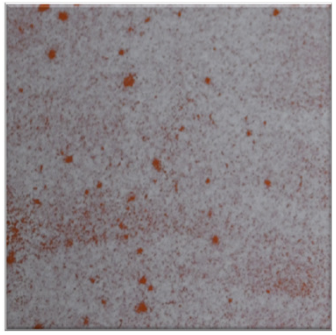
Physical Testing – Water Submersion Test (Internal Method)

Tg 5

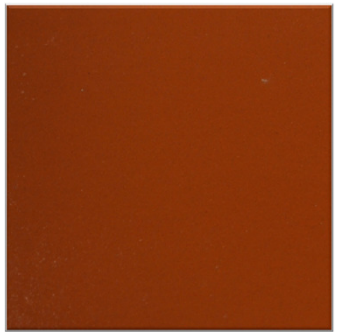


Tg 35

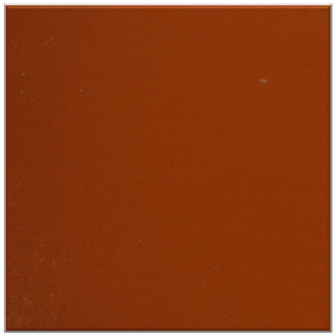


Tg 65

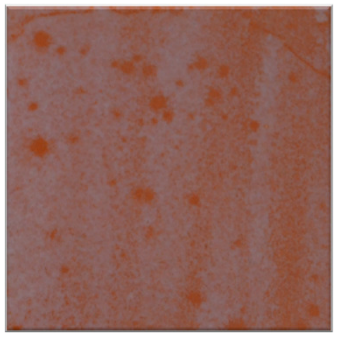
SX Tg 5



SX Tg 35



SX Tg 65



Note: Coated Red Quarry Tiles dried at room temp for 4 hours, then submerged in water for 1 week.

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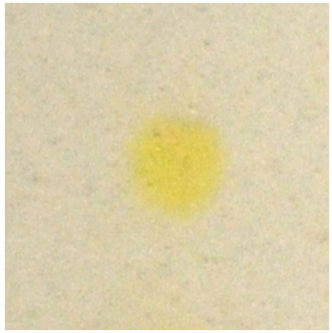
Physical Testing – Stain Resistance Test (ASTM D-1308)

Tg 5

Tg 35



Tg 65

SX Tg 5

SX Tg 35

SX Tg 65

Mustard
(Clear over Oak)

Betadine
(Clear over VCT Tile)

Skydrol Fluid
(Clear over Concrete)

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Physical Testing – Alcohol Resistance Test (AATCC, ASTM, KCMA)

Tg 5

Tg 35

Tg 65

SX Tg 5

SX Tg 35

SX Tg 65

Alcohol Rubs
(Paint over PVC)

Hand Sanitizer Gel
(Clear over Concrete)

100 Proof Alcohol
(Clear over Oak)

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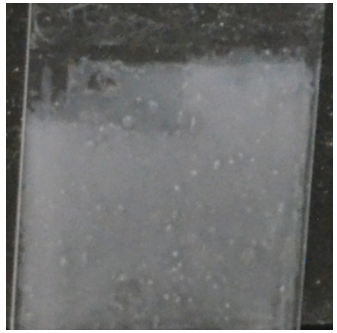
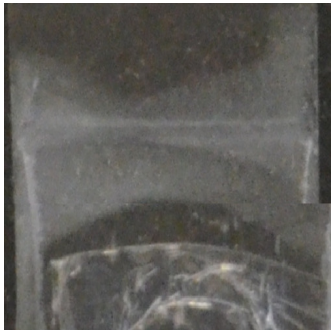
Physical Testing – Alkali Submerged Test (Internal Method)

Tg 5

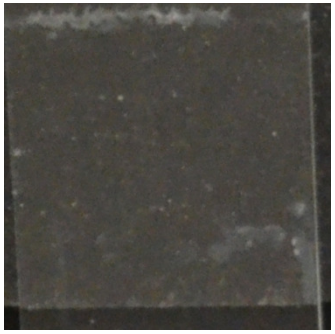
Tg 35



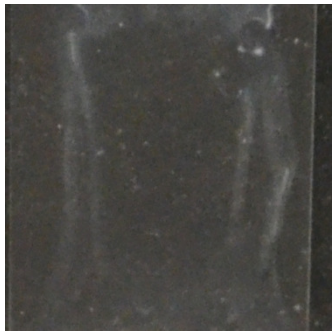
Tg 65



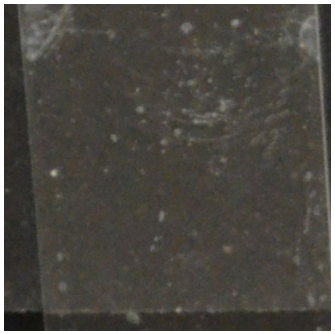
SX Tg 5



SX Tg 35



SX Tg 65



Note: Coated glass panel dried at room temp for 48 hours, then submerged in 2.5% Sodium Hydroxide Solution for 1 hour at 80°C .

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Physical Testing – Hot Tire Resistance Test (Internal Method)

Tg 5

Tg 35

Tg 65

SX Tg 5

SX Tg 35

SX Tg 65

Note: Coated panel dried at room temp for 48 hours, then 60°C tire strip pressed on surface for 15 minutes at 1000 psi.

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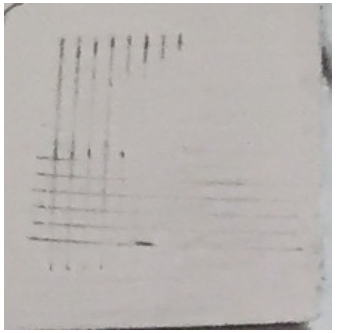
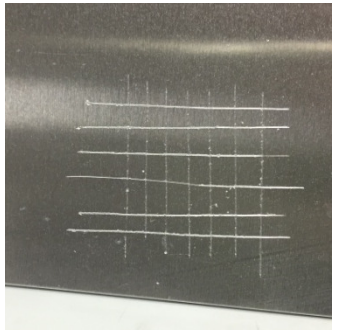
Physical Testing –Adhesion Test (ASTM D-3359 & D-7234)

SX Tg 5



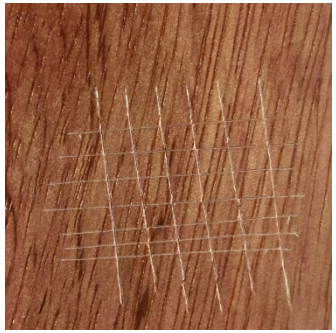
Paint over PVC

SX Tg 35

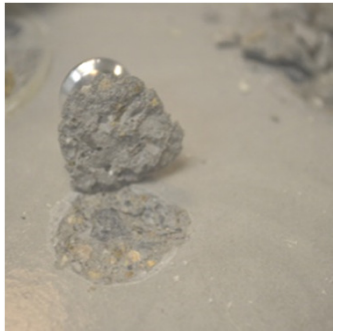


Clear over CRS

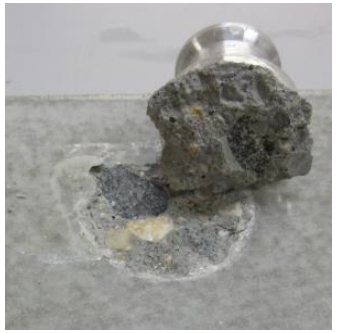
SX Tg 65



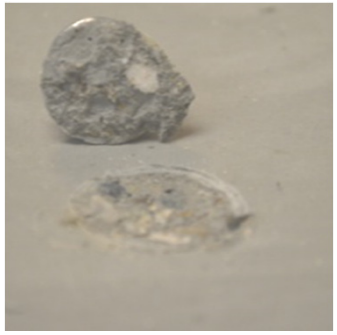
Clear over Oak



Clear Primer over Concrete



Clear Primer over Concrete



Clear Primer over Concrete

Note: Concrete tested with P.A.T.T.I. Pneumatic Adhesion Pull-off Tester.

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Summary of the Self-Crosslinking Presentation

- Developed a room temperature waterbased self-crosslinking mechanism.
- Self-crosslinking mechanism based on unique dual chemistries.
- Dual chemistries allow for ability to “dial-in” property improvements.
- Improvement on stain, chemical and water resistances over uncrosslinked acrylics (similar to expected results with post-added crosslinkers).
- Easy transition from standard acrylic to self-crosslinking acrylic of same Tg, due to same stability / compatibility profile and formulation requirements.
- Better economics & EHS profile using self-crosslinking acrylics.
- Like all of our Technologies (Bimodal, Wax Graft, etc), can be manufactured at any Interpolymer facility.

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- Jessica Corwin, Development Chemist (Interpolymer MA)
- Tim Martin, Retired Technical Director of Interpolymer US

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Thank you & Questions?

www.interpolymer.com