A New Self-Crosslinking Acrylic Late
Garage Floor and Masonry Applicati

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With increased market demands for lower-VOC coatings, formulators face challenges with providing customers with products that meet their expectations. One such challenge is in horizontal masonry and garage floor-type coatings. These coatings must resist common chemicals (such as gasoline, brake fluid, transmission fluid, motor oil, cleaners, etc.), be abrasion resistant, and have hot-tire resistance to prevent peeling and tire stains. In this article, we discuss a new fast-cure self-crosslinking epoxy modified acrylic copolymer latex that can be formulated into <50 g/L VOC coatings. These coatings meet the demands required for garage floor and other horizontal masonry applications (both clear and pigmented).

GARAGE FLOOR COATING CHALLENGES

Garage floor coating formulators have two coating types to offer their customers. A two-component (2K) coating, which consist of a formulated coating base and an external hardener (crosslinker), or a one-component (1K) coating, which consists solely of a formulated base. Two-component garage floor coatings have been the norm in high performance areas, which provide a crosslinking mechanism for improved chemical, stain, and abrasion resistance. These coatings do have shortcomings though, such as slow cure time, limited potlife, and the need for a hardener to be added before application. One-component garage floor coatings have the advantage of no external hardener, faster cure time, and long-term potlife. The challenge with 1K coatings is achieving long-term adhesion to the garage floor and resistance to chemicals and stains. A 1K garage floor coating that performs like a 2K one is very desirable for garage floor coating suppliers.

LATEX DESIGN CHALLENGES

As new regulations trend toward lower VOCs, latex design has become more important. Solvent-based garage floor paints, once the norm, have been supplanted with water-based systems in most areas of DIY and low- to medium-demand maintenance applications. This has put more requirements on the formulator to develop cost-effective coatings that meet VOC regulations and the customers' expectations of durability.

To meet the reduced VOC regulations, latex suppliers have developed lower glass transition temperature (T_g) latexes that have low minimum film forming temperatures (MFFT). These latexes require less coalescent solvents, thereby lowering VOCs. The disadvantage with these latexes is that formulated paints are softer and more prone to blocking, chemical degradation, and indentation from heavy objects. Several approaches have been used to help improve the physical properties of formulated coatings made with these softer latexes.

One such approach involves blending hard and soft latexes to improve the previously mentioned physical properties. This technique offers the low film forming temperature of the soft latex and the blocking and indentation resistance of the hard latex. The disadvantage of these blends is that more coalescing solvent is still needed for adequate MFFT, and optimum properties may not be met.

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A second approach is the introduction of crosslinking sites to the latex. The amount and type of crosslinking can have a major effect on the properties of a formulated coating. Although crosslinking can improve chemical, blocking, and indentation resistance, it can also lead to other undesirable properties. These include brittleness, limited elongation, and film-forming anomalies.

A new approach has been developed that involves using a self-crosslinkable epoxy modified acrylic copolymer latex.* This latex can be formulated into <50 g/L VOC 1K garage floor coatings with excellent physical and application properties. The coating has been tested extensively and the results are reviewed in *Table 1*.

EXPERIMENTAL

An initial benchmarking study was performed on seven commercial 1K and three commercial 2K water-based epoxy garage floor coatings. Two commercial 1K (a top-performing and an average-performing) and the top-performing commercial 2K water-based garage floor coatings were tested against a formulated garage floor coating made with the new self-crosslinking epoxy modified acrylic copolymer latex. Each coating was prepared and applied per manufacturers' instructions. The physical characteristics of all four formulated coatings are listed in *Table 2*.

Hot-Tire Resistance

Two coats of each tested product were applied with a foam brush to 4 x 6 in. concrete blocks, allowing four hours' dry time between each application. After the final coat, the blocks were dried at ambient conditions for 24 and 72 h before testing. For the hot-tire test, 1 x 6 in. pieces of tire tread (Goodyear Eagle RS-A) were heated in an oven set at 60°C and in a 60°C water bath for two hours. A tire tread from each heated method was immediately placed on each of the coated concrete blocks. A wooden block was then placed over the two tire pieces and the whole assembly placed in a 125 psi press for one hour. Then, the pressure was released slowly and the tire treads removed from the coated blocks. The blocks were washed and rated on staining, tire tread imprint, and adhesion of the coating to the blocks (delamination of coating from the cement block during tire removal). After initial ratings, the blocks were washed with soap and water and then re-rated. The ratings are based on a (0–5) scale with 5 being no effect and 0 being significant effect.

Chemical Resistance

Two coats of each coating were applied with a foam brush to 4 x 6 in. concrete blocks, allowing four hours' dry time between coats. After the final coat, the blocks were dried at ambient conditions for 24 and 72 h before testing. Two drops of each chemical were applied to the coated concrete blocks and covered with a watch glass for one hour. After the one hour, the chemicals were wiped off; cleaned with a mild soap solution; and rated for stain, blushing, and softening of the coating.

Cure Time

Each coating was drawn down on a Leneta card with a 6-mil drawdown bar and tested for dry-to-touch time, dry-hard time, and dry-through time per ASTM D 1640-83 test method.

Adhesion to Concrete

Two coats of each coating were applied with a foam brush to 4 x 6 in. concrete blocks, allowing four hours' dry time between coats. After the final coat, the blocks were dried at ambient conditions for 24 h before testing. Crosshatch adhesion testing was performed on the dry coated blocks per ASTM D 3359 test method. After dry adhesion testing, the coated blocks were submerged in water for 24 h, dried for five minutes, and tested for adhesion per ASTM D 3359 test method and scratched with a penny to see if the coating was removed.

Adhesion to Unglazed Tile

Each coating was applied with a foam brush to an unglazed red quarry tile and allowed to dry for one week at ambient conditions. Crosshatch adhesion per ASTM D 3359 and pull-off adhesion per ASTM D 4541 were performed on each coated unglazed red quarry tile.

Taber Abrasion

Two coats of each coating were applied by a 6-mil drawdown bar to a Leneta card, with 24 h dry time between each coating. After final coat, the coated

*Developed by OMNOVA Solutions.

TABLE 1—New Self-Crosslinking Acrylic Latex Physical Properties

PH	8–9
TOTAL SOLIDS, %	47–49
BROOKFIELD VISCOSITY	<300 cPs
MFFT, °C	7–9
SPECIFIC GRAVITY	1.03–1.06

TABLE 2—Physical Characteristics of Benchmarked Garage Floor Coatings

COATING PHYSICAL CHARACTERISTICS	NEW ACRYLIC LATEX GARAGE FLOOR COATING	COMMERCIAL PRODUCT A	COMMERCIAL PRODUCT B	COMMERCIAL PRODUCT C
COATING TYPE	1K	1K	1K	2K
VOC (g/L)	<50	<50	< 50	<100
% SOLIDS	48.3	42.4	35.1	65
GLOSS (60°)	16	8.5	17.2	74
BROOKFIELD VISCOSITY (cPs)	90	94	102	122
INTERIOR/EXTERIOR	INTERIOR/EXTERIOR	INTERIOR/EXTERIOR	INTERIOR/EXTERIOR	INTERIOR

Leneta cards were dried at ambient conditions for three days before testing. The coated cards were weighed and tested on a Taber 5131 Abraser per ASTM D 4060. The test conditions were CS10 abrading wheel, 1 kg load, 500 cycles, and 70% vacuum level. The coated charts were reweighed after testing to determine weight loss.

Hardness

Each coating was applied by a 6-mil drawdown bar anodized aluminum QUV panels and allowed to dry at ambient conditions for 72 h. After drying, the coated panels were measured for pencil hardness per ASTM D 3363 test method. Hardness is rated in the following scale, from hardest to softest: 9H, 8H, 7H, 6H, 5H, 4H, 3H, 2H, H, F, HB, B, 1B, 2B, 3B, 4B, 5B, 6B, 7B, 8B, 9B.

UV Resistance

A clear coating of the new acrylic latex garage floor coating was applied with a 6-mil drawdown bar to an anodized aluminum QUV panel and allowed to dry for three days. The panel was then put in a QUV Weather-Ometer for 10,000 h. After the 10,000-h exposure was complete, the coated panel was removed from the QUV, inspected for coating defects, and the color difference measured between the initial and exposed panel using a HunterLab ColorEye.

DISCUSSION

A formulated garage floor coating made with the new self-crosslinking epoxy modified acrylic copolymer latex was benchmarked against the top-performing commercial 1K and two top-performing commercial 2K water-based garage floor coatings. The benchmark test results are discussed in the following.

Hot-Tire Resistance

For the four garage floor coatings tested, the hot-tire resistance test data and test blocks for the 24-h cure are shown in *Table 3* and *Figure 1*, and the 72-h cure data are shown in *Table 4* and *Figure 2*. This test is used to mimic a car being pulled into the garage after a trip on a

A new approach has been developed that involves using a self-crosslinkable epoxy modified acrylic copolymer latex. This latex can be formulated into <50 g/L VOC 1K garage floor coatings with excellent physical and application properties.

TABLE 3—24-Hour Cure Hot-Tire Resistance Test Data

RATINGS	ACRYLIC LATEX GARAGE FLOOR COATING	COMMERCIAL PRODUCT A	COMMERCIAL PRODUCT B	COMMERCIAL PRODUCT C
COATING TYPE	1K	1K	1K	2K
WET HOT TIRE				
STAIN, INITIAL	3	3	3	3
STAIN, CLEANED	4	3.5	0 (COATING WASHED OFF)	4
TIRE IMPRINT, INITIAL	3	3	3	2
TIRE IMPRINT, CLEANED	4	3	0 (COATING WASHED OFF)	2
ADHESION, INITIAL	5	0	0	5
ADHESION, CLEANED	5	0	0 (COATING WASHED OFF)	5
DRY HOT TIRE				
STAIN, INITIAL	4.5	4	4.5	4
STAIN, CLEANED	4.5	4	0 (COATING WASHED OFF)	4.5
TIRE IMPRINT, INITIAL	4	4	4.5	2.5
TIRE IMPRINT, CLEANED	4.5	4.5	0 (COATING WASHED OFF)	2.5
ADHESION, INITIAL	5	5	5	5
ADHESION, CLEANED	5	5	0 (COATING WASHED OFF)	5

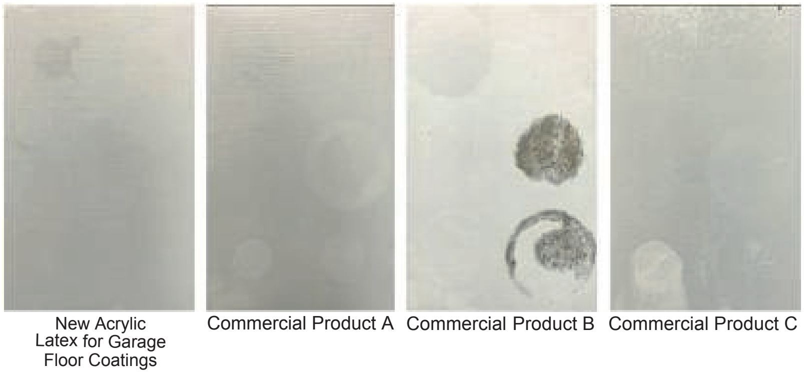
FIGURE 1—24-hour cure hot-tire resistance test blocks.

TABLE 4—72-Hour Cure Hot-Tire Resistance Test Data

RATINGS	ACRYLIC LATEX GARAGE FLOOR COATING	COMMERCIAL PRODUCT A	COMMERCIAL PRODUCT B	COMMERCIAL PRODUCT C
COATING TYPE	1K	1K	1K	2K
		WET HOT TIRE		
STAIN, INITIAL	3	3	3	3
STAIN, CLEANED	4	4	0 (COATING WASHED OFF)	4
TIRE IMPRINT, INITIAL	3	3	3	2
TIRE IMPRINT, CLEANED	4	3	0 (COATING WASHED OFF)	2
ADHESION, INITIAL	5	0	0	5
ADHESION, CLEANED	5	0	0 (COATING WASHED OFF)	5
		DRY HOT TIRE		
STAIN, INITIAL	4.5	4.5	4.5	4
STAIN, CLEANED	4.5	4.5	0 (COATING WASHED OFF)	4.5
TIRE IMPRINT, INITIAL	4	4.5	4.5	3.5
TIRE IMPRINT, CLEANED	4.5	4.5	0 (COATING WASHED OFF)	4
ADHESION, INITIAL	5	5	5	5
ADHESION, CLEANED	5	5	0 (COATING WASHED OFF)	5

FIGURE 2—72-hour cure hot-tire resistance test blocks.

FIGURE 3—24-hour cure chemical resistance test blocks.



hot day and then exiting the garage after the coating has cured for 24 h and 72 h. The data show that the new acrylic latex garage floor coating had excellent adhesion to the concrete, and no tire imprint was left after the pressure was removed. Slight staining from the tire was seen, but most of the staining could be washed away with a mild soap and water solution. The 1K commercial product A and B both showed adhesion loss on the wet hot-tire resistance test, and more staining and tire imprint when compared to the new acrylic garage floor coating after 24-h and 72-h cure. The imprint did recover slightly, but could still be clearly seen even after a week at ambient conditions. The commercial product C showed significant tire imprint after 24-h and 72-h cure and did not recover even after three months at ambient conditions.

Chemical Resistance

The chemical resistance test data for the 24-h cure are shown in *Table 5* and *Figure 3*, while results of 72-h cure are shown in *Table 6* and *Figure 4*. The chemicals tested were gasoline, transmission fluid, brake fluid, motor oil, Formula 409, and radiator fluid *(see Figure 5)*. Gasoline, brake fluid, and Formula 409 tend to be the harshest chemicals used in this test. The new acrylic latex garage floor coating showed excellent stain and softening resistance, especially with brake fluid. Its performance exceeded all 1K and 2K commercial products that were tested. After 30 min, the coating did recover to its original hardness and adhesion with no long-term effects. Gloss differences could be seen when the chemicals were removed and the blocks viewed at an angle. No color difference was seen between tested and untested areas when measured by a HunterLab ColorEye spectrometer. These glossy areas did fade with time.

Cure Time

Table 7 shows the results of the Cure Time test performed on the four garage floor coatings. The new acrylic latex garage floor coating significantly outperforms all coatings tested for speed of cure, especially against the 2K system.

Quicker cure times help shorten recoat times and allow earlier return to service for the garage floor. Potlife is the time period that the product should be used within. For 2K coatings, the potlife begins when the hardener is added to the base. After the potlife is reached, any leftover material should be discarded. It can be seen from the above data that the 1K systems have unlimited potlife, while the commercial 2K system must be used within two hours for commercial product C.

Adhesion to Concrete

Table 8 shows the results for coating adhesion to concrete for the four garage floor coatings that were tested. Adhesion to concrete is the most important attribute of a garage floor coating. The new acrylic latex garage floor coating had excellent adhesion to concrete and performed better at dry crosshatch adhesion than the commercial product A and B. It was also on par with commercial product C. The new acrylic latex garage floor coating also had very good adhesion to concrete after the coated block was soaked in water for 24 h. No coating defects (delamination, blistering, blushing, etc.) were observed after removal from the water.

These coatings were also applied to a freshly cleaned concrete pad near the entrance of a parking lot. The coatings were applied per manufacturers' instructions and allowed to cure at ambient conditions for three days before the entrance was put back into service. More than 50 cars travel in and out of this parking lot daily, along with heavy trucks and snow plows. This parking lot is not covered and sees full exposure to the elements. Salt is also laid down when needed. After three months, all commercial 1K coatings showed 75% coating loss, while the 2K coatings showed no loss. The new acrylic latex garage floor coating shows no coating loss after five months, and its performance was on par with the 2K systems tested. Pictures of the new acrylic latex garage floor coating that was applied to the pad five months earlier, both before and after cleaning, are shown in *Figures* 6 and 7.

TABLE 5—24-Hour Cure Chemical Resistance Test Data

STAINING AGENT	ACRYLIC LATEX GARAGE FLOOR COATING	COMMERCIAL PRODUCT A	COMMERCIAL PRODUCT B	COMMERCIAL PRODUCT C
COATING TYPE	1K	1K	1K	2K
ONE-HOUR EXPOSURE				
GASOLINE (STAIN): (SOFTENING):	4 3	4 3	0 (COATING WASHED OFF) 0 (COATING WASHED OFF)	3 4
BRAKE FLUID (STAIN): (SOFTENING):	5 4	3 2	0 (COATING WASHED OFF) 0 (COATING WASHED OFF)	2 2
TRANSMISSION FLUID (STAIN): (SOFTENING):	5 5	5 5	0 (COATING WASHED OFF) 0 (COATING WASHED OFF)	5 5
MOTOR OIL (STAIN): (SOFTENING):	5 5	5 5	0 (COATING WASHED OFF) 0 (COATING WASHED OFF)	5 5
ANTIFREEZE (STAIN): (SOFTENING):	5 5	3.5 3	0 (COATING WASHED OFF) 0 (COATING WASHED OFF)	4 3
FORMULA 409 (STAIN): (SOFTENING):	5 5	3.5 3	0 (COATING WASHED OFF) 0 (COATING WASHED OFF)	4 4

TABLE 6—72-Hour Cure Chemical Resistance Test Data

STAINING AGENT	NEW ACRYLIC LATEX GARAGE FLOOR COATING	COMMERCIAL PRODUCT A	COMMERCIAL PRODUCT B	COMMERCIAL PRODUCT C
COATING TYPE	1K	1K	1K	2K
ONE-HOUR EXPOSURE				
GASOLINE (STAIN): (SOFTENING):	4 3	4 3	0 (COATING WASHED OFF) 0 (COATING WASHED OFF)	4 3
BRAKE FLUID (STAIN): (SOFTENING):	4 4	3 3	0 (COATING WASHED OFF) 0 (COATING WASHED OFF)	2 3
TRANSMISSION FLUID (STAIN): (SOFTENING):	5 5	5 5	0 (COATING WASHED OFF) 0 (COATING WASHED OFF)	5 5
MOTOR OIL (STAIN): (SOFTENING):	5 5	5 5	0 (COATING WASHED OFF) 0 (COATING WASHED OFF)	5 5
ANTIFREEZE (STAIN): (SOFTENING):	5 5	4 3	0 (COATING WASHED OFF) 0 (COATING WASHED OFF)	5 5
FORMULA 409 (STAIN): (SOFTENING):	5 5	3 3	0 (COATING WASHED OFF) 0 (COATING WASHED OFF)	5 4

TABLE 7—Cure Time Test Data

STAINING AGENT	NEW ACRYLIC LATEX GARAGE FLOOR COATING	COMMERCIAL PRODUCT A	COMMERCIAL PRODUCT B	COMMERCIAL PRODUCT C
DRY-TO-TOUCH TIME	<30 MIN	<45 MIN	<45 MIN	> 4 H
DRY-HARD TIME	<30 MIN	<60 MIN	~ 45 MIN	> 4 H
DRY-THROUGH TIME	<30 MIN	~ 60 MIN	~ 60 MIN H	> 4 H
POTLIFE	UNLIMITED	UNLIMITED	UNLIMITED	< 2 H

TABLE 8—Adhesion to Concrete Test Data

TEST METHOD	ACRYLIC LATEX GARAGE FLOOR COATING	COMMERCIAL PRODUCT A	COMMERCIAL PRODUCT B	COMMERCIAL PRODUCT C
COATING TYPE	1K	1K	1K	2K
DRY CROSSHATCH ADHESION	5B	3B	1B	5B
24-H WATER SOAK CROSSHATCH ADHESION	4B	5B	1B	5B
24-H WATER SOAK COIN SCRATCH	NO COATING REMOVAL	SLIGHT COATING REMOVAL	COATING REMOVED	NO COATING REMOVAL

FIGURE 4—72-hour cure chemical resistance test blocks.

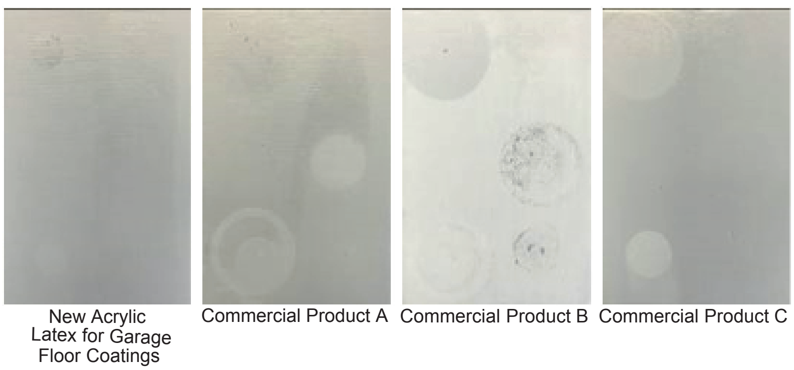


FIGURE 6—New acrylic latex garage floor coating applied to concrete pad after five months (uncleaned).

FIGURE 5—Chemical resistance test legend.

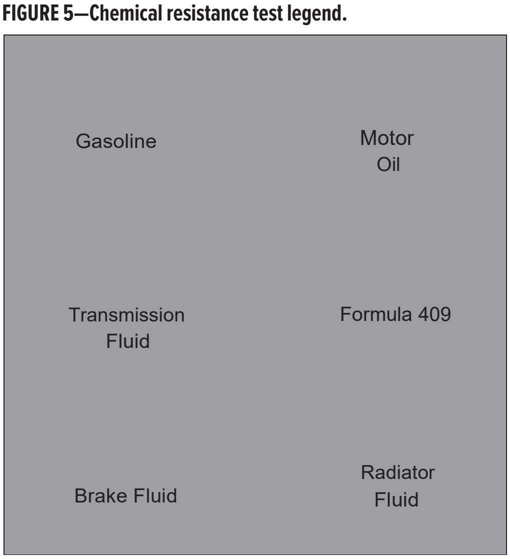


FIGURE 7—New acrylic latex garage floor coating applied to concrete pad after five months (cleaned).

TABLE 9—Adhesion to Red Quarry Tile Test Data

TEST METHOD	ACRYLIC LATEX GARAGE FLOOR COATING	COMMERCIAL PRODUCT A	COMMERCIAL PRODUCT B	COMMERCIAL PRODUCT C
COATING TYPE	1K	1K	1K	2K
DRY CROSSHATCH ADHESION	5B	3B	5B	5B
PULL-OFF ADHESION (PSI)	2333	1981	1944	2116

TABLE 10—Taber Abrasion Test Data

	ACRYLIC LATEX GARAGE FLOOR COATING	COMMERCIAL PRODUCT A	COMMERCIAL PRODUCT B	COMMERCIAL PRODUCT C
COATING TYPE	1K	1K	1K	2K
WEIGHT LOSS	15 MG	45 MG	20 MG	16 MG

TABLE 11— Hardness Test Data

	ACRYLIC LATEX GARAGE FLOOR COATING	COMMERCIAL PRODUCT A	COMMERCIAL PRODUCT B	COMMERCIAL PRODUCT C
COATING TYPE	1K	1K	2K	2K
PENCIL HARDNESS	H	B	2H	2H

TABLE 12—UV Exposure Data

NEW ACRYLIC LATEX GARAGE FLOOR COATING				
CIE L*a*b*	ΔL*	Δa*	Δb*	ΔE*
COLOR DIFFERENCE	0.86	-0.15	-0.07	1.09

Adhesion to Red Quarry Tile

Adhesion for the four garage floor coatings to red quarry tile is shown in *Table 9*. Red quarry tile is used because its physical properties and cohesive strength are more consistent than the cement blocks used for testing. The new acrylic latex garage floor coating showed excellent adhesion to the red quarry tile as tested by crosshatch and pull-off adhesion, and the adhesion is on par with the 2K systems tested.

Taber Abrasion

All four garage floor coatings were tested for abrasion resistance and the results are listed in *Table 10*. This test helps predict wear resistance of the coating, especially from abrasive materials. The new acrylic latex garage floor showed excellent abrasion resistance, and its performance was on par with the commercial 2K tested.

Hardness

Pencil hardness for all four garage floor coatings was tested, and the results are shown in *Table 11*. This test is used to predict toughness and scratch resistance of the coating. The new garage floor latex outperformed the commercial 1K coating by a considerable margin and competes with the commercial 2K coatings.

UV Exposure

QUV resistance of the new acrylic garage floor latex was tested. No film defects such as chalking, pitting, gloss reduction, etc. was seen. The HunterLab ColorEye spectrometer CIE L*a*b* data comparing 10,000 h QUV exposure to the initial read is listed in *Table 12*.

CONCLUSION

With increased market demands for lower VOC coatings, new latexes must be developed that offer durability and convenience with a lower coalescent solvent demand. With careful design of the polymer latex, these properties can be met. The new fast-cure self-crosslinking epoxy modified acrylic copolymer latex described here was designed in this manner. The intent is to give formulators of garage floor and masonry coatings a new latex that can be used in formulations that can offer the best properties of a 2K in a 1K system at <50 g/L VOC. ❊

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