FEATURED PRODUCT SHEET Energy Curable Resins

EBECRYL® 893 Resin for Field Applied UV Curable Concrete Floor Coatings

In the early to mid 2000's, commercial UV curing moved out of the factory and into the field, with numerous improvements in UV curing equipment pushing this transformation. Floor coatings are one of the main applications for field applied UV cured coatings. Today, these field applied or on site floor coatings for wood, vinyl, tile, and concrete are all in some phase of commercialization.

The benefits of UV cured field applied floor coatings are similar to factory applied floor coatings: increased productivity and performance. In addition, the immediate cure aspect provides cost savings to the end user through immediate use, and added benefits of quality, since the finish will not be damaged once it is cured.

CONCRETE

All conventional concrete coatings are multi-component systems, and the two-component epoxy/amine and urethane (isocyanate/polyol) are the most common. These epoxy and urethane coatings require more than one day before return to service. Faster curing systems include polyaspartic and methyl methacrylate coatings, which can be returned to service in hours instead of days. However, the pot life of these fast curing systems dramatically compromises the open time necessary for proper application, and can result in wasted product and deficiencies in appearance and product performance.

The rate of cure of multi-component systems are also limited by temperature, and are often unacceptable for refrigerated end uses or cold weather application. Other disadvantages of conventional concrete coatings include high volatile organic content (VOC) and odor, and lack of exterior durability, ease of cleaning, and abrasion resistance. UV curable concrete coatings can address many of the shortcomings of these conventional concrete coatings. Table 1 summarizes the major points of comparison between conventional and UV curable concrete coatings. Also, improvements in durability, hardness, solvent resistance, and chemical resistance have been noted in the literature of UV curable concrete coating suppliers.

EBECRYL 893

EBECRYL 893 is a modified polyester acrylate specifically developed for UV curable field applied concrete floor coatings. EBECRYL 893 is low in viscosity, providing latitude in formulating for these low viscosity applications. It also provides resistance to yellowing upon cure and over its lifetime. Concrete coatings based on EBECRYL 893 provide a good balance of properties such as cure speed, adhesion, hardness, and scratch resistance. Good chemical and solvent resistance and high gloss are also obtained with concrete coatings based on EBECRYL 893.

Table 2 gives a starting point formulation (SPF) for clear concrete floor coatings. The SPF for a pigmented concrete floor coating is given in Table 3. It is recommended that these coatings be applied over sealed substrate to provide improved appearance and adhesion. Table 4 gives a SPF for a UV curable sealer based on UCECOAT® resins, but conventional sealers can also be used. For optimized topcoat performance towards yellowing resistance, the use of UCECOAT 7631 or 7689 is advised. (See the Featured Product Sheet "UCECOAT Resins for UV Curable Sealers for Concrete & Vinyl Composition Tile (VCT)" for more information.) Variations on the SPF, using different additives and monomers for viscosity reduction, have also been tested for performance. OTA-480®, or a 33/66 blend of $NPG(PO)_2DA$® (EBECRYL 145) and DPGDA® were used to replace the EBECRYL 160 shown in the SPF in Table 2. These coatings were tested at various dilutions, with various sealers, on various substrates, and at various UV exposures, and gave coating properties similar to the EBECRYL 160 dilution.

TABLE 1. Comparison of Conventional and UV Curable Concrete Coatings

COATING TECHNOLOGY	CURE SPEED	POT LIFE	VOC	ODOR	EASE OF CLEANING	EXTERIOR DURABILITY	ABRASION RESISTANCE	PRICE
EPOXY	Hours to Days	1-4 Hours	Low	Low	Moderate	No	Moderate	Low
URETHANE	Hours to Days	<1 Hour	Low	Low	Moderate	Yes	Good	Medium
POLYUREA	Minutes to Hours	<1 Hour	Low	Low	Moderate	Some	Excellent	Medium
POLYASPARTIC	Minutes to Hours	<30 Minutes	Low	Low	Moderate	Yes	Excellent	High
METHYL METHACRYLATE	1 Hour	<10-20 Minutes	High	High	Good	Yes	Good	High
UV CURABLE	Instant	Infinite	Low	Low	Excellent	Yes	Excellent	High

The performance properties of one clear topcoat/sealer combination are given in Table 5. A 33/66 blend of NPG(PO)$_2$DA (EBECRYL 145) and DPGDA was used for dilution in this example, and the substrate was concrete tiles. The properties of a pigmented topcoat/sealer combination are shown in Table 6. In this example, EBECRYL 160 (TMPEOTA®) was used for monomer dilution, and the substrate was fiber cement panels. High gloss, excellent appearance, and outstanding chemical and solvent resistance are demonstrated by both UV curable coatings.

A substantial improvement in scratch resistance of the concrete coatings can be achieved through the use of EBECRYL 154, a functionalized nanocomposite acrylate. By replacing 15% of the EBECRYL 893 with EBECRYL 154, the number of steel wool double rubs can be increased from 25 to 135, while leaving other properties essentially unchanged. (See Table 5)

Hot tire pickup resistance is important for garage and warehouse applications. Coatings without this resistance are softened by the heat and water from tires on automobiles or forklifts. Then under pressure from the weight of the vehicles, the plasticizers in the tires bond the tire to the coating. The end result is coating removal, and/or black tire marks on the coating. Coatings with higher crosslink density tend to perform better in these applications than coatings that are less crosslinked.

There is no standard lab method of testing for hot tire pickup resistance of concrete coatings. Cytec has developed an internal method in order to do this testing in a laboratory environment. The results from this method should not be compared to those from other methods unless correlations have been completed.

Both dry and wet hot tire pickup testing were performed on EBECRYL 893 based UV curable pigmented concrete topcoats. (Table 3 SPF) The topcoats were applied to sealed fiber cement panels. All coatings passed the tests. The tires did not stick to the coatings, and were removed remarkably easily. The dry tire left no marks. The wet tire left a mark, which was much reduced, but still slightly visible after cleaning. Earlier work with EBECRYL 891 based clear concrete coatings showed no marks with the dry tire test, and the slight marks left by the wet tire test were easily and completely cleaned. These results are better than those typically seen for 2K waterbased epoxy coatings. Pictures of the results are shown in Figures 1, 2, and 3, and the test method is described in the Addendum.

The yellowing of EBECRYL 893 was tested through exposure to a 300 watt Osram light bulb, at a distance of 40 cm. The Osram light bulb simulates sunlight, and is recommended for industrial material testing. After 4 days exposure, the EBECRYL 893 diluted with 21% EBECRYL 160 (TMPEOTA), photoinitiated with 4% Darocur® MBF, and coated at 100 microns on a white MDF back panel, gave a delta b of 1.4 compared to an unexposed sample. This very low yellowing value indicates suitability of use for concrete coatings.

TABLE 2. Starting Point Formulation for EBECRYL 893 Based Clear Concrete Topcoat

CYTEC PRODUCT	%	PURPOSE / PROPERTY
EBECRYL 893	**75.5**	**Coating Performance**
EBECRYL 160 (TMPEOTA) or OTA-480 or NPG(PO)$_2$DA/DPGDA (33/66)	**20.0**	**Viscosity Reduction; Adapt % to match viscosity to application method; Monomer choice can also affect coating properties**
Darocur® MBF[(1)]	**3.8**	**Photoinitiator**
Tego® Airex 920[(2)]	**0.2**	**Defoamer**
Tego® Wet 250[(2)]	**0.5**	**Wetting Agent**
	100.0	
Viscosity (cP @ 25° C)	**385**	
1-2 coats for 150-175 µm (6-7 mils) total coat weight on sealed concrete		**Sealer improves aesthetics**
UV cure exposure for partial or gel cure (mJ/cm^2)	**390**	**Sufficient cure for recoatability and intercoat adhesion**
UV cure exposure for full cure (mJ/cm^2)	**580**	**Crosslinked polymer for resistance properties and aesthetics**

[(1)]Product of BASF Corporation
[(2)]Product of Evonik Tego Chemie GmbH

TABLE 3. Starting Point Formulation for EBECRYL 893 Based Pigmented Concrete Topcoat

CYTEC PRODUCT	%	PURPOSE / PROPERTY
EBECRYL 893	67.34	Coating Performance
EBECRYL 160 (TMPEOTA)	17.90	Viscosity Reduction
Darocur® MBF[(1)]	1.70	Photoinitiator
Irgacure® 819[(1)]	0.85	Photoinitiator
Lucirin® TPO-L[(1)]	1.70	Photoinitiator
Tego® Airex 900[(2)]	0.43	Defoamer
Tego® Foamex N[(2)]	0.43	Defoamer
Basantol® Black X82[(1)]	0.26	Pigment
White Pigment Paste*	8.53	Pigment
MODAFLOW® 9200[(3)]	0.43	Flow & Leveling
BYK® 410[(4)]	0.43	Rheology Modifier
	100.0	
Viscosity (cP @ 25° C)	400	
2 coats for 100-150 µm (4-6 mils) total coat weight on sealed concrete		Sealer improves aesthetics
UV cure exposure for partial or gel cure (mJ/cm^2)	580	Sufficient cure for recoatability and intercoat adhesion
UV cure exposure for full cure (mJ/cm^2)	830	Crosslinked polymer for resistance properties and aesthetics

***White Pigment Paste: 29.5% DPGDA/ 3% EBECRYL 330/ 67.5% TiO_2 (Sachtleben® R210[(5)])**

[(1)]Product of BASF Corporation
[(2)]Product of Evonik Tego Chemie GmbH
[(3)]Product of Cytec Industries Inc.
[(4)]Product of Byk Additives & Instruments
[(5)]Product of Sachtleben Chemie GmbH

TABLE 4. Starting Point Formulation for UV Curable Sealer Based on UCECOAT Resins

CYTEC PRODUCT	%	PURPOSE / PROPERTY
UCECOAT® Resin 7578, 7631, or 7733 (EU) 7578, 7689, or 7733 (US)	92.3	Coating Performance
ADDITOL® VXW 4973(1)	0.5	Defoamer
ADDITOL VXW 6503(1)	0.2	Flow & Leveling
Isopropanol	5.0	Coalescent
ADDITOL BCPK(1)	1.5	Photoinitiator
Lucirin® TPO-L(2)	0.5	
	100.0	
Viscosity (cP @ 25° C)	20	
Coat at 50-175 µm (2-7 mils) wet; 16-60 µm or 0.5-2 mils dry film thickness; 1-2 coats recommended		Sealer improves aesthetics and adhesion
Sealers should be dried before re-coating, but do not need an intermediate UV cure. UV cure one time after the topcoat has been applied, or partially cure (gel cure) the sealer to insure intercoat adhesion.		

(1)Product of Cytec Industries Inc.
(2)Product of BASF Corporation

TABLE 5. Performance Properties of Clear Concrete Topcoat Based on EBECRYL 893, with and without the Addition of EBECRYL 154

PROPERTY	TOPCOAT	TOPCOAT + EBECRYL 154
Substrate	Concrete Tiles	Concrete Tiles
Sealer and Coat Weight	UCECOAT 7578 2 x 50 µm dry (2 x 2 mils dry)	UCECOAT 7578 2 x 50 µm dry (2 x 2 mils dry)
Topcoat and Coat Weight	EBECRYL 893 1 x 150µm (6 mils)	EBECRYL 893 1 x 150µm (6 mils)
Monomer Dilution in Topcoat	15% $NPG(PO)_2DA$ and 30% DPGDA	15% $NPG(PO)_2DA$ and 30% DPGDA
UV Cure Exposure	1 x 410 mJ/cm^2	1 x 410 mJ/cm^2
Gloss (60°)	92	90
Appearance	High clarity; No surface defects	High clarity; No surface defects
X-Cut Adhesion (3M 610 tape)	4A	4A
Coin Test	Very slight burnish	Very slight burnish
Pencil Hardness	5B	4B
MEK Double Rubs	200+	200+
Steel Wool (0000) Double Rubs	25	135
Chemical Resistance (24 hour spot test, with cottonball, covered)		
Mustard	Slight stain (no stain at 30 minutes)	Slight stain (no stain at 30 minutes)
Betadine	Slight stain (no stain at 30 minutes)	Slight stain (no stain at 30 minutes)
RIT® Dye (navy, undiluted)	Slight stain (no stain at 30 minutes)	Slight stain (no stain at 30 minutes)
Xylene	No Effect	No Effect
Olive Oil	No Effect	No Effect
Formula 409®	No Effect	No Effect
Vinegar	No Effect	No Effect
Water	No Effect	No Effect
Ethanol (50%)	Slight distortion	Slight distortion
Isopropanol (70%)	No Effect	No Effect
Windex®	No Effect	No Effect
Pickle Juice	No Effect	No Effect
Brake Fluid	No Effect	No Effect
Transmission Fluid	No Effect	No Effect

TABLE 6. Performance Properties of Pigmented Concrete Topcoat Based on EBECRYL 893

PROPERTY	VALUE
Substrate	Fiber Cement Panels
Sealer and Coat Weight	UCECOAT 7733 1 x 50µm dry (2 mils dry)
Topcoat and Coat Weight	EBECRYL 893 2 x 75 µm (2 x 3 mils)
Monomer Dilution in Topcoat	20% EBECRYL 160 (TMPEOTA)
UV Cure Exposure	Air dry sealer: <3% moisture content 1 x 580 mJ/cm^2 first topcoat 1 x 830 mJ/cm^2 second topcoat
Gloss (60°)	84
X-Cut Adhesion (Tesa 4104 tape)	5A
Pencil Hardness	3H
Water Double Rubs	200+
Isopropanol Double Rubs	200+
Chemical Resistance (24 hour spot test, with cottonball, covered)	
Ketchup	No Stain
Mustard	Slight Stain (no stain at 4 hours)
Coffee	No Stain
Arachide Oil (vegetable oil)	No Stain
Ethanol (50%)	No Stain
NaOH (10%)	No Stain
NH_3 (10%)	No Stain
Acetic Acid (7%)	No Stain
Javel (sodium hypochlorite) (9%)	No Stain
Eosin (red dye) (2%)	Moderate Stain
Hot Tire Pick Up Resistance	
Dry	No coating pick up No marks; No impression
Wet	No coating pick up Very Slight marks; No impression

FIGURE 1. Dry Hot Tire Pick Up Resistance

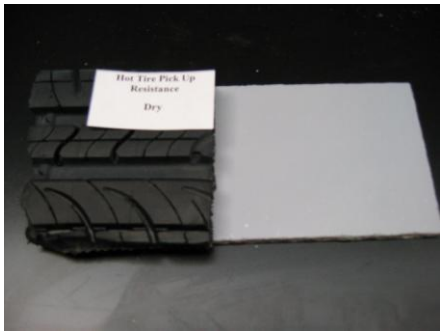

FIGURE 2. Wet Hot Tire Pick Up Resistance

FIGURE 3. Wet Hot Tire Pick Up Resistance, Cleaned

Addendum. Hot Tire Pick Up Test Method

There is no standard lab method of testing for hot tire pickup resistance of concrete coatings. Cytec has developed an internal method to do this testing in a laboratory environment. The results from this method should not be compared to those from other methods unless correlations have been completed. The method utilizes 10x10 cm pieces of tire (Michelin Pilote Primacy Radial XSE: 195/55R-16-87V) and a 20 Kg weight. For dry hot tire pickup resistance, the tire is placed on the coated fiber cement panel, and then the weight is placed on the tire. The entire apparatus is then placed in a 40° C oven for 4 hours. For wet hot tire pickup resistance, the tire is immersed in water at 50° C for 18 hours, then placed on the coated fiber cement panel, after which all is sealed in a plastic bag. The weight is placed on the tire, and the entire apparatus is then placed in a 50° C oven for 3 hours. After the heating time is completed, the tire is immediately removed from the coated fiber cement panel, and the surface of both the coating and the tire is examined. A failure means that some coating has been removed by the tire. It is not a failure if the tire marks the coating, as long as no coating is removed. The coating can be further studied by evaluating lightness/darkness of tire marks, whether or not the marks are on the surface only or impressed into the coating, and ease of cleaning of tire marks.

Technical Contacts for these products: Jo Ann Arceneaux at +1-678-255-4740 or joann.arceneaux@cytec.com and Jim Smith at +1-678-255-4733 or james.c.smith@cytec.com and Guido Vanmeulder at +32-2-334 5559 or guido.vanmeulder@cytec.com

Cytec Industries Inc. in its own name and on behalf of its affiliated companies (collectively, "Cytec") decline any liability with respect to the use made by anyone of the information contained herein. The information contained herein represents Cytec's best knowledge thereon without constituting any express or implied guarantee or warranty of any kind (including, but not limited to, regarding the accuracy, the completeness or relevance of the data set out herein). Cytec is the sole owner or authorized user of the intellectual property rights relating to the information communicated. The information relating to the use of the products is given for information purposes only. No guarantee or warranty is provided that the product is adapted for any specific use. The user or purchaser should perform its own tests to determine the suitability for a particular purpose. The final choice of use of a product remains the sole responsibility of the user.

© 2010 Cytec Industries Inc. All rights reserved.

TRADEMARK NOTICE: The ® indicates a Registered Trademark in the United States and the ™ or * indicates a Trademark in the United States. The mark may also be registered, the subject of an application for registration or a trademark in other countries.