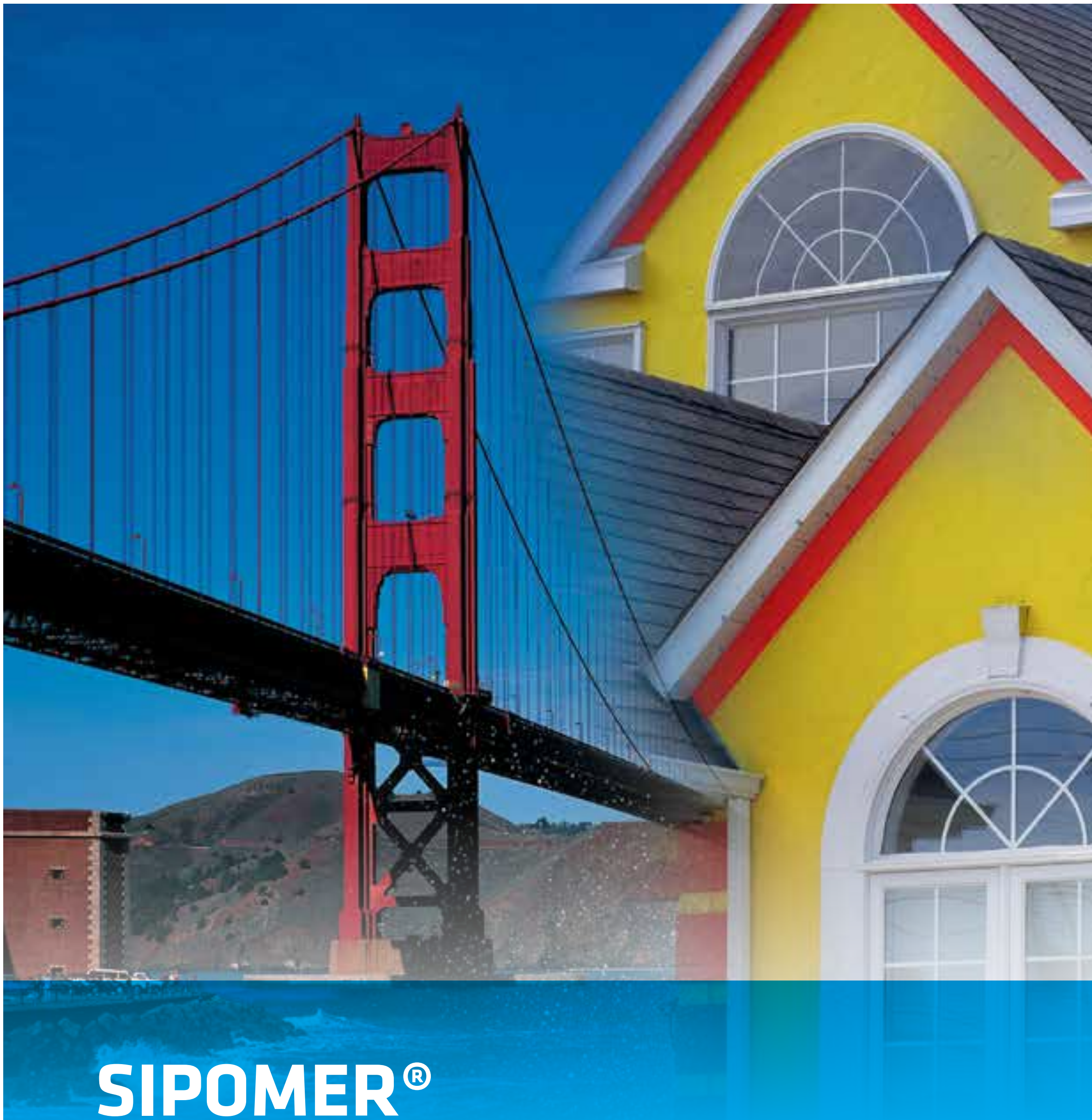


SOLVAY

asking more from chemistry®

SIPOMER®

Specialty Monomers

For enhanced performance

Solvay Novecare Coatings

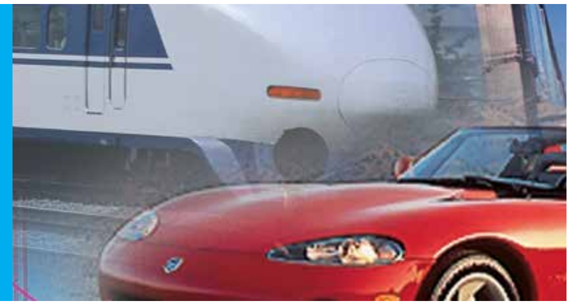
Novecare Coatings is a global leader in surfactant and specialty monomers committed to emulsion and specialty polymers. With over 40 years serving this industry, we have developed one of the most extensive portfolios of specialty monomers **(SIPOMER®)** dedicated to improve architectural, industrial coatings and adhesives.

Leveraging our portfolio of chemistries and local application expertise, we continue designing structures that will help you solve today’s challenges and define tomorrow’s standards.

CONTENTS

Note: These products are produced at worldwide locations through through the Novecare division of Solvay.

SIPOMER®
"So little delivers so much"



SIPOMER®s are very efficient. In most application, addition of 0.5 to 3% of these monomers deliver significant performance and bring functionality to your polymers.

By leveraging our diverse chemistry platforms, Solvay designs solutions adapted to both monomer systems and formulation performance. Whether your formulation is waterborne, solventborne or you seek support in transitioning towards waterborne, **SIPOMER®** will deliver in the following properties:

From Technology to Solutions

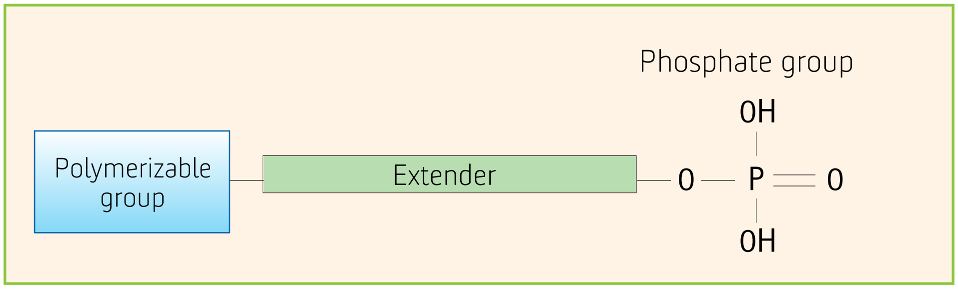
Process →
- Clean EP Process
- Improved mechanical, thermal & salt stability
- Limit foaming

Adhesion →
- Wet Adhesion
- Metal & Inorganic
- Wood
- Interaction with Pigments

Surface Properties →
- High Scrub
- Gloss
- Low water sensitivity
- EZ Clean
- Scratch resistance

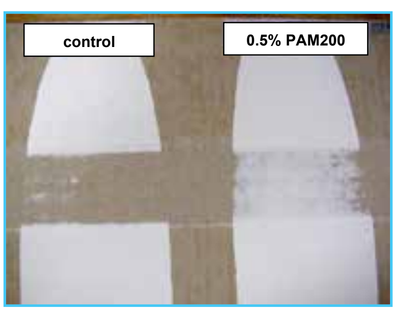
Mechanical Properties →
- Tg depletion
- Tg Increase
- Peel Strength

SIPOMER® PAM
"Adhesion and Much More"



	Reactive Group	Nature of Extender	Application
SIPOMER® PAM 100	Methacrylate	Hydrophilic	Industrial
SIPOMER® PAM 200	Methacrylate	Hydrophobic	Industrial/ Architectural / Adhesive
SIPOMER® PAM 300	Acrylate	Hydrophobic	UV/EB Cure
SIPOMER® PAM 4000	Methacrylate	~	Architectural
SIPOMER® PAM 5000	Allyl Ether	Slightly Hydrophilic	Architectural

Applications 0.5 to 1 wt% PHM



Concrete Concrete

After 2000 scrub cycles

Performance Benefits

- Improves binder robustness
- Adhesion to metal
- Adhesion to inorganic substrate
- Adhesion to glass
- Scrub resistance
- Color development
- Gloss enhancement

Uses

SIPOMER® PAMs are available in a variety of structures compatible with most coatings chemistries, technologies and applications.

Effective in Different Polymer Systems	Effective on a Variety of Substrates
Acrylic	Aluminium (plain and chromated)
Styrene/acrylic	Cold rolled steel
VeoVa/acrylic	Zinc phosphated steel
Vinyl VeoVA	Iron phosphated steel
Polyurethane (via acrylic polyols)	Galvanized steel
	Stainless steel
	Glass
	Concrete

SIPOMER® PAM
"Adhesion and Much More"

Technologies for different markets

SIPOMER® PAM in various resins by either emulsion or solution polymerization.

	SIPOMER® PAM-100	SIPOMER® PAM-200	SIPOMER® PAM-300	SIPOMER® PAM-4000	SIPOMER® PAM-5000
EMULSION POLYMERIZATION					
> You want to add the phosphate monomer with no other modification to an existing latex recipe.	SIPOMER® PAM-100 can be added to the monomer feed in acidic form or to a separate feed in neutralized form.	Due to its surfactantcy properties, SIPOMER® PAM-200 may generate problems such as secondary nucleation.	Due to its surfactantcy properties, SIPOMER® PAM-300 may generate problems such as secondary nucleation.	SIPOMER® PAM 4000 is perfectly suited to be used in monomer mix	SIPOMER® PAM 5000 is perfectly suited to be used in monomer mix
> You want to minimize or or eliminate the primary surfactant.	*reduce the total amount of surfactant needed * cannot be used as a primary surfactant.	Reduce drastically the use of surfactant or may be used as the sole surfactant in emulsion polymerization.	Reduce drastically the use of surfactant or may be used as the sole surfactant in emulsion polymerization.	*reduce the total amount of surfactant needed *cannot be used as a primary surfactant.	*reduce the total amount of surfactant needed *cannot be used as a primary surfactant.
> You want to stabilize a pre-emulsion without any conventional surfactant.	Not Surface active	SIPOMER® PAM-200 may be used as a sole emulsifer to stabilize pre-emulsion.	SIPOMER® PAM-300 may be used as a sole emulsifer to stabilize pre-emulsion.	Not Surface active	Not Surface active
SOLUTION POLYMERIZATION					
> Water soluble	SIPOMER® PAM-100 is more hydrophilic and totally soluble in water when neutralized.	Due to poor solubility in water, using SIPOMER® PAM-200 may lead to micellar polymerization.	Due to poor solubility in water, using SIPOMER® PAM 300 may lead to micellar polymerization.	Water Soluble	Water Soluble
> Solventborne (Polyacrylate Polyols…)	SIPOMER® PAM-100 can be used to make resins but might have compatibility issues with some polymers.	SIPOMER® PAM-200 is soluble in a broad range of monomers and solvents.	SIPOMER® PAM-300 is soluble in a broad range of monomers and solvents and suitable for UV/EB applications.		
UV/EB Cure					
UV/EB cure			The acrylic functionality of SIPOMER® PAM-300 provides a higher reactivity in radiation cure application		

Best Possible Not suitable

Example: Car Refinish: More cars coated with fewer problems

Direct-to-metal substrates represent a significant field for innovation yielding process simplification and environmentally friendly solutions such as:

- Direct-to-metal priming that consolidates a complex process into one step
- Shift from solventborne to waterborne resin systems

Standard primers for car refinishing are based on 2K polyurethane solventborne resin systems. Either **SIPOMER® PAM-100** or **SIPOMER® PAM-200**, based on the formulation and technology used, will be effective in improving metal adhesion of such systems.

Thanks to their superior MAP/DAP ratio, SIPOMER® PAM-100 and SIPOMER® PAM-200 are easily incorporated into polyurethane systems with minimum impact on viscosity. SIPOMER® PAM 200 can be used in polyurethane waterborne systems where it provides improved adhesion with system and stabilization features.

Adhesion Data in 2K Polyurethane Solventborne Systems
SIPOMER® PAM-200 can significantly improve the dry and wet adhesion on both aluminum and cold-rolled steel. SIPOMER® PAM is used to make acrylic polyols.

ALUMINUM			
IMMERSION HOURS	DRY	2	4
Control	1B	0B	0B
1% PAM	3-4B	0B	0B
4% PAM	5B	0B	0B

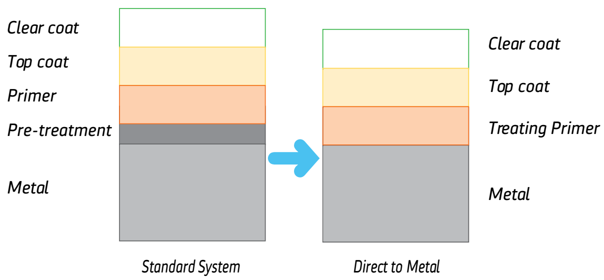
Adhesion is evaluated according to ASTM D3359 test: OB poor adhesion - 5B perfect adhesion.

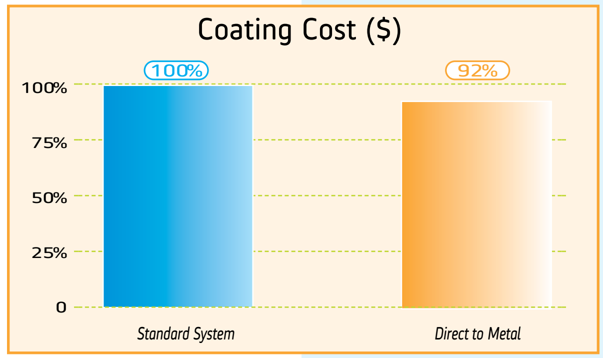
COLD-ROLLED STEEL						
IMMERSION HOURS	DRY	2	4	8	24	48
Control	5B	4-5B	2B	0B	0B	0B
1% PAM	5B	2B	2B	1B	0B	0B
4% PAM	5B	5B	5B	5B	4-5B	4-5B

SIPOMER® PAM
"Adhesion and Much More"

Automotive Refinish: Direct-to-Metal (DTM) Benefits

Ready-to-apply top coat with DTM primer in 30 minutes instead of 12 hours with standard systems



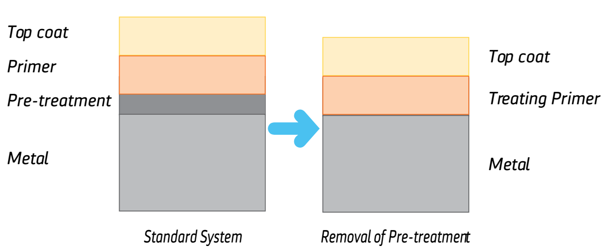


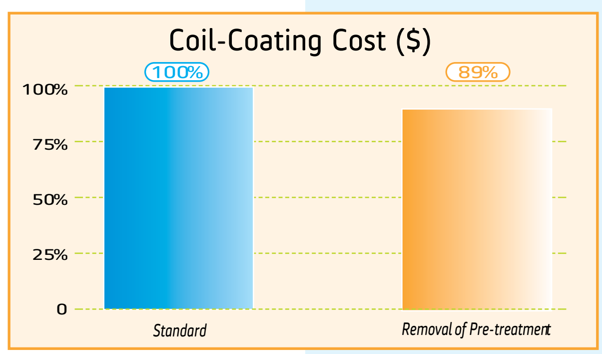
Example: Coil Coating: Improved efficiency and environmentally friendly

Coil coating is a continuous and highly automated process whereas the metal coil is unwound and both the top and bottom sides are cleaned, chemically treated, primed, oven cured, top coated, oven cured again, and rewound for shipment. Thanks to this process, large coils can be coated at high speed before fabrication. Resins incorporating **SIPOMER® PAMs** will boost primer adhesion and anti-corrosion properties eliminating the need for pre-treatment step(s) translating into less waste, energy & process time.

Benefits :

- Process savings: one step vs. two steps
- Eliminate waste treatment and reporting/regulation requirements Linked to the use of heavy metals such as chrome and phosphorous.





Example: Maintenance Coatings: An environmental solution that works!

Organic coatings play an important role in corrosion protection. One of the key challenges to convert solventborne systems to more sustainable, water-based formulation resides in significant loss in adhesion and anticorrosion performances.

Thanks to it's excellence in metal adhesion, **SIPOMER® PAM-200** boosts the performance of acrylic waterborne resins enabling matching performance versus solventborne anticorrosion coatings, allowing low VOC coatings formulations and consumers who are demanding new products that meet or exceed the requirements for lower VOC coatings.

Good Adhesion Results

SIPOMER® PAM-200 was used to modify a waterborne styrene/acrylic resin. An anticorrosion paint was formulated and tested for adhesion and corrosion-resistance properties. Compared with a control paint formulated without **SIPOMER® PAM-200**, the results are below:

	PAINT-BASED ON S/A LATEX WITH 1%		PAINT-BASED ON S/A CONTROL LATEX		*S/A: Styrene/Acrylic*
	CROSSHATCH RESULTS AFTER WATER IMMERSION		CROSSHATCH RESULTS AFTER WATER IMMERSION		*Adhesion is evaluated according to ASTM D3359 test: 0B poor adhesion – 5B perfect adhesion. Adhesion is evaluated after 24 hours and after 520 hours of immersion in water.*
	24 hrs	520 hrs	24 hrs	520 hrs	
> Cold-rolled steel	5B	5B	4B	2B	
> Iron phosphate steel	5B	5B	1B	1B	
> Zinc phosphate steel	3B	3B	0B	0B	

Good Anti-Corrosion Results

Corrosion resistance on cold-rolled steel after 520 hours of Salt Spray Test Paint based on S/A latex with 1% Sipomer PAM-200

Corrosion resistance on cold-rolled steel after 520 hours of Salt Spray Test Paint based on control latex

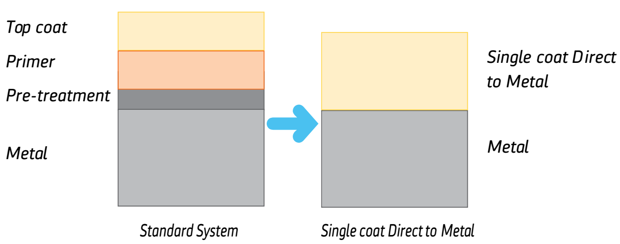
Anticorrosion is evaluated according to ASTM B117 testing reference: Standard Test Method of Salt Spray

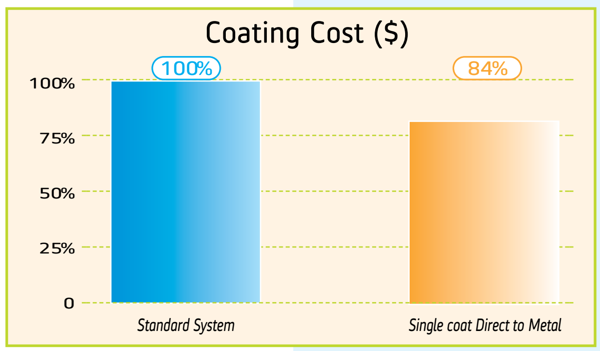
SIPOMER® PAM
"Adhesion and Much More"

Special-Purpose Coatings: Improved performance and efficiency

This segment includes coatings for various metal substrates mainly applied by Original Equipment Manufacturers. This market ranges from coatings for large vehicles, such as trucks, farm tractors and cranes to house appliances. Different technologies compete in this market with the objective of a single, multipurpose coating applied directly to metal. The result is elimination of pre-treatment and fewer steps in the process!

Either **SIPOMER® PAM-100** or **SIPOMER® PAM-200**, based on the formulation and technology used, can boost acrylic resin performances in terms of adhesion and corrosion resistance and offer a viable solution for directto-metal applications.





Good results without pre-treated substrate

SIPOMER® PAM-100 was used to modify a waterborne styrene/acrylic resin. The resin was formulated in a clearcoat and tested for adhesion on untreated, coldrolled steel. Wet adhesion was evaluated under different test conditions:

- Water-spots test
- Immersion test
- After 24 hours recovery

	Control 2%	PAM-100
4-hour spot test	0B (0%)	4B (95%)
4-hour immersion test	0B (0%)	3B (92%)
24-hour recovery test	0B (0%)	5B (100%)

Anticorrosion is evaluated according to ASTM D3359
OB: poor adhesion 5B: perfect adhesion

Conclusions

SIPOMER® PAM-100 and **SIPOMER® PAM-200** specialty monomers enable process simplification and cost savings for the industrial coatings market. Whether your application is automotive refinishing, coil coatings,maintenance or special purpose coatings, the benefits of using the SIPOMER® PAMs include:

- Elimination of costly metal pre-treatment step
- Reduction of layers in the coating system
- Cost saving of labor required for the coating application
- A shift from heavy metals-based conversion coatings to organic
- A shift from solventborne to waterborne systems

SIPOMER® PAM-4000 – Metal Adhesion Promoter

BLANK	SIPOMER® PAM 4000

Cross-hatched Tape Adhesion Test - Cold Steel

Monomer Ratio (BOTM)	
MMA	51.5
BA	46.5
MAA	1
SIPOMER® PAM-4000	1

Surfactant Charge (BOTM)	
Rhodapex RS-610 A25	0.5 in Kettle 1.0 in Pre-emulsion

Initiator System:
Thermal, Ammonium Persulfate

Seed:
20% Initiator Solution / 4% Pre-Emulsion

Particle Size :
126 nm

Latex Stability :
Freeze/Thaw Stability - 5+ cycles
Heat Stability (60C) - 30+ days

SIPOMER® PAM
“Adhesion and Much More”

High Scrub for high PVC binders in Architectural coatings with SIPOMER® PAM-5000

Latex Property Results

	Benchmark	SIPOMER® PAM 5000
Particle size (nm)	119	126
Solids content (%)	50.30%	50.10%
Grit / 120mesh (ppm)	92	22
Coagulum	Clean	Clean
Viscosity @ 20 rpms (mPa)	548	494
Viscosity @ 50 rpms (mPa)	386	252

Matte Paint Application Data
Scrub Resistance Results (PVC = 82)

Scrub Resistance Measurement	Benchmark	1 % SIPOMER® PAM 5000
ISO test first serial (μ)	36	17
DIN scrub resistance (cycles)	1050	4000

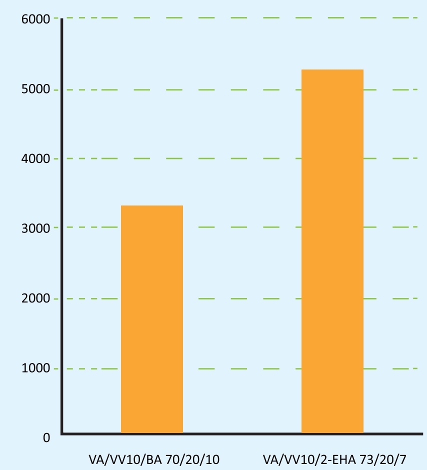
Improve Scrub Resistance in High PVC Paints

SIPOMER® PAM-5000 – Styrene/Acrylic Starting Point Recipe

Monomer Ratio (BOTM)	
Styrene	49.5
BA	47.5
AA	2
SIPOMER® PAM-5000	1.0 (in Kettle Charge)

Surfactant Charge (BOTM)	
Rhodapex® LA-40S	0.1 in Kettle Charge 0.9 in Pre-emulsion
Rhodafac® RS-610A25	1.0 in Pre-emulsion
Initiator System: Thermal, Ammonium Persulfate	
Seed: 20% Initiator Solution / 4% Pre-Emulsion	
Particle Size: 120 nm	
Latex Stability: 5 cycles of Freeze/Thaw Stability	

Number of cycles
DIN scrub resistance at 85 % PVC



High PVC Vinyl VeoVA paint formulation

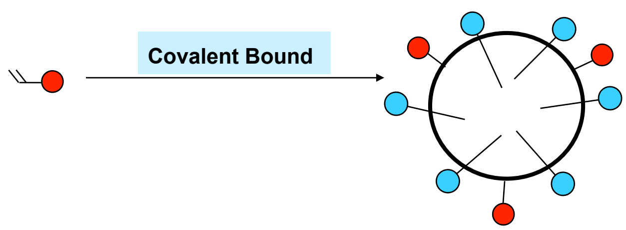
	Ingredients	Parts per weigh
Initial Reactor Charge	Demineralised water Rhodafac® RS 710-E (10%aq. Sol. At pH 7-8) Potassium persulphate	399 25 1
Pre-emulsion	Demineralised water Rhodafac® RS 710-E (10%aq. Sol. At pH 7-8) Sodium bicarbonate Vinyl VeoVA* 2-Ethylhexyl acrylate SIPOMER® COPS-1 (40% aq. Sol.) Acrylic acid Vinyl acetate SIPOMER® PAM 5000 (30% aq. Sol. At pH 5) Silquest A 171	393 45 3 200 70 9.4 1.5 730 33.2 2.5
Initiator solution	Demineralised water Potassium persulphate	120 1
Other		
Line one	Demineralised water Ter-butyl hydroperoxyde (70% aq. Sol.)	20 1.4
Line two	Demineralised water Bruggolite FF6M	20 1.2
Neutralisation	AMP 95 until pH of 8-8.5	8.3
Biocide	Parmetol K40	2

General Guidance for use of SIPOMER® PAM Monomers

	DO	DON'T
> Storage –Feedings tanks	**Do use stainless steel or plastic containers to store solutions of SIPOMER® PAM.**	Don't use iron containers that can be corroded by acidic SIPOMER® PAM releasing metal ions that could trigger the polymerization.
> High reactivity	**Do follow the order of introduction of our starting recipes. Put SIPOMER® PAM in the kettle when the reaction temperature is met. Do feed separately or in the monomer mixture/pre-emulsion.**	Don't introduce SIPOMER® PAM in the initial charge before heating. Don't mix with the solution of the initiator. This would rapidly polymerize even without heating.
> Heat stability of polymer	**Do neutralize the polymer before heating at elevated temperature (> 140° C).** **Copolymers are more stable and can be handled above 200° C. This is strongly dependent on the nature of the polymer and must be checked case by case.**	Don't heat acidic homopolymers to temperatures above 140° C.
> Hydrolytic stability	**Do keep between pH = 5 and pH = 9 for long time storage or when using at temperatures above 60° C.**	Don't use diluted SIPOMER® PAM very acidic (pH < 3) or basic (pH > 10) conditions. This would hydrolyze the ester linkage and the phosphate group.
> Corrosion	**Do neutralize with a non volatile base and add corrosion inhibitor. Keep the coating at pH > 9 for good anticorrosion properties.**	Don't use SIPOMER® PAM in acidic form when post neutralization is not possible.

SIPOMER®
Polymerizable Stabilizer

Stabilizers



	Reactive Group	Nature of Extender	« Head » group
SIPOMER® COPS	Allyl ether	Hydrophobic	Sodium Sulfonate
SIPOMER® AAE10	Allyl ether	Hydrophilic	Ethoxylate
SIPOMER® AES-100	Allyl ether	Hydrophilic	Ammonium Sulfate

SIPOMER® COPS-1 is a 40% aqueous solution of sodium 1-allyloxy-2-hydroylpropyl sulfonate:

CH2 = CH - CH2 - O - CH2 - CH(OH) - CH2 - SO3Na

Even at levels as low as 0.5 - 1.0% (based on total monomer), **SIPOMER® COPS-1** provides latex stability, such as shelf life, freeze/thaw and mechanical and chemical stability. It also provides block resistance for the final polymer.

With **SIPOMER® COPS-1**, the levels of conventional can be reduced significantly. Surfactants are key component in providing stability to latex.

However their migration to the interface causes water sensitivity to the dry polymer film.

SIPOMER® COPS-1 reacts with other reacts with other comonomers through the chemical (covalent) bond. The sulfonate group will remain at the surface of the particle providing very good stability to the latex. Since the functionality is anchored to the polymer backbone, it will not migrate after film formation and thus cannot modify interfacial properties. As a result of the reduction of conventional surfactant, the foaming tendency of the latex and the water sensitivity of the polymer film are both reduced.

Key Features

- Improve mechanical stability
- Improve thermal stability
- Improve salt stability
- Decrease need in surfactant
- Reduce foaming & water sensitivity

Applications

- Use 0.5 Wt% based on total monomer (BOTM)
- All acrylic, styrene acrylic, vinyl acrylic, vinyl VeoVA

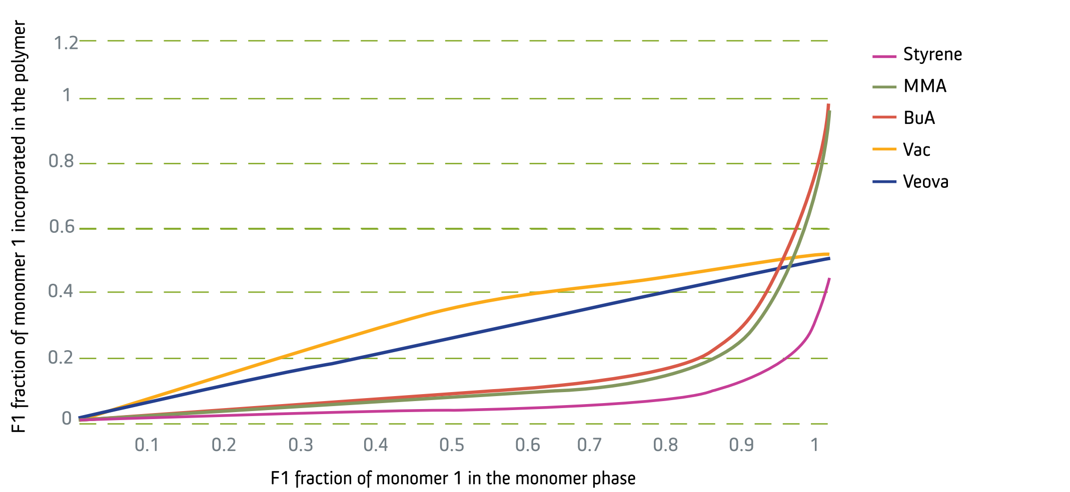
SIPOMER® COPS-1
Polymerizable Stabilizer

Reactivity Ratio Data for SIPOMER® COPS-1 (M1)

M_2	r_1	r_2
Styrene	0.0001	29.4900
Methyl Methacrylate	0.0483	19.6200
Butyl Acrylate	0.0411	15.0034
Vinyl Acetate	0.0001	1.5162
Veova 10	0.0002	3.1700

The reactivity ratio data show that the r1 values for **SIPOMER® COPS-1** are close to 0, suggesting that homopolymerization of this monomer is unlikely. There is no need for adding an inhibitor to this monomer. As shown on the Mayo representation below, the most favorable reactivity ratios were found for **SIPOMER® COPS-1** with vinyl acetate and VeoVA 10. However, **SIPOMER® COPS-1** can also work very effectively in acrylic and styrene/acrylic systems.

Mayo Curves for SIPOMER® COPS-1



SIPOMER® COPS-1
Polymerizable Stabilizer

Addition of SIPOMER® COPS-1

SIPOMER® COPS-1 improves Freeze/Thaw Stability

Latexes	Acrylic control	Acrylic with COPS-1	Styrene/acrylic control	Styrene/acrylic with COPS-1
Surfactant % BOTM	Rhodacal® DS4 1	Rhodacal® DS4 1	Rhodapex® LA40S 1.5	Rhodapex® LA40S 1.5
SIPOMER® COPS-1 % BOTM	0	0.5	0	0.5
Particle size (nm) Solids (%)	17.9 49.8	186 49.9	175 51.1	149 51.1
Freeze thaw cycles	0	5	0	5

Rhodacal DS4: Sodium dodecylbenzene sulfonate (23%)
Rhodapex LA40S: Sodium dodecyl ether sulfate; 4 EO (32%)

Freeze/thaw test
Procedure: Latex was placed in -15C conditions for 12 hours and thawed back to RT for 8 hours. Cycles were repeated 5 times.

SIPOMER® COPS-1 improves mechanical stability

Latexes	Acrylic control	Acrylic with SIPOMER® COPS-1
Surfactant % BOTM	Rhodacal® DS4 1	Rhodacal® DS4 1
SIPOMER® COPS-1 % BOTM	0	0.5
Particle size (nm) Solids (%)	179 49.8	186 49.9
Waring blender 5 minutes at 20,000 rpm	Failed	Passed

Mechanical test procedure:
Pour 200 mL of latex into a Waring blender. Mix latex at 20,000 rpm under high shear for 5 minutes. If the latex does not completely coagulate after 5 minutes of mixing, it "passes." If it coagulates within 5 minutes of mixing, it fails.

SIPOMER® COPS-1 improves chemical stability

Latexes	Acrylic Control 1	Acrylic Control 2	Acrylic with SIPOMER® COPS-1	Acrylic with nonionic surfactant
Anionic surfactant Rhodapex® LA40S (%BOTM)	1.0	1.5	1.0	1.5
Nonionic surfactant (% BOTM)	0	0	0	1.0
SIPOMER® COPS-1 (% BOTM)	0	0	0.5	0
% CaCl2 added to latex for immediate coagulation	3	6	5	5

Latex Chemical Stability:
The ability of latex to resist coagulation in the presence of salts. (Salt used is Calcium chloride)

Procedure:
Add CaCl2 at different levels to the latex until immediate coagulation is observed.
The data above should be read as follows:
CaCl2 was added (in term of weight % compared to total latex -% BOTL):
«3%» means that the system was stable at 2% of CaCl2
«6%» means that the system was stable at 5% of CaCl2

Comments:
By adding COPS-1, the chemical stability results are improved. To have the same effect in terms of chemical stability, normally non ionic surfactant is used. COPS-1 improves chemical stability without increasing the amount of free surfactant.

Substitution of surfactant by SIPOMER® COPS-1 in a latex formulation

Latexes	Acrylic control	Acrylic with SIPOMER® COPS-1
Surfactant % BOTM	Rhodacal® DS4 1.0	Rhodacal® DS4 0.5
SIPOMER® COPS-1 Particle size (nm)	0 179	0.5 196
Solids (%) Wet coagulum (% BOTL)	49.8 0.7	50.6 0.7
Freeze/Thaw cycles Mechanical stability	1 Passed	5 Passed
Foaming height (mL)	200	120

Mechanical test procedure:
Pour 200 mL of latex into a Waring blender. Mix latex at 20,000 rpm under high shear for 5 minutes. If the latex does not completely coagulate after 5 minutes of mixing, it "passes." If it coagulates within 5 minutes of mixing, it fails.

SIPOMER® COPS-3
Polymerizable Stabilizer

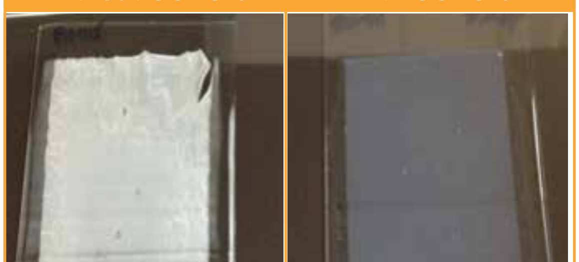
SIPOMER® COPS-3

Product Specifications	
Appearance	Transparent liquid
Active content	39.0-42.0
Color APHA	200 Max
pH (10% aqueous solution)	6.0 - 9.0
Ionic type	Anionic

Features:
- Good pigment binding power
- High PVC paints system
- Anti-corrosion properties
- Improved color acceptance
- Good stain and block resistance
- Improve adhesion to different inorganic substrate
- Applicable to most of monomers systems: SA, FA, VA, VeoVA, etc.

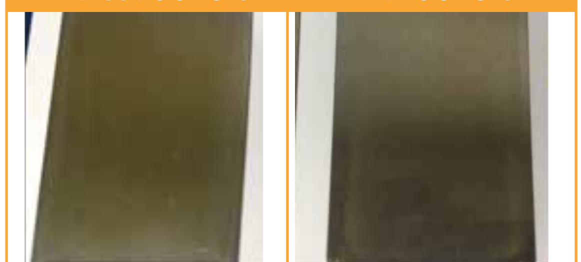
Improve Water-Resistance & Corrosion Inhibition
50wt% SA latex: 1% of Rhodapex® LA 40S; 0.5% of BOTM COPS-3

Without COPS-3 | **With COPS-3**



- Glass substrate: 100 um film
- Soaking into water for 24 hrs

Without COPS-3 | **With COPS-3**



- Substrate: Iron phosphate panel
  Curing @ room temperature, 60-70% RH

COPS-3 in Vinyl VeoVA System
- 55% Vinyl VeoVA System: VAM/VeoVA-10:70:30
- 1% BOTM of COPS-3
- 0.3% BOTM of RS610-A25 & 2% BOTM of Rhodasurf® 6530

	Commercial SA	Without COPS-3	COPS-3
Particle size (nm)	~150	262.2	238.7
75 PVC paints			
Scrub resistance	550	405	1168

*Only available in China

SIPOMER® AES 100
Copolymerizable Stabilizer

SIPOMER® AES-100

Latex	
MMA	52
BA	47
MAA	1

Particle Size: 150 nm

Surfactant	
Type	Rhodapex® LA40S
Amount in Kettle:	0.10%
Amount in Feed:	0.90%

In situ-seeded pre-emulsion

Amount of AES-100	0%	1%	1%
Way of Addition of AES-100		Feed	Kettle
Dry Grit	130 ppm	10 ppm	70 ppm
Mechanical Stability	3'	9'	9'
F/T stability	0	> 5	> 5
Calcium Stability	2%	5%	6%

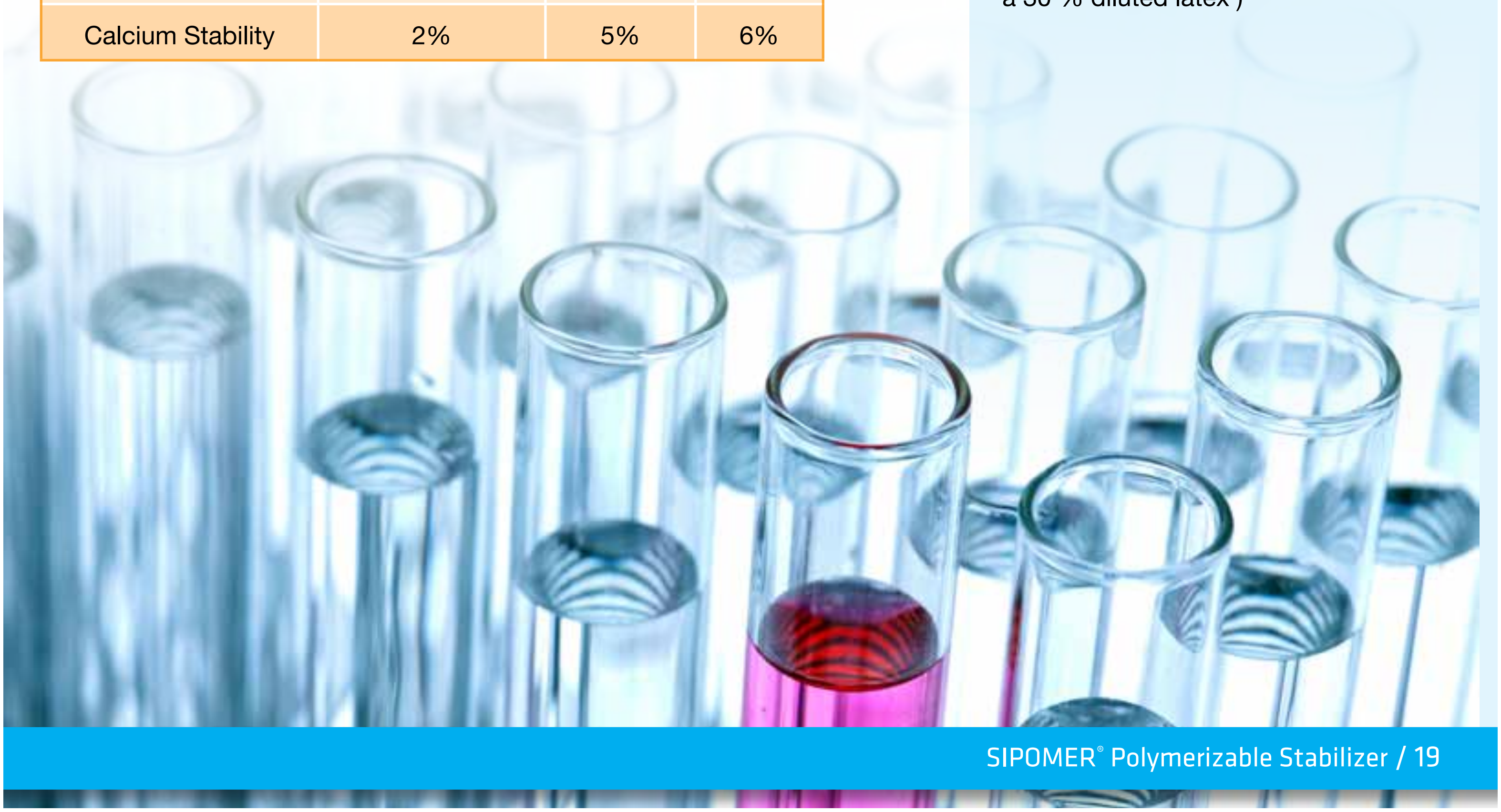
Key Benefits

- Reduce Grit
- Increase stability (mechanical, FT, chemical)

Dry Grit: Filtration on 100 micron net

Mechanical Stability: Waring Blender 22.000 rpm (time to coagulation)

Calcium Stability: CaCl2*2H2O/Dry latex ratio (concentration to coagulate a 30 % diluted latex)



SIPOMER® WAM
Wet Adhesion Monomers

"The 1% that makes the difference"

	Reactive Group	Binders
SIPOMER® WAM	Allyl Ether	Both acrylic & vinyl copolymers
SIPOMER® WAM II	Methacrylamide	Acrylics
SIPOMER® WAM E W50	Methacrylate Ester	Acrylics

Superior wet-adhesion properties

SIPOMER® WAM was custom designed to combine the benefits of amine and ureido functionalities in a single monomer. The Table below shows the synergistic effects of this combination.

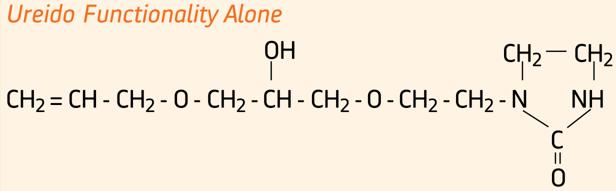
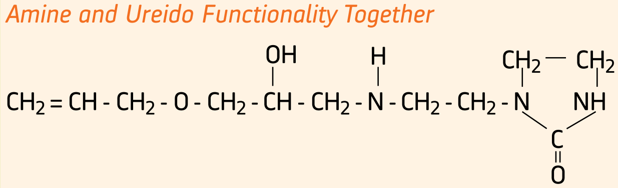
SIPOMER® WAM is incorporated into all-acrylic and vinyl-acrylic polymer systems through its allylic functionality. It provides wet adhesion in two ways:

- The ureido ring promotes interaction with the substrate via its high polarity and hydrogen bonding.
- The amine functionality provides an additional site for interaction with substrate and pigment.

SIPOMER® WAM modifies the latex binder, enabling it to wet the pigment particles more effectively, due to reduced interfacial tension.

SIPOMER® WAM into the polymer backbone greatly improves wet-adhesion of both all-acrylic and vinyl-acrylic latex paint systems for both interior and exterior applications.

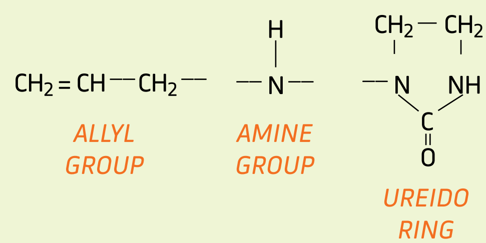
Effects of Amine and Ureido Functionalities, Alone and In Combination

Wet Adhesiopn Monomer (1 % in All-Acrylic Latex)	All-Acrylic Paint Gardner-Scrub*
Amine Functionality Alone $CH_2=CH-CH_2-O-CH_2-CH(OH)-CH_2-NH-CH_2-CH_2-CH_2-CH_3$	420
Ureido Functionality Alone 	1 280
Amine and Ureido Functionality Together 	1 500 +

* Cycles to failure

SIPOMER® WAM

Structure



Incorporation into polymer backbone through allylic functionality.

Promotion of adhesion via dual mechanism:

- *Ureido ring - promotes interaction via high polarity and hydrogen bonding*
- *Amine functionality - site for interaction with anionic substrate and pigment*

Lab tests demonstrate exceptional wet adhesion

Test after test has proven that all-acrylic and vinyl-acrylic polymers containing **SIPOMER® WAM** provide latex paints with the best and most cost-effective wet-adhesion properties available. In a Wet Pick Adhesion Test, latex with **SIPOMER® WAM** showed greater wet adhesion as indicated by the substantially smaller area of peeling. And in a Wet Adhesion Abrasion Test, the latex paint containing **SIPOMER® WAM** demonstrated outstanding wet-scrub performance.

Results of Wet Pick Adhesion Test

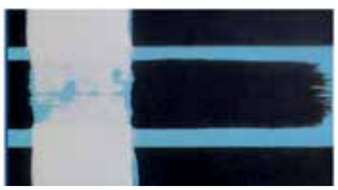
Latex paint before Wet Pick Adhesion Test.

Latex paint, without Sipomer WAM, after Wet Pick Adhesion Test.

Latex paint, with Sipomer WAM, after Wet Pick Adhesion Test.

Results of Abrasion Test

Latex paint before Wet Adhesion Abrasion Test.



Latex paint, without Sipomer WAM, after Wet Adhesion Abrasion Test.

Latex paint, with Sipomer WAM, after Wet Adhesion Abrasion Test.

SIPOMER® WAM-based paints compared to commercial products

As shown in the Table below, polymers containing **SIPOMER® WAM** were evaluated against commercial wet adhesion systems. Paints based on **SIPOMER® WAM** exhibited superior wet-adhesion properties as well as greater shelf stability and improved color stability. When effective use levels were measured, **SIPOMER® WAM** also proved to be the most cost-effective wet-adhesion promoting system available.

Gardner Scrub Test Results with SIPOMER® WAM-Based Paints Versus Commercial Standards

All-Acrylic Latexes	Edge Abrasion, Cycles	Failure, Cycles
Control	17	47
Solvay (1% WAM)	1050	1500 +
Commercial General Purpose	224	1500 +
Commercial Premium	979	1500 +

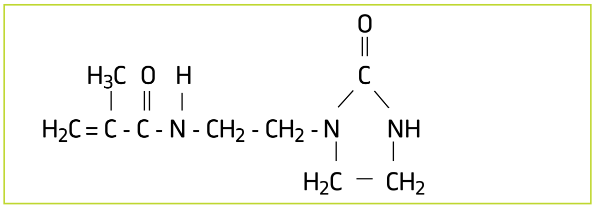
Vinyl-Acrylic Latexes	Edge Abrasion, Cycles	Failure, Cycles
Control	14	52
Solvay (1% WAM)	1000	1500 +
Commercial General Purpose	600	1500 +

SIPOMER® WAM II
Wet Adhesion Monomer

Innovative chemical structure

With **SIPOMER® WAM II**, emulsion polymerization producers can formulate products with an easy-to-use wet-adhesion monomer which is effectively polymerized in both redox and thermal processes.

MAEEU



The MAEEU advantage is its ability to easily copolymerize in all-acrylic, vinyl-acrylic and styreneacrylic latex systems.

SIPOMER® WAM II provides enhanced wet-adhesion, wet-scrub resistance and solvent resistance in a wide range of latex systems. SIPOMER® WAM II's improved performance is the result of MAEEU (methacrylamidoethyl-ethyleneurea), an advanced ureido-based adhesion promoting monomer.

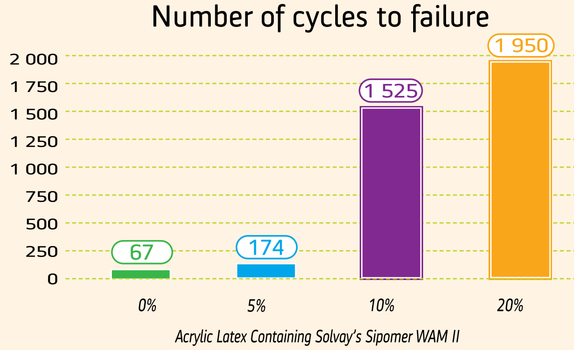
SIPOMER® WAM II in Latex Blends

In Solvay's emulsion polymerization laboratories, wet adhesion in a latex containing Sipomer WAM II blended with conventional latexes was tested. In four sample blends, increasing amounts (0%, 5%, 10% and 20%) of an acrylic latex containing Sipomer WAM II were combined with a commercial vinyl-acrylic latex.
The wet-scrub resistance was then measured in each of the four samples.

Test Results

- The bar on the left indicates the wet-scrub resistance of the pure commercial vinyl-acrylic latex. It withstood only 67 cycles until failure.
- From left to right, the bars demonstrate that by increasing the percentage of the acrylic blend latex containing Solvay's Sipomer WAM II, the number of cycles directly increases.

Wet-Scrub Resistance
Number of cycles to failure



Comparable scrub resistance is achieved when the latex containing Sipomer WAM II is used with commercial acrylic and strryene-acrylic latexes.

Dramatically improved wet-scrub resistance

Wet-Scrub Resistance Test

Results of tests conducted in Solvay's emulsion polymerization laboratories clearly validate the superior performance of latex paints which incorporate **Sipomer WAM II**.

1. Before Scrub Test

- Two flat latex paint formulations at 43% PVC were prepared and applied.
- The left strip does not contain **Sipomer WAM II**.
- The right strip does contain Solvay's advanced **Sipomer WAM II**.

Latex paint without Sipomer WAM II — Latex paint with Sipomer WAM II

2. After 85 Cycles

- Without **Sipomer WAM II**, the paint on the left fails after 85 cycles, indicating poor wet adhesion and scrub resistance.
- The **Sipomer WAM II** based paint is still intact.

Latex paint without Sipomer WAM II — Latex paint with Sipomer WAM II

3. After 2000 Cycles

- Even after 2000 cycles, Solvay's **Sipomer WAM II** demonstrates outstanding wet scrub resistance.

Latex paint without Sipomer WAM II — Latex paint with Sipomer WAM II

Similar results with SIPOMER® WAM II in semi-gloss paint

When all-acrylic latexes containing **SIPOMER® WAM II** were formulated into a semi-gloss paint at 23% PVC, improved wet-scrub resistance was demonstrated. The paint formulated without **SIPOMER® WAM II** began lifting from the substrate at 95 cycles. The paint formulated with **SIPOMER® WAM II** exhibited outstanding scrub resistance, completely covering the substrate after 2000 cycles.

SIPOMER® WAM Ester
Wet Adhesion Monomers

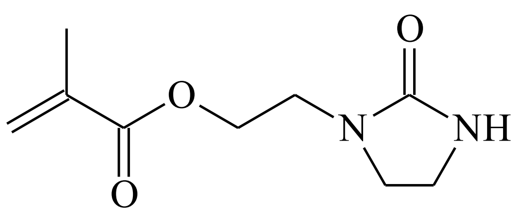
SIPOMER® WAM E Technologies

- Wet adhesion monomers for emulsion polymerization
    - Based on N-(2-Methacryloyloxyethyl) ethylene urea chemistry
    - Typical usage levels between 0.5 and 2.0 BOTM
- Primarily recommended for waterborne acrylic and styrene acrylic binder systems
    - Improve wet adhesion
    - Improve scrub resistance
- Also used in polymerizations and co-polymerizations in bulk, suspension and solution with polymers for use in plastics, leather, paper and textile industries

SIPOMER® WAM Ester

- **SIPOMER® WAM E W50**

  50 % Active in Water



- Methacrylate polymerizable group
- Ureido ring functionality for wet adhesion
- Choice of activity and diluents

Typical Properties

Property	SIPOMER® WAM E W50
Appearance	Yellowish Liquid
Gardner Color	5 max
Solids, %	48 – 52
Viscosity, cPs	50 max
Density at 25 °C, g/mL	1.00 – 1.20
MMA, %	2.0 max

Features:

- Excellent wet adhesion improvement
- Significant scrub resistance improvement
- Readily incorporated into most polymer systems
- Excellent binder conversion rate

Application Testing

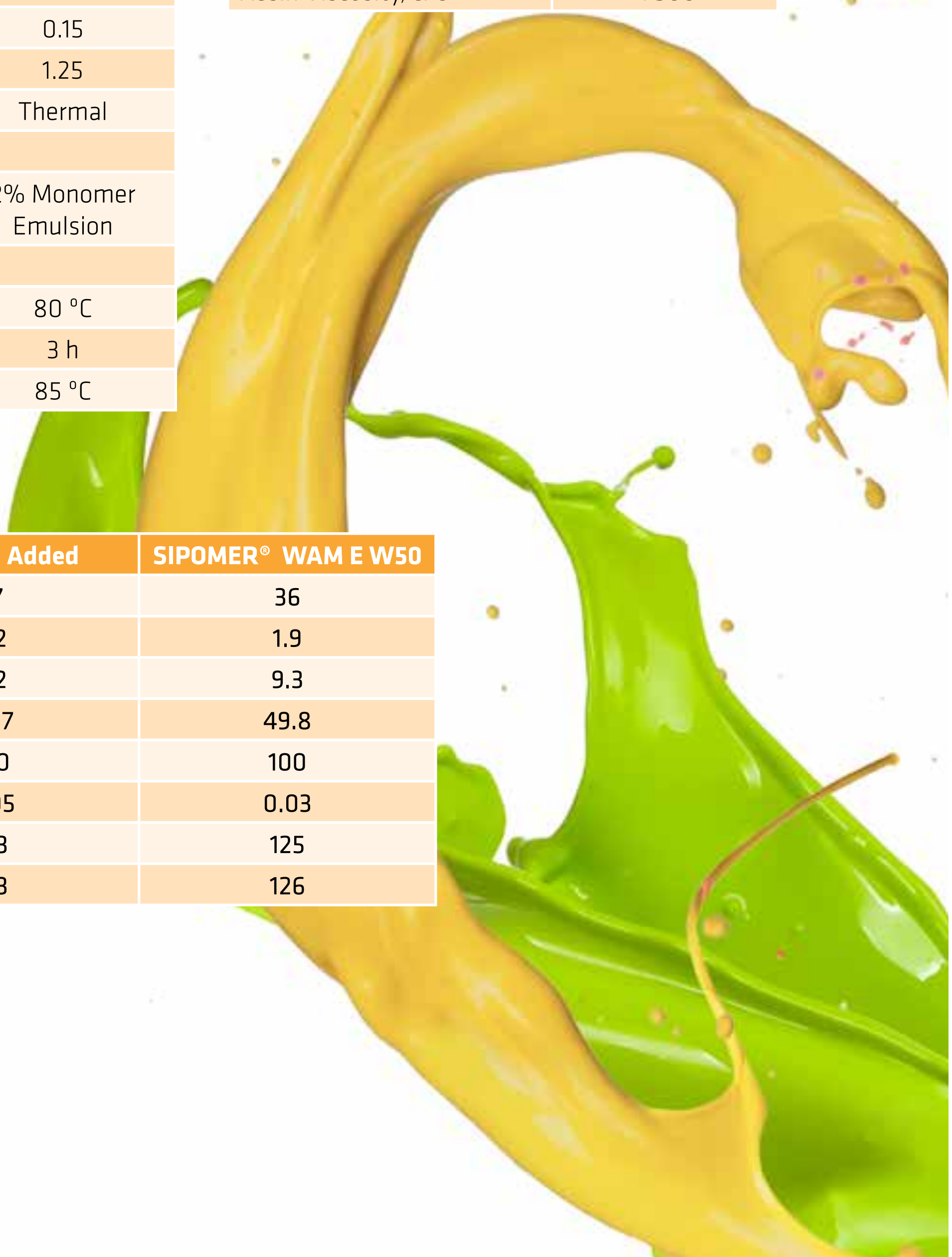
- Evaluated SIPOMER® WAM E W 50 & WAM E MMA 50 products in all-acrylic latex binder system
- Paint application test were conducted in a semi gloss all-acrylic paint system
- Tested for wet adhesion, scrub, gloss, viscosity, stability and all other paint properties

SIPOMER® WAM Ester
Wet Adhesion Monomers

All-Acrylic Emulsion Polymerization Formula

Materials	BOTM
Monomers	
MMA*	52
BA	46
MAA	1
Wet Adhesion Monomer**	1
Surfactant – Rhodacal DS-4	1
Kettle	0.15
Monomer Emulsion	1.25
Initiator System (2 % in water)	Thermal
Ammonium Persulfate	
Seed	2% Monomer Emulsion
25 % Initiator Solution	
Temperature during Monomer Addition	80 °C
Monomer Addition	3 h
Post-Monomer Addition Temperature	85 °C

Property	Target
Resin Solids	50%
Seed Particle Size	40 max
Final Particle Size	130 nm
pH	9.0 – 9.5
Dried Coagulum, %	0.25 max
Resin Viscosity, cPs	< 500



Emulsion Polymerization Results

Binder Property	No WAM Added	SIPOMER® WAM E W50
Seed Particle Size, nm	37	36
pH before neutralization	2.2	1.9
pH after neutralization	9.2	9.3
Solids, %	49.7	49.8
Conversion, %	100	100
Dried coagulum, %	0.05	0.03
Resin Viscosity, cPs	123	125
Resin Particle Size, nm	133	126

S/G Acrylic Paint Test Formula

Materials	PARTS
GRIND	
Water	6.0
Propylene Glycol	2.0
Rhodoline® 111	1.0
Rhodoline® 681F	0.2
Rhodoline® WA 100	0.2
Ti-Pure R-826	27.0
LETDOWN	
Latex	40.0
Rhodoline® 681F	0.1
Texanol	2.0
Acrysol RM-8W	0.5
Acrysol 2020 NPR	0.4
Water	20.6

Property	Target
Gloss	45 - 55
PVC	25
KU Viscosity	95 - 97
ICI Viscosity	0.8 – 1.3

Paint Test Results

Property	Blank	SIPOMER® WAM E W50
Viscosity, ON, KU	95.4	96.3
Viscosity, ON, ICI	0.84	1.13
Gloss, 20/60/85 °	13.3/50.9/78.7	11.4/47.6/76.4
Contrast Ratio	97.3	97.9
Scrub Test*		
# cycles to breakthrough	500	4752
Wet Adhesion Test**	100 %	497 %

* Scrub test results on vinyl scrub panel
** Wet adhesion Scrub Test ASTM D6900-10

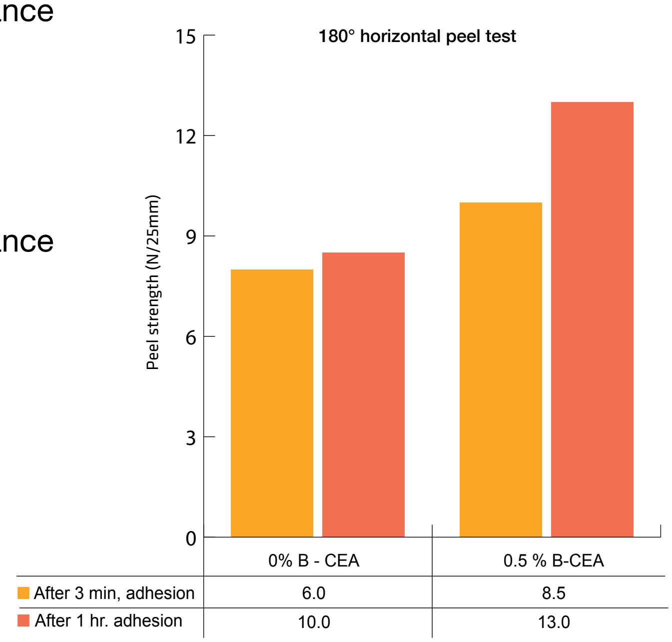
SIPOMER®
Resin Modifiers

SIPOMER® IBOA
Radiation curing resins application
- Improves toughness, chemical and abrasion resistance
- Reactive Diluent
- Radcure polymerizable

SIPOMER® IBOMA
Clear coat application
- Improves toughness, chemical and abrasion resistance
- Easily incorporated in resins (methacrylate)

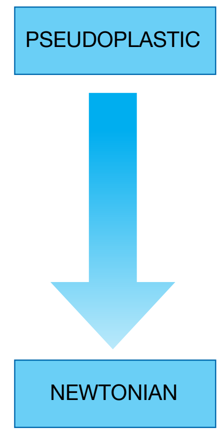
SIPOMER® ß-CEA
Adhesives application
- Lowers Tg
- Improves adhesion

"Improved peel strength"
100% Acrylic Pressure Sensitive Adhesive



SIPOMER® BEM – SIPOMER® SEM – SIPOMER® HPM series
Rheology

By combining its experience in specialty monomers and emulsion polymerization, Solvay extended the available range of specialty methacrylic esters monomer for HASE thickeners.



SIPOMER® BEM
SIPOMER® BEM delivers low shear efficiency.

SIPOMER® HPM 400
SIPOMER® HPM 400 delivers low to mid shear efficiency. SIPOMER® HPM 400 allows to easily match cellulosic thickeners profiles.

SIPOMER® HPM-100
SIPOMER® HPM 100 delivers mid shear efficiency.

SIPOMER® SEM 25
SIPOMER® SEM 25 delivers mid to high shear efficiency.

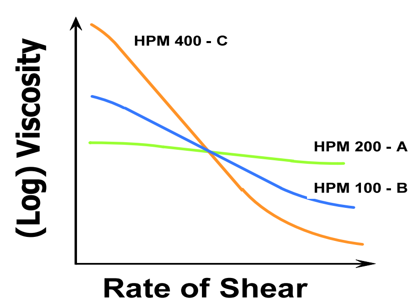
SIPOMER® HPM 200
SIPOMER® HPM 200 delivers high shear efficiency. SIPOMER® HPM 200 allows to easily match Newtonian thickeners profiles.

Solvay SIPOMER® HPMs are 50 Wt% active specialty methacrylic monomers designed to easily access desired rheology profiles. Working with SIPOMER® HPMs provides choice in profile and significant cost saving versus “generic” HASE.

Properties
Solvay SIPOMER® HPMs were incorporated in standard HASE polymer recipes and benchmarked versus well known “generic” HASE at equal viscosity (95KU) in 30 Wt% solid latex (table 1) as well as at equal use level in flat paints (table 2). While the HPM 200 based thickener presents a very performant solution as Newtonian ICI builder, the HPM 100 based HASE combines KU building and improved ICI viscosity. Whereas cellulosic replacement is targeted, HPM 400 based system offers matching profile with higher efficiency.

	Active HASE Wt%	Brookfield (cP)	ICI (P)
HPM 200 based hase - A	1.87	1400	2.55
Benchmark 1	3.17	1350	2.25
HPM 100 based hase - B	0.56	6800	0.6
Benchmark 2	0.57	4600	0.5
HPM 400 based hase - C	0.42	7600	0.25
Benchmark 3	0.36	7200	0.22
HEC	0.76	7600	0.25

Table 1: All paint latex system were adjusted to 95 (±2) KU stormer viscosity



	HPM 400 based HASE	Benchmark 3	HPM 100 based HASE	Benchmark 2	HPM 200 based HASE	Benchmark 1
Usage (Wt% Active)	0.5	0.5	0.5	0.5	1.6	1.6
Equilibrium Stormer Viscosity (KU)	78.6	83.5	100.6	94.6	100.3	113.4
Equilibrium ICI (P)	0.7	0.6	1	1	2.05	1.5
Gloss, 20° / 60° / 85°	1.3/2.4/5.9	1.3/2.3/5.5	1.3/2.4/6.1	1.3/2.5/7.1	1.3/2.6/7.8	1.3/2.5/7.0
	Used as KU builders				Used as ICI builders	

Table 2: SIPOMER® HPMs based HASE bench marked at equal use level in a flat paint formula

SIPOMER® Product Performance

Trade name	% of Solid	Tg (°C)	% Water	Inhibitor ppm	Specific gravity	Intern			
						US (TSCA)	Canada (DSL)	Europe+ (EINECS)	Australia (AICS)
Adhesion and Much More									
SIPOMER® PAM-100	100	-18	<1	MEHQ/~5000	1.2	●	–	●	●
SIPOMER® PAM-200	100	0	<1	MEHQ/~5000	1.1	●	–	●	●
SIPOMER® PAM-300	100	-40	<1	MEHQ/~5000	1.1	●	–	●	–
SIPOMER® PAM-4000	100	ND	<0.25	MEHQ/~400	1.2	●	●	●	●
SIPOMER® PAM 5000	100	NA	1.0 max	none	1.25	●	–	●	–
Polymerizable Stabilizers									
SIPOMER® COPS-1	–	NA	60	none	1.17	●	●	●	●
SIPOMER® COPS-3*	25	NA	75	none	–	–	–		–
SIPOMER® AES-100	97	NA	<2.0	none	1.0	●	–	●	–
SIPOMER® AAE-10	99	NA	<0.3	none	–	●	●	●	●
Resin Modifiers									
SIPOMER® IBOA	100	94	<0.05	MEHQ/112	0.985	●	●	●	●
SIPOMER® IBOMA	100	110	<0.05	MEHQ/108	0.983	●	●	●	●
SIPOMER® B-CEA	30*	37	0.5	MEHQ/1000	1.2	●	●	●	●

+ Availability is based on REACH status

ND – not determined
NA – not applicable

* Asia - Latin America - MEA
* Remainder consists of acrylic acid (~20%) and higher adducts (~50%)

** SIPOMER® BEM contains ~25% methacrylic acid
*** SIPOMER® SEM-25 contains ~20% methacrylic acid
**** SIPOMER® WAM II-25 contains ~25% methacrylic acid

al Inventory Status

South Korea (KECL)	Japan (MIT)	China (JECSC)	Philippines (PICCS)	New Zealand (NZIoC)	Performance Features and Application
●	—	●	—	●	— Improved adhesion on metal, glass, and other inorganic substrates — High mono/di alkyl phosphate ratio and low resididual acid — Improved latex stability
●	—	●	—	—	— Improved adhesion on metal, glass, and other inorganic substrates — Excellent compatibility with most common organic systems — High mono/di alkyl phosphate ratio and low resididual acid — Improved anti-corrosion properties
—	—	●	—	—	— Improved adhesion on metal, glass, and other inorganic substrates — Excellent compatibility with most common organic systems — High mono/di alkyl phosphate ratio and low resididual acid — Improved anti-corrosion properties — Polymerizable surfactant
●	—	●	●	●	— Improved adhesion on metal substrate — Improved latex stability — Improved gloss
—	—				Improved scrub resistance when formulated into vinyl binders for high PVC paints
●	●	●	●	●	Reactive co-stabilizer providing: — Low foaming latexes — Better latex stability at low surfactant dosage — Coatings with improved water and bleach resistance
—	—	●	—	—	Reactive co-stabilizer providing scrub/washability for high PVC coating formulation
—	—	—	—	—	Reactive co-stabilizer providing: — Low foaming latexes — Better latex stability at low surfactant dosage — Coatings with improved water and bleach resistance
●	●	●	●	●	Non ionic reactive co-stabilizer — Low foaming latexes — Better latex stability at low surfactant dosage — Coatings with improved water and bleach resistance
●	●	●	●	●	High Tg hydrophobic monomer providing: —Improved chemical and water resistance — Better gloss and better mar resistance — An excellent radiation curable reactive diluent
●	●	●	●	●	High Tg hydrophobic monomer providing: — Improved chemical and water resistance — Better gloss and better mar resistance — Lower viscosity in high solid solvent based resin systems
●	●	●	●	●	Low Tg acidic monomer: — Effective adhesion promoter for resins used in coatings and adhesives — Improved peel strength for adhesives

International Inventory Status Codes

● Listed | — Not Listed

SIPOMER® Product Performance continued

Trade name	% of Solid	Tg (°C)	% Water	Inhibitor ppm	Specific gravity	US (TSCA)	Canada (DSL)	Europe+ (EINECS)	Australia (AICS)
						Interna			
Rheology									
SIPOMER® BEM	50**	ND	25	MEHQ/1000	1.06	●	●	●	–
SIPOMER® SEM-25	60***	ND	20	MEHQ/600	1.07	●	●	●	–
SIPOMER® HPM 100	50	ND	50	MEHQ/1000	1.06	●	●	●	●
SIPOMER® HPM 200	50	ND	50	MEHQ/1000	1.06	●	●	●	●
SIPOMER® HPM 400	50	ND	50	MEHQ/1000	1.06	●	●	●	–
Wet Adhesion									
SIPOMER® WAM	90		10	none	1.15	●	●	●	–
SIPOMER® WAM II	50***	87	30	HQ/1800	1.11	●	●	●	●
SIPOMER® WAM E W50	50	ND	50	TEMPO 250 and HQ 750 ppm	1.100	●	–	–	●

+ Availability is based on REACH status
ND – not determined

* Asia - Latin America - MEA
* Remainder consists of acrylic acid (~20%) and higher adducts (~50%)
** SIPOMER® BEM contains ~25% methacrylic acid
*** SIPOMER® SEM-25 contains ~20% methacrylic acid
**** SIPOMER® WAM II-25 contains ~25% methacrylic acid

Recommended product formulations

Product	Starting Formulations
>SIPOMER® COPS-1	Acrylic Latex Formulation: 0.5% Anionic Surfactant/0.5% Sipomer COPS-1 (1% BOTL) Styrene/Acrylic Latex Formulation: 1.5% Anionic Surfactant/0.5% Sipomer COPS-1 Acrylic Synthesis (52 MMA/46.5 BA/1.0 MAA/0.5 Sipomer COPS-1)
>SIPOMER® PAM-100	Latex Synthesis: Acrylic Copolymer with 2% Sipomer PAM-100 Styrene Acrylic Latex Recipe with 1% Sipomer PAM-100 Vinyl Acetate/Acrylic Latex with Sipomer PAM-100
>SIPOMER® PAM-200	Latex Synthesis: Acrylic Latex Recipe with 1% Sipomer PAM-200 Acrylic Polyol Recipe
>SIPOMER® WAM	Thermal All-Acrylic Process Thermal Styrene-Acrylic Process Redox Vinyl-Acrylic Process (80 VAc/19 BA/1 WAM)
>SIPOMER® WAM-II	All-Acrylic Blend Latex, Thermal Process (51 MMA/46.1 BA/0.9 MAA/2 MAEEU) All-Acrylic Thermal Process (52 MMA/46 BA/1 MAA/1MAEEU) Styrene-Acrylic Thermal Process (45 S/53.2-EHA/1 MAA/1 MAEEU) Vinyl-Acrylic Thermal Process (80 VAc/18.5 BA/0.5 MAA/1 MAEEU) Thermal Vinyl-Veova 10 Process (70.0 VA/28.5 V-10/0.5 MAA/1 MAEEU)

l Inventory Status					
South Korea (KECL)	Japan (MIT)	China (JECSC)	Philippines (PICCS)	New Zealand (NZIoC)	Performance Features and Application
●	—	●	●	●	Specialty monomer design for low shear HASE polymer
—	—	●	—	●	Specialty monomer design for mid to high shear HASE polymer
●	—				Specialty monomer design for mid shear HASE polymer
—	●				Specialty monomer design for newtonian HASE polymer
●	—				Specialty monomer design for low to mid shear HASE polymer
—	—	—	—	●	Wet adhesion monomer for latex paints
●	●	●	●	●	Wet adhesion monomer for latex paints
—	●	●	—	●	Wet adhesion monomer for latex paints

International Inventory Status Codes

● Listed | — Not Listed

For technical data sheets and other products, visit our website: www.solvay.com

SOLVAY Way
The way we do business

Solvay puts into practice a sustainable development policy called **Solvay Way** because we are convinced our future is dependent upon the responsible way in which we conduct our current activities — a way that reflects our commitment to each of our stakeholders. **Solvay Way** encompasses three interlinked, equally important spheres: the Environment Sphere, the People Sphere and the Economic Sphere.

Based on a framework of responsibilities, **Solvay Way** allows Solvay sites and businesses to conduct self—assessments of their practices and establish action plans that promote continuous progress. At Solvay, the way we do business creates sustainable value for all our stakeholders through innovation and partnership.

> Responsible Care is the chemical industry's voluntary continuous improvement initiative to promote safe handling of products. (1987)

> The UN's Global Compact aims to ensure that heads of companies promote and uphold 10 universal principles concerning human rights, Working Conditions, Respect for the environment and anti—corruption. (2003)

> The International Federation of Chemical, Energy, Mine and General Workers' Unions. (2005)

> Solvay Novecare has achieved world—wide ISO—9001 Quality Management System Multi—Site Certification. (2008)

SOLVAY
asking more from chemistry®

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Material Safety Data Sheets (MSDS) are available by emailing us or contacting your sales representative. Always consult the appropriate MSDS before using any of our products.

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