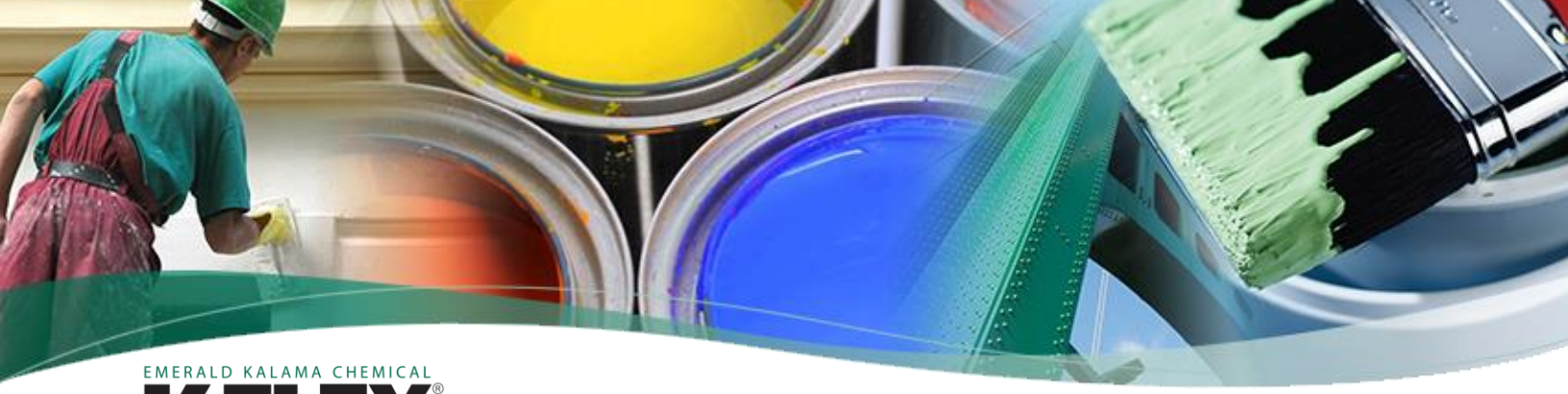


EMERALD KALAMA CHEMICAL

K-FLEX®

K-Flex® Dibenzoate Coalescents for Paints and Coatings

Coalescents have been and continue to be a key material used to enhance film formation and other properties in coatings formulations. Dibenzoate chemistry is becoming the preferred low-VOC coalescent for use in coatings. Dibenzoates aid the formulator in **lowering VOC content in formulations while improving key performance characteristics** and providing the best balance of performance and value to alternative chemistries.

As polar coalescents, K-FLEX® dibenzoates are used to coalesce polar polymers ranging from acrylic types including styrene or ethylene copolymers, polyvinyl acetate and acrylics. The original dibenzoate products were diethylene glycol dibenzoate (DEGDB) and dipropylene glycol dibenzoate (DPGDB). Many commercial products blend these two materials to yield liquids with good handling and tailored performance features in the end-use application.

Emerald Kalama Chemical offers the classic dibenzoates, as well as some new grades and blends created for the needs of the marketplace. K-FLEX® coalescents offer an excellent low-VOC solution for formulators looking to satisfy both legislative requirements and consumer demand.

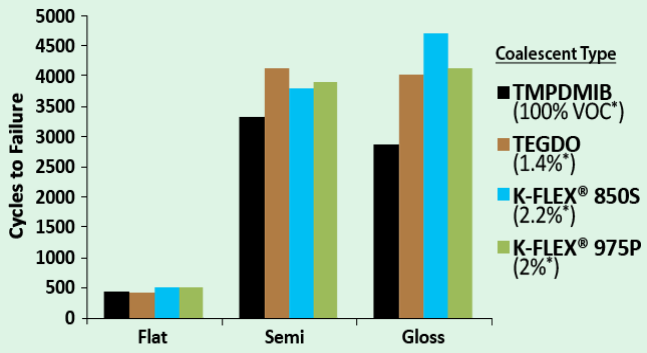
- **Low-VOC**
- **Non-SVHC**
- **Non-phthalate**
- **Approval for use in direct food contact applications**
- **Global registrations**
- **REACH compliant**

Classified as non-SVHC and non-PBT, K-FLEX® dibenzoates are label-free in the EU under CLP and GHS regulations. Additionally, K-FLEX® 975P and K-FLEX 850P risk-phrase-free.

Next Generation Products

Coalescents based on dibenzoate chemistry are becoming increasingly common in applications where coalescents such as 2,2,4-trimethyl-1,3-pentanediol monoisobutyrate (TMPDMIB) might traditionally have been used. This is because they provide comparable—or, in many cases, improved—performance properties in addition to lowering VOCs. Dibenzoate coalescents are also compatible with typical coating polymers, leading to stronger, better coalesced films with excellent scrub resistance, gloss, toughness, clarity, and MFFT/Tg suppression.

Scrub Resistance as a Function of Coalescent



Dibenzoate coalescents such as **K-FLEX® 850S and K-FLEX® 975P** exhibit increased scrub resistance to higher-VOC coalescents while maintaining needed open time and block resistance.

** % weight lost, 110°C for 1 hour, ASTM D2369, Part of EPA 24*

Evaluation Methodology

Emerald Kalama Chemical uses analytical instruments such as those depicted above to evaluate performance of coalescents in a variety of applications, including coatings.

Emerald Performance Materials®
Kalama Chemical

Recommended Products for Paints and Coatings

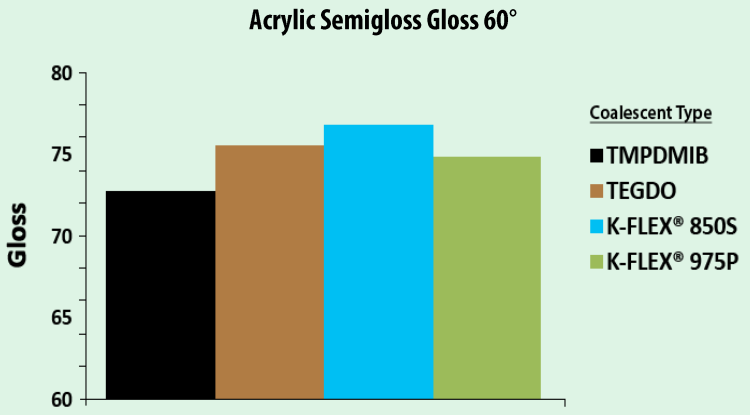
K-FLEX® 975P – Economical to use and created to offer a broad range of compatibility with polar polymers, with improved handling due to its lower freeze point. Highly recommended low-VOC coalescent for interior and exterior latex paints, industrial coatings, and special purpose coatings.

K-FLEX® 500P –Specifically designed for coatings formulations where very low VOC content is required. Highly recommended for use in a variety of coatings, including interior and exterior latex paints, industrial coatings, lacquers, and special purpose coatings.

K-FLEX® 850S – A value-added blend of classic dibenzoate coalescents. Very effective and low-VOC choice for interior and exterior latex paints, industrial coatings, and special purpose coatings.

COATINGS PERFORMANCE CHARACTERISTICS

In paints and coatings, our research & development Team found that low-VOC coalescents such as **K-FLEX® 850S and K-FLEX® 975P** developed better gloss than higher VOC coalescents such as TMPDMIB, forming tighter, better films while also maintaining compatibility. Because of gloss development with K-FLEX® coalescents, the formulator also has the opportunity to add more filler to keep the original gloss level, making the system more economical.



Emerald Kalama Chemical is a business group of Emerald Performance Materials, a manufacturer of additives and polymers that make your products last longer, look, taste, smell, or perform better. We are a world-scale producer of toluene oxidation products, shipping 425 million pounds annually to nearly 70 countries across the globe. Products include benzoic acid and various benzoate and dibenzoate ester, alcohol and aldehyde derivates for food preservatives, flavor and fragrance ingredients, coalescents and industrial applications. Manufacturing in Kalama, WA (USA) and Rotterdam, The Netherlands – service to our customers globally.

Contact Us

Emerald Kalama Chemical
1296 Third Street, NW
Kalama, Washington
800.223.0035 | +1.360.673.2550
kflex@emeraldmaterials.com

Asia Pacific
1708 Shui on Centre, 6-8 Harbour Rd
Wanchai, Hong Kong, China
+852.2598.7990
kflex.asia@emeraldmaterials.com

Europe, Middle East, Africa
Mijnweg 1, 6167 AC Geleen, Netherlands
+31.88.888.0512
kflex.emea@emeraldmaterials.com

www.emeraldmaterials.com | kalama@emeraldmaterials.com
April 2014

Emerald Performance Materials®
Kalama Chemical

CVC Thermoset Specialties

We Offer

- Products that deliver enhanced performance
- Application and technology expertise
- North American ISO-certified facilities
- Global service with regional distribution partners

Our Legacy

CVC Thermoset Specialties' RLP Products are a unique, proprietary technology originally developed by BFGoodrich, which enhance performance in a wide array of technically challenging end-uses around the world. The product family had been sold for many decades under the Hycar® tradename by predecessor corporations – BFGoodrich, Noveon and Lubrizol. Following the formation of Emerald Performance Materials in 2006, the products were rebranded as Hypro® Reactive Liquid Polymers.

Prior to its acquisition by Emerald Performance Materials in 2008, CVC Specialty Chemicals had been creating and manufacturing specialty epoxy resins since 1982. Over the years, the company expanded its product offerings to coatings and adhesive formulators with the acquisition of the specialty epoxy resin line of CL Industries (Georgetown, IL) and substituted urea accelerators from Omicron Chemical. Manufacturing and R&D capabilities were enhanced by the 1995 purchase and subsequent expansions of the Akzo Chemical plant in Maple Shade, NJ.

CVC Thermoset Specialty Product Lines

- **Specialty Epoxy Resins**
- **Reactive Liquid Polymers**
- **Elastomer-Modified Epoxy Resins**
- **Epoxy Functional Reactive Modifiers**
- **Curing Agents, Catalysts and Accelerators**

EPALLOY® Specialty Epoxy Resins

Improved chemical resistance, thermal performance, modulus, cure speed, and UV stability over other standard resins for coatings, composite, and adhesive applications. Technologies include Epoxidized Phenol Novolacs, Resorcinol Modified Novolacs, Bis A Modified and Cycloaliphatic Epoxy Resins.

CVC Thermoset Specialties

An Emerald Performance Materials Company

Hypro® Reactive Liquid Polymers

Addition of our innovative Hypro® Reactive Liquid Polymers (RLP) to your thermoset resin formulation will significantly enhance performance such as fracture toughness, low temperature mechanical properties, impact/crack/chip resistance, flexibility and adhesion to difficult to adhere-to substrates. Carboxy, Amine, Epoxy, Methacrylate(Vinyl), Glycidyl Ester and Hydroxy end-functionality allows for crosslinking in a variety of systems. Ideally suited for Epoxy, Vinyl Ester, UPE Urethane and Acrylic Resin Systems. Newer low viscosity epoxy functional grades can be used for glass and carbon fiber reinforced composites.

HYPOX® Elastomer-Modified Epoxy Resins

Elastomer modification of epoxy resins is a valuable way to further enhance performance features such as: fracture toughness, peel strength, flexibility, low temperature performance, durability and adhesion to non-polar surfaces versus unmodified products. Technologies include Dimer Acid and CTBN Adducts, and Urethane Modified Epoxy Resins.

ERISYS® Epoxy Functional Reactive Modifiers

Monomers are used in epoxy formulations to reduce viscosity and improve handling, processing, and application properties of formulations. Monomers and modifiers also enhance features, such as flexibility and toughness, and maintain chemical resistance and UV stability. Chemistries included Aromatic & Aliphatic Glycidyl Ethers, Glycidyl Amine and Glycidyl Esters.

OMICURE® Curing Agents, Catalysts and Accelerators

Accelerating the cure speed and/or reducing the cure temperature are important to optimize productivity, energy use, and ultimate physical properties. We offer Dicyandiamide and Boron-Based catalysts for Latent, one-component Heat Cured Epoxy Systems. Substituted Urea catalysts help to accelerate the cure speed and reduce cure temperatures of Dicyandiamide cured formulations and help to optimize productivity, energy use, and ultimate physical properties.

Emerald Corporation

CVC Thermoset Specialties is a division of Emerald Performance Materials (EPM). EPM produces a broad portfolio of additives and polymers used in diverse consumer and industrial products around the world. Its products play a variety of roles in the products that are consumed and used every day enabling them to last longer, look, smell, taste or perform better. For more information, visit www.emeraldmaterials.com.

		Coatings						Adhesives & Sealants							Composites								Polymer Modification			Electrical / Electronic		
	Product Line	Primers – Automotive and Aerospace	Powder Coatings	Flooring and Concrete Coatings	Industrial and Maintenance	Cross-linkers – Overprint Varnish and Other	Topcoat – Automotive Refinish and UV Stable	Mastics and Sound Deadening	Window Sealants	Injection Molded Structural and Pumpable Pastes	Civil Engineering – Floor Joints, Anchor Bolt	Pressure Sensitive Adhesives	Urethane Adhesives	Film Adhesives	Filament Winding – Pipes/Valves/Tanks	SMC & BMC Modification	Aerospace and Recreational Prepregs	Tooling and Stereolithography	Pultrusion	Syntatic Foam Insulation	Wind Energy – Infusion, Hand Layup, Tooling and Adhesives	Resin Infusion – Industrial and Wind	Vinyl Ester	PVC Plastisol Modification	Polyurethane Modification	Potting/Encapsulation	Insulating Varnish – Dip & VPI	Printed Circuit Boards
Reactive Liquid Polymers	Hypro® CT Series RLP																											
	Hypro® AT Series RLP																											
	Hypro® VT Series RLP																											
	Hypro® ET Series RLP																											
	Hypro® LV Series RLP																											
	Hypro® HT Series RLP																											
Specialty Epoxy Resins	EPALLOY® 8000 Series – Unmodified Phenol Novolac Resins																											
	ERISYS® RN Series – Resorcinol Modified Novolacs																											
	EPALLOY® 7100 Series – Bis A Modified Novolacs Resins & Blends																											
	EPALLOY® 5000 Series – Hydrogenated Bis A Resins																											
Elastomer Modified Resins	HyPox® D-Series Dimer Acid Modified Epoxy Resins																											
	HyPox® R-Series CT Modified Epoxy Resins																											
	HyPox® U-Series Urethane Modified Epoxy Resins																											
Epoxy Functional Reactive Modifiers	ERISYS® GE 5,6,7 and 8 Series – Aliphatic Glycidyl Ethers																											
	ERISYS® GE 10 Series – Aromatic Monoglycidyl Ethers																											
	ERISYS® GE 20 Series – Aliphatic Diglycidyl Ethers																											
	ERISYS® GE 30 Series – Aliphatic Triglycidyl Ethers																											
	ERISYS® GE 60 – Sorbitol Polyglycidyl Ether																											
	ERISYS® GS Series – Glycidyl Esters																											
	ERISYS® GA Series – Glycidyl Amines																											
Curing Agents, Catalysts & Accelerators	Omicure® U Series – Substituted Urea Accelerators																											
	Omicure® DDA Series – Dicyandiamide Accelerators																											
	Omicure® B Series – Boron-based Catalysts																											

For more information on these products contact:

CVC Thermoset Specialties
844 N. Lenola Road
Moorestown, NJ 08057
800-296-0040 (CVC)
856-533-3000 (CVC)
856-533-3003 (Fax - CVC)
888-889-9150 (RLP)
330-374-2766 (Fax - RLP)

www.cvc.emeraldmaterials.com

Corporate Headquarters
Emerald Performance Materials, LLC
2020 Front Street
Cuyahoga Falls, OH 44221
330-916-6700
330-916-6737 (Fax)

www.emeraldmaterials.com

Regional Sales Offices
ASIA PACIFIC
CVC Thermoset Specialties
1708 Shui On Centre
6-8 Harbour Road
Wanchai, Hong Kong
852-2598-7990

Europe/Middle East/Africa
CVC Thermoset Specialties
Mijnweg 1
6167 AC Geleen
Netherlands
+31 88 888 0500

CVC Thermoset Specialties

An Emerald Performance Materials Company

K-FLEX® Plasticizers:

- Non-Phthalate
- Low VOC
- Non-SVHC
- REACH Compliant

EMERALD KALAMA CHEMICAL

K-FLEX®

Plasticizers & Coalescents

Emerald Kalama Chemical

General Uses

K-FLEX® plasticizers, modifiers and coalescents are used because of their excellent performance and balance of properties. They are non-phthalate, low in VOCs, and have positive attributes from a product safety and health perspective compared to other choices.

The K-FLEX product line continues to grow, to develop new technology, to expand into new applications and meet the evolving needs of the industries we serve. Our team is engaged – participating in key industry associations, delivering presentations on our latest technical development and seeking out new and creative ways to bring value-added solutions to our customers.

As a leader in benzoate chemistry, we focus on operational excellence. We now produce our K-FLEX product line in Rotterdam, the Netherlands and Kalama, WA (US), from operations strategically located on ports and rail lines to serve our customers globally. We are expanding worldwide and have recently added a new technical center, expanded operations and new reactors to increase our global footprint. Together, our plants ship approximately 200,000 MT to nearly 70 countries with more than half of our sales outside the Netherlands and United States. Both plants are backward integrated into key feedstocks to produce a wide array of benzoates, plasticizers, aroma chemicals and other intermediates.

One of the key properties of K-FLEX products is their compatibility with a wide range of polymers, particularly polar materials. This makes K-FLEX products highly effective in many of the most widely used non-olefin based polymers: vinyl-acetate, ethylene vinyl acetate, acrylic, styrenated acrylic, styrene-butadiene, PVC, polysulphide, nitrocellulose, nitrile, and polyurethane. These polymers are also widely used in many end-use applications, including adhesives, sealants, caulks, paint, coatings, graphic arts, resilient flooring, vinyl wall covering and artificial leather.

For many years, our adhesives customers have turned to dibenzoate plasticizers because they offer the best overall performance, providing excellent viscosity response, reduced set times, increased open times, increased film flexibility and clarity, reduced heat sealing temperatures, and improved film resistance to oil and grease. These properties are valued in mastics and caulking compounds, sealants, and adhesive applications used in the packaging industry for carton sealing and forming, book binding, labeling, furniture, luggage and shoes. Specific clearances for use in adhesives and coatings with direct contact to food (as indirect food additives) are shown in the product selection guide in this brochure.

In recent years, more customers have come to appreciate the value that benzoate plasticizers can bring, as they work to meet lower and lower VOC industry requirements or seek an alternative to phthalates. New technology and patent-pending materials deliver performance benefits to coatings which extend beyond the reduction of VOCs: improving scrub resistance and gloss while maintaining important features such as good blocking resistance and low dirt pick-up. This balance of performance features may be surprising to many formulators, who expect plasticizers– which are more persistent in the film than traditional volatile coalescents– to have unsatisfactory performance in these areas. The newest generation K-FLEX products definitely show very effective performance overall in coatings.

Our latest developments in plasticizers for vinyl applications likewise show some outstanding performance features. These very high solvators for PVC are fast fusing and will increase processing speed and lower processing temperatures. K-FLEX plasticizers also exhibit superior wear performance, increased stain resistance and resistance to extraction by solvents such as kerosene, cotton seed oil and other non-polar materials. These properties make it an excellent choice for the production of vinyl flooring, artificial leather (cloth), wallpaper, extrusions, calendaring and plastisols. Blends of K-FLEX plasticizers with general purpose-type plasticizers – or with other specialty plasticizers such as adipates and citrates – are often used to take advantage of the exceptional properties of the K-FLEX plasticizers.

Please contact us. Our K-FLEX team welcomes the opportunity to work with you.

K-FLEX® Plasticizers…
Keeping an eye on your future.

Emerald Kalama Chemical is a business group of Emerald Performance Materials, a manufacturer of additives and polymers which make your products last longer, look, taste, smell, or perform better. Emerald Kalama Chemical is a world-scale producer of a variety of toluene oxidation products including benzoic acid and various benzoate and dibenzoate ester, alcohol and aldehyde derivates for food preservatives, aroma chemicals, plasticizers, and a range of industrial applications.

Products Available

K-FLEX® DP – Dipropylene glycol dibenzoate is one of the most versatile polar, high solvating plasticizers. It is compatible with a wide range of polar polymers and rubbers, including TPU. It is an excellent choice for high solvating plasticizer applications.

K-FLEX® PG – Propylene glycol dibenzoate is designed primarily for use in PVC compositions. It imparts outstanding stain resistance and durability in vinyl applications and can be used in adhesives at higher loading levels without degrading performance.

K-FLEX® 500 – A classic dibenzoate blend. As a polar plasticizer, it is a high solvator for PVC and compatible with polar polymers such as polyvinyl acetate. It is primarily used in adhesive applications.

K-FLEX® 500P – A dibenzoate blend designed for coatings or other applications where ultra low levels of VOCs are desired.

K-FLEX® 850P –A dibenzoate blend designed for vinyl applications with economy as a focus. It offers excellent stain resistance, durability and can be used alone or in blends with other plasticizers.

K-FLEX® 850S – A low VOC blend of dibenzoates optimized for use in waterborne latex applications. Widely used in the industry because of the excellent combination of efficiency, economy and performance benefits it provides to the formulator. In Europe K-FLEX® 850S is label free.

K-FLEX® 975P – A dibenzoate triblend compatible with polar polymers. It offers a lower freeze point and better handling properties than other modern binary dibenzoate blends.

We are strategically located near shipping ports and railways to ensure economical and fast delivery of products to our customers.

K-FLEX® Plasticizers

Application Chart

Application	Uses	K-FLEX® 850S	K-FLEX® 850P	K-FLEX® 500	K-FLEX® 500P	K-FLEX® 975P	K-FLEX® PG	K-FLEX® DP
Adhesives & Sealants	Hot-melt Adhesives		○	○		●		
	Latex Adhesives	●		○		●		○
	Putty	○				●		○
	Plastisol/Vinyl Sealants		●			●		○
	Latex Caulks & Sealants		●			●		○
	Polysulphide Sealants	○	●					○
	Silane Modified Polymer Sealants		○			●		
Paints & Coatings	Interior Latex Paint	●		○	●	●		
	Exterior Latex Paint	●		○	●	●		
	Industrial Coatings	●		○	●	●		
	Special Purpose Coatings	●		○	●	●		
	Lacquers - Nitrocellulosic & Acrylic	○		●	●			●
	Dispersions		○			○		
Paper	Paper Coatings	●				○		
Vinyl Applications	Plastisol Flooring		●	○		●	○	
	PVC Melt Compounding		●			●	○	
	Plastisol Consumer Products		○			●	○	
	Plastisol Printing		○				○	●
Personal Care	Nail Care						○	●
	Depilatory Wax		○					●
Graphic Arts & Printing	Flexographic Ink	●				○		
Agriculture	Pesticide							●
Industrial Intermediates	Equipment Clean Out & Purge		●					

● Highly Recommended ○ Effective

K-FLEX® Plasticizers add value to a wide range of applications and are compatible in many polymers.

Typical Physical Properties

Property	K-FLEX® 850S	K-FLEX® 850P	K-FLEX® 500	K-FLEX® 500P	K-FLEX® 975P*	K-FLEX® PG	K-FLEX® DP
Boiling Point (5 mm Hg,°C)	180	180	191	236	215	157	195
Boiling Point (750 mm Hg,°C, extrapolated)	>330	>330	>350	>350	>350	>300	>350
Density, ASTM D1475,25°C,g/ml	1.14	1.14	1.14	1.15	1.15	1.14	1.11
Density, ASTM D1475,25°C,lbs/gal	9.6	9.6	9.5	9.6	9.6	9.5	9.3
Freeze Point,°C	14	12	6	6	4	-50**	-51**
Moisture Content, %	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Viscosity, Brookfield RVT, 20 RPMs at 250C, cps and mPa.S	72	76	80	107	73	81	99
VIscosity, Kinematic, 25°C,cSt	63	66	70	93	63	71	89
VOC%, ASTM D-2369	2.2	1.7	2.9	0.9	2	5.8	3.2
FDA Coverage							
21 CFR 175.105	Yes	Yes	Yes	Yes	Yes	Yes	Yes
21 CFR 176.170	Yes	Yes	Yes	Yes	No*	No	Yes
22 CFR 176.180	Yes	Yes	Yes	Yes	No*	No	Yes

* K-FLEX 975P may be used as a plasticizer at a level not to exceed 20% in an adhesive under 21 CFR 176.170 and 21 CFR 176.180, provided the adhesive is separated from the food by a functional barrier, or is limited to contact with food so as not to exceed trace amounts at seams and edges.

** Glass Point by DSC

Plasticizer/Polymer Compatibility[1]

Plasticizer	Solubility Parameter (cal/cm³)	Resin Compatibility %																	
		PVC	PVAC	PVButyral (% PVOH Content)		Cellulose Nitrate	Cellulose Acetyl (Acetyl Content)		CAP	CAB (% Butyryl Content)		EC	PS	PU	PC	PMMA	SBR	Chlorinated Rubber	
				13%	21%		Lo	Hi		17%	37%							CR	N
Diethylene Glycol Dibenzoate (DEGDB)[2]	10.1	100	100	100	33	100	10	10	100	100	100	100	0		50	100			
Dipropylene Glycol Dibenzoate (DPGDB)[3]	9.6	100	100	100	100	100	10	10		25	100	100	33	100	33	100	100[4]	100	100
Acetyl Tri-n-butyl Citrate (ATBC)	9.0	100	100	50	50	100	30	50										100	100
Butyl Benzyl Phthalate (BBP)	9.9	100	100	100	50	100	10	10	80	100	100	100	100	25	60	100	50	80	30
Di-2-Ethylhexl Adipate (DEHA)	8.5	75	0	25	25	35	0	0	10	25	25	100	100	15	10	15	50	100	30
Di-2-Ethylhexl Phthalate (DEHP)	8.2	100	5	>15	>15	100	0	0	20	50	50	100	100	25	25	100	50	100	30

[1] Source: The Technology of Plasticizers, Sears and Darby, John Wiley & Sons.
[2] Component of K-FLEX 850S and K-FLEX 500.
[3] Component of K-FLEX 850S, K-FLEX 500 and K-FLEX DP.
[4] Value for DEGDB and DPGDB blend. No values were provided for the individual dibenzoates.

Regulatory Listing/Approvals

FDA Statement

K-FLEX® 850S, K-FLEX® 850P, K-FLEX® 500, K-FLEX® 500P, K-FLEX® PG, K-FLEX® DP Plasticizers may be safely used as plasticizers in food packaging adhesives; in paper and paper coatings in contact with dry foods; and, in certain instances in paper and paperboard coatings in contact with dry; aqueous and fatty foods.

21CFR§175.105: Indirect Food Additives – substances that may be safely used as components of adhesives.
K-FLEX® 850S, K-FLEX® 850P, K-FLEX® 500, K-FLEX® 500P, K-FLEX® 975P, K-FLEX® PG, K-FLEX® DP Plasticizers may be safely used as adhesive components intended for use in packaging, transporting, or holding food in accordance with the prescribed conditions and limitations listed in 21CFR§175.105.

21CFR§176.170: Indirect Food Additives – substances that may be safely used as components of the coated or uncoated food-contact surface of paper and paperboard intended for use in producing, manufacturing, packaging, processing, preparing, treating, packing, transporting or holding aqueous and fatty foods.
K-FLEX® 850S, K-FLEX® 850P, K-FLEX® 500, K-FLEX® 500P, K-FLEX® DP Plasticizers may be safely used in aqueous and fatty application areas in accordance with the prescribed conditions and limitations listed in 21CFR§176.170.

21CFR§176.180: Indirect Food Additives – substances that may be safely used as components of the coated or uncoated food-contact surface of paper and paperboard intended for use in producing, manufacturing, packaging, processing, preparing, treating, packing, transporting or holding dry food of the type(s) identified in 21CFR§176.170(c), Table 1.
K-FLEX® 850S, K-FLEX® 850P, K-FLEX® 500, K-FLEX® 500P, K-FLEX® DP

*** K-FLEX® 975P** may be used as a plasticizer at a level not to exceed 20% in an adhesive under 21 CFR 176.170 and 21 CFR 176.180, provided the adhesive is separated from the food by a functional barrier, or is limited to contact with food so as not to exceed trace amounts at seams and edges.

Bringing value with high quality products produced in our world-scale ISO 9001:2000 and ISO-14001 certified facility.

Global Inventory

All chemical substances in **K-FLEX® 850S, K-FLEX® 850P, K-FLEX® 500, K-FLEX® 500P, K-FLEX® 975P*, K-FLEX® PG* and K-FLEX® DP** are included on or exempted from listing on the following inventories:

Australia	**AICS**
Canada	**DSL, DSL**
China	**IECSC**
Europe	**EINECS**
Japan	**ENCS**
Korea	**KECI**
New Zealand	**NZIoC**
Philippines	**PICCS**
Taiwan	**ECSI**
United States	**TSCA**

U.S. OSHA Communication Standard

K-FLEX® 850S, K-FLEX® 850P, K-FLEX® 500, K-FLEX® 500P, K-FLEX® 975P, K-FLEX® PG and K-FLEX® DP are not regulated as hazardous substances.

Canadian WHMIS Classification

K-FLEX® 850S, K-FLEX® 850P, K-FLEX® 500, K-FLEX® 500P, K-FLEX® 975P, K-FLEX® PG and K-FLEX® DP are not regulated as hazardous substances.

STORAGE AND HANDLING:
At Emerald Kalama Chemical's production facility, the K-FLEX plasticizers are stored in type 304 stainless steel storage tanks. These storage tanks are nitrogen padded to reduce discoloration of the product. Type 304 stainless steel pipe and valves are also used. High density polyethylene has been shown to be suitable for product shipment but we have no direct experience in piping systems. Since K-FLEX products are excellent plasticizers for polyvinyl chloride (PVC), PVC piping systems should not be used. Sliding vane type positive displacement pumps have given us excellent service.

It is recommended that storage tanks be heated and insulated and that pumps and transfer piping also be heat-treated and insulated. Our engineers are always ready to discuss the storage and handling of any of our products.

Additional information can be found in the Material Safety Data Sheet.

* K-FLEX® 975P and K-FLEX® PG contain a component on Canada's NDSL.

Emerald Performance Materials®
Kalama Chemical

Emerald Kalama Chemical, LLC
1296 Third Street, N.W.
Kalama, WA 98625

360.673.2550
360.673.3564 (Fax)

kflex@emeraldmaterials.com

Emerald Kalama Chemical, BV
Mijnweg 1
6167 AP Geleen, The Netherlands

31.88.888.0500
31.88.888.0520

kflex.emea@emeraldmaterials.com

Emerald Shared Services
Emerald Performance Materials, LLC
2020 Front Street
Cuyahoga Falls, OH 44221

330.916.6700
330.916.6734 (Fax)

www.emeraldmaterials.com

International Offices
Emerald Performance Hong Kong, LLC
1708 Shui On Centre
6-8 Harbour Road
Wanchai, Hong Kong, China

852.2598.7990
kflex.asia@emeraldmaterials.com

Business Group Information

Emerald Kalama Chemical – 360.673.2550 / 800.223.0035
Emerald Kalama Chemical BV – 31.88.888.0500

Leading producer of ingredients sold worldwide as plasticizers, food and beverage preservatives, flavors and fragrance, and pharmaceutical and industrial intermediates.

Emerald Specialties – Hilton Davis
513.841.4000 / 800.477.1022

One of the leading producers of certified dyes and lakes used to add color to food, cosmetics and pharmaceutical products. Also a leading producer of high-quality pigment dispersions for coatings, graphic arts, plastics and many specialty applications.

Emerald Specialties – Foam Control
307.634.7699 / 800.770.5226

Produces foam control additives and silicone-based products for a broad range of applications. It maintains a large number of clearances for food applications, such as Kosher, Halal, FDA and HACCP.

Emerald Specialties – Carolina Chemical – 704.393.0089 / 877.300.9545

Largest U.S. producer of glyoxal resins. These products are used in the paper and textiles industries to improve wet strength, impart wrinkle-resistance and control shrinkage. Leading manufacturer of sulfated oils, water repellents, industrial foam control, reactive silicone materials and waxes for a variety of applications.

CVC Thermoset Specialties – 856.533.3000 / 800.296.0040

A leader in the manufacture of unique reactive liquid polymers, specialty epoxy resins, elastomer modified epoxy resins, epoxy functional monomers and modifiers, catalysts and accelerators. CVC products are sold worldwide and are integral components of coatings, adhesives, electrical potting, compounds, encapsulants and composites. Produced in Maple Shade, NJ (shown at left) and Akron, OH (depicted below).

Emerald Polymer Additives and Nitrile – 330.374.2418 / 888.889.9150

One of the largest North American producers of polymer additives (antioxidants and accelerators) and the only North American producer of TMQ (Good-Rite® Resin D) and ODPA (Stalite® S). Produced at two sites – the one depicted at left is Henry, IL and the one depicted below, shared with Nitrile Polymers in Akron, OH. Also the largest U.S. producer of specialty nitrile emulsions. These are water-based polymers used in specialty coatings, paper, coal tar emulsions and other industrial end uses.

CVC Thermoset Specialties

SUPPLYING SPECIALTY THERMOSETS WORLDWIDE

Capabilities & Product Selection Guide

EPALLOY® Specialty Epoxy Resins

ERISYS™ Epoxy Functional Reactive Modifiers

Hypro™ Reactive Liquid Polymers

HyPox™ Elastomer Modified Epoxy Resins

OMICURE™ Curing Agents, Accelerators and Catalysts

Emerald Performance Materials®

Specialty Thermosets

Table of Contents

When your application requires high performance, turn to CVC Thermoset Specialties for resins, modifiers and additives.

CVC Thermoset Specialties provides specialty epoxies and other thermoset resins in demanding applications.

- Composites
- Adhesives
- Coatings
- Electrical Insulation

Automobile and aircraft frames, corrosion resistant pipes and valves, graphite golf club shafts and tennis racquet frames, electronic laminates, jet skis and marine hulls are just a few of the applications that benefit from our products.

The CVC Legacy

Emerald Performance Materials® created CVC Thermoset Specialties to combine the expertise of the Hypro™ Reactive Liquid Polymer (RLP) Line, a proprietary technology developed by BFGoodrich, and the specialty epoxy materials from CVC Specialty Chemicals Inc. CVC Thermoset Specialties' technologies enhance thermoset performance in technically sophisticated applications around the world.

The Hypro RLP product family, previously sold under the Hycar® trade name, continues to grow and expand with new products and new application platforms in coatings, adhesives, composites, and electrical insulation.

CVC Specialty Chemicals had been creating and manufacturing specialty epoxy resins since 1982. Over the years, the company expanded its manufacturing and R&D capabilities, and its product offerings of specialty and elastomer-modified epoxies, epoxy-reactive modifiers, catalysts and accelerators for epoxy formulators.

Together – Unique Chemistry Delivering Performance

CVC's specialty raw materials are critical building blocks for applications in coatings, adhesives, composites, civil engineering and electronics. These building blocks include five product platforms –

- **EPALLOY®** Specialty Epoxy Resins
- **ERISYS™** Epoxy Functional Reactive Modifiers
- **Hypro™** Reactive Liquid Polymers
- **HyPox™** Elastomer Modified Epoxy Resins
- **OMICURE™** Catalysts, Accelerators and Curing Agents

EPALLOY specialty epoxy technologies deliver improved performance in high performance maintenance/marine coatings, adhesives, encapsulants and composites. CVC offers four families of specialty epoxy resins:

- EPALLOY 8000 - Phenol Novolac Epoxy
- EPALLOY 7000 - Bis-A Modified Novolac Epoxy and Blends
- EPALLOY 5000 - Cycloaliphatic Epoxy
- ERISYS - Resorcinol Epoxy and Resorcinol Novolac Epoxy

These specialty epoxy resins provide better chemical resistance, thermal performance, modulus, cure speed and UV resistance than standard liquid epoxy resins.

ERISYS epoxy functional reactive modifiers enhance performance, reduce viscosity, and improve handling and processing of epoxy formulations. CVC offers one of the broadest ranges of epoxy-functional modifiers:

- ERISYS GE 5, 6, 7 & 8 Series - Aliphatic Monoglycidyl Ethers
- ERISYS GE 10 Series - Aromatic Monoglycidyl Ethers
- ERISYS GE 20 Series - Aliphatic Diglycidyl Ethers
- ERISYS GE 30 Series - Aliphatic Triglycidyl Ethers
- ERISYS GS Series - Glycidyl Esters
- ERISYS GA Series - Glycidyl Amines
- ERISYS GE 40 & 60 Series - Aliphatic Polyglycidyl Ethers

Their benefits include enhanced flexibility and toughness, while maintaining chemical resistance and UV stability. Some of the products are high in bio-renewal content.

Hypro RLP Reactive Liquid Polymers are low molecular weight synthetic rubber with chemical functionality. These reactive additives incorporate rubber properties into epoxies, acrylates, vinyl esters and polyesters. They improve the toughness and low-temperature properties in coatings, adhesives, sealants and composites. Hypro reactive liquid polymers are butadiene homo-polymers and butadiene-acrylonitrile copolymers with terminal functionality.

- Hypro CTBN - Carboxyl-Terminated Butadiene-Acrylonitrile Copolymer
- Hypro ATBN - Amine-Terminated Butadiene-Acrylonitrile Copolymer
- Hypro ETBN - Epoxy-Terminated Butadiene-Acrylonitrile Copolymer
- Hypro VTBNX - Methacrylate(Vinyl)-Terminated Butadiene-Acrylonitrile Copolymer
- Hypro HTB - Hydroxyl-Terminated Polybutadiene (Polybutadiene Polyol)

The toughness shows in many attributes: crack resistance, fracture toughness, impact resistance, resilience, interlaminar adhesion, peel adhesion and thermo cycling. Hypro HTB is the key resin in specialty polyurethane potting compounds, coatings, adhesives and sealants.

HyPox elastomer modified epoxies enhance fracture toughness, low temperature mechanical properties, impact/crack/chip-resistance, peel strength and/or flexibility of epoxy coatings, adhesives, sealants and composites.

- HyPox R - Hypro CTBN Modified Epoxy Resin
- HyPox D - Dimer Acid Modified Epoxy Resin
- HyPox U - Urethane Modified Epoxy Resin

HyPox RF and RM elastomer-modified low viscosity epoxy resins combine high elastomer content with the convenience of handling epoxy resins.

OMICURE dicyandiamide, boron-based catalysts, and substituted urea catalysts are key components of latent, 1K heat cured epoxy systems.

- OMICURE - DDA Dicyandiamide
- OMICURE - Substituted Urea Accelerators
- OMICURE - Miscellaneous Catalysts, Curatives, Accelerators

They control the cure speed and reduce cure temperatures of dicyandiamide cured formulations and help optimize productivity, energy use, and ultimate physical properties.

▸EPALLOY® Specialty Epoxy Resins

Improved chemical resistance, thermal performance, modulus, cure speed and UV stability are just a few of the performance advantages with EPALLOY Specialty Epoxy Resins and blends over other standard resins. These products bring the critical difference to high performance coatings, composites and adhesives applications. Technologies and product lines include:

- Phenol Novolac Epoxy Resins (EPALLOY 8000 Series)
- Resorcinol and Resorcinol Modified Novolac Epoxy Resins (ERISYS RDGE & RN Series)
- Bis-A Modified Novolac Epoxy Resins (EPALLOY 7000 Series)
- Cycloaliphatic Epoxy Resins (EPALLOY 5000 Series)

Phenol Novolac Epoxy Resins

- Excellent chemical resistance
- High-functionality, cross-link density & T_g

	Product Name	Average Epoxy Functionality	Viscosity at 25°C, cP	EEW, g/eq	HCC, max %	Gardner Color, max	Description / Use
Bisphenol F Epoxy Resins	EPALLOY 8220	2.05	1,800 - 2,800	164 - 176	0.10	2	Lowest viscosity Bis-F resin. Near monomeric product for blends to prevent crystallization in Bis-A resins.
	EPALLOY 8230	2.15	3,500 - 4,700	164 - 176	0.10	3	Standard low viscosity non-crystallizing resin for excellent 100% solids coatings and composite applications. Resistant to 98% sulfuric acid and strong polar solvents.
Epoxy Phenol Novolac Resins	EPALLOY 8240	2.35	6,000 - 7,100	164 - 176	0.10	3	Lowest viscosity unmodified epoxy novolac available. Lower in viscosity than standard Bis-A resin. EPALLOY 8240 is preferred for secondary containment tank linings and industrial flooring.
	EPALLOY 8250	2.60	18,000 - 28,000	165 - 178	0.10	3	Mid-range functionality epoxy novolac with viscosity only slightly higher than standard Bis-A resin. For high temperature, highly corrosive applications. Preferred replacement for novolac based vinyl esters.
	EPALLOY 8280	2.8	1,100-1,700 @ 52°C	172 - 179	0.10	2	Mid-range functionality for improved T_g and corrosion resistance.
	EPALLOY 8330	3.60	20,000 - 30,000 @ 52°C	171 - 183	0.10	3	Standard epoxy novolac for highest chemical resistance and T_g.
	EPALLOY 8350	3.60	30,000 - 50,000 @ 52°C	175 - 184	0.10	3	Higher viscosity equivalent to 8330.
	EPALLOY 8370	3.90	15,000 - 25,000 @ 72°C	205 - 212	0.10	3	Highest functionality epoxy phenol novolac resin.

▸EPALLOY® Specialty Epoxy Resins (cont.)

Multifunctional and Faster Cure

	Product Name	Average Epoxy Functionality	Viscosity at 72°C, cP	EEW, g/eq	HCC, max %	Gardner Color, max	Description / Use
Multifunctional Epoxy Resin							
Modified Bisphenol A Epoxy Resin	EPALLOY 9000	3.0	5,500 - 6,500	160 - 180	0.4	2	High functionality, low melt viscosity resin for high temperature applications and T_g modification of other epoxy resins.

	Product Name	Viscosity at 52°C, cP	EEW, g/eq	HCC, max %	Gardner Color, max	Description / Use
Modified Bis-A Epoxy for Faster Cure						
Modified Bisphenol A Epoxy Resin	EPALLOY 7200	2,000 - 4,000	195 - 215	0.5	2	Modified BPA epoxy to provide for faster cure for all temperatures. Eliminates blushing in slower curing epoxies. Excellent for coatings.

Low HCC Bis-F and novolac products are available for some materials above as made to order products.

Resorcinol Epoxy Resin

- Low-viscosity modifier
- Excellent chemical resistance

	Product Name	Average Epoxy Functionality	Viscosity at 25°C, cP	EEW, g/eq	HCC, max %	Gardner Color, max	Description / Use
Resorcinol Epoxy Resin	ERISYS RDGE	2.0	300 - 500	120 - 135	0.10	2	Resorcinol Diglycidyl Ether. Very low viscosity, high reactivity epoxy resin. Modifying resin for novolacs in corrosion resistant coatings and composites.

High purity grade ERISYS RDGE-H is available as a made to order product.

▸EPALLOY® Specialty Epoxy Resins (cont.)

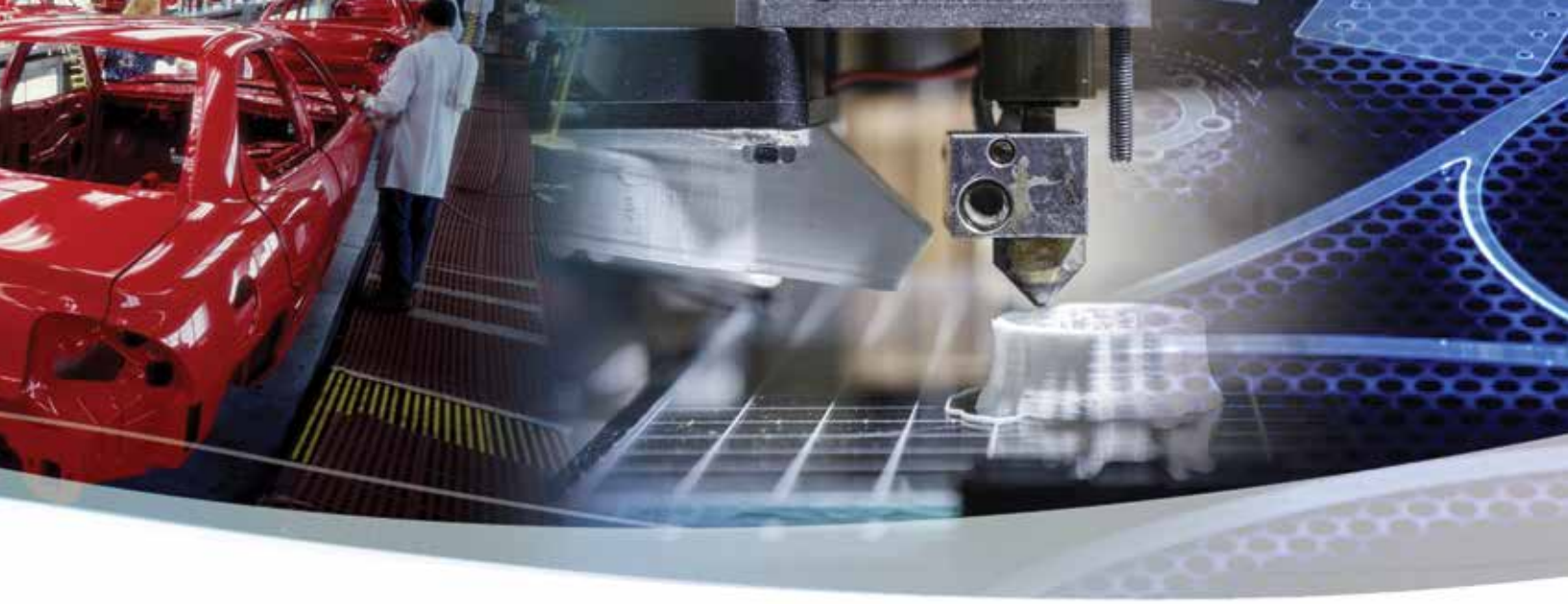
Resorcinol Modified Phenol Novolac Epoxy Resins

- Maximum chemical resistance

	Product Name	Average Epoxy Functionality	Viscosity at 25°C, cP	EEW, g/eq	HCC, max %	Gardner Color, max	Description / Use
Resorcinol Modified Phenol Novolac Epoxy Resins	ERISYS RF50	2.0	700 - 1,400	140 - 155	0.10	2	Non-crystallizing lowest viscosity resorcinol/phenol novolac epoxy resin.
	ERISYS RN25	2.4	5,000 - 6,500	152 - 165	0.10	5	Non-crystallizing medium viscosity resorcinol/phenol novolac epoxy resin.
	ERISYS RN3650	2.8	7,000 - 9,000	141 - 156	0.10	3	Highest functionality resorcinol modified phenol novolac epoxy resin. Maximum chemical resistance and T_g.

Bisphenol A/F Modified Phenol Novolac Epoxy Resins

	Product Name	Average Epoxy Functionality	Viscosity at 25°C, cP	EEW, g/eq	HCC, max %	Gardner Color, max	Description / Use
Bisphenol A Modified Phenol Novolac Epoxy Resins	EPALLOY 7138	2.0	5,500 - 7,500	175 - 185	0.10	1	Low viscosity non-crystallizing novolac modified Bis-A epoxy resin. Excellent replacement for high purity Bis-A resins in filament winding applications.
	EPALLOY 7170	2.05	7,000 - 10,000	177 - 187	0.10	1	Non-crystallizing Bis-A/F resin. 30% epoxidized Bis-F content.
Bisphenol F Modified Phenol Novolac Epoxy Resin	EPALLOY 9237-70	2.10	5,000 - 7,000	170 - 181	0.10	2	Non-crystallizing Bis-A modified Bis-F epoxy resin. Highest Bis-F content and highest T_g in this class.



▸EPALLOY® Specialty Epoxy Resins (cont.)

Cycloaliphatic Epoxy Resins

- Excellent for non-yellowing coatings, electrical insulating components
- Bis-A free epoxy resins

	Product Name	Viscosity at 25°C, cP	EEW, g/eq	HCC, max %	APHA Color, max	Description / Use
Hydrogenated Bisphenol A Epoxy Resins	EPALLOY 5000	1,300 - 2,500	210 - 230	0.2	100	UV Resistant, lower viscosity cycloaliphatic alternative to standard Bis-A resin. Applications include weatherable coatings as replacement to urethane coatings. Excellent adhesion to metal.
	EPALLOY 5001	2,000 - 4,500	190 - 210	0.3	3 Gardner	Faster cure version of EPALLOY 5000 through increased epoxy functionality. (Functionality = 2.4) Ideal for weatherable coatings.
Cycloaliphatic Glycidyl Ester	EPALLOY 5200	700 - 900	160 - 180	0.4	100	Low viscosity Cycloaliphatic Glycidyl Ester epoxy resin used mostly in applications for outdoor electrical insulation designed for medium and high voltage.

Other resin blends available upon request on a made-to-order basis.

Bisphenol A Epoxy Resin & Blends

	Product Name	Viscosity at 25°C, cP	EEW, g/eq	HCC, max %	Gardner Color, max	Description / Use
UNMODIFIED						
Undiluted Bisphenol A Epoxy Resin	EPALLOY 7192	0 - V (1)	230 - 280	0.1	3	Undiluted high molecular weight semi-solid Bisphenol A epoxy resin well suited for tough, durable formulations with improved adhesion.
DILUTED *Bis-A epoxy resin blended with ERISYS diluent.*						
Diluted Bisphenol A Epoxy Resins	EPALLOY 7190 A83	500 - 700	185 - 198	0.1	2	LER diluted with 17% ERISYS GE-6
	EPALLOY 7190 G76	500 - 800	179 - 193	0.1	2	LER diluted with 24% ERISYS GE-10
	EPALLOY 7190 J82	500 - 700	197 - 207	0.1	2	LER diluted with 18% ERISYS GE-8
	EPALLOY 7190 N75	500 - 800	163 - 175	0.1	2	LER diluted with 25% ERISYS GE-20

Other resin blends available upon request on a made-to-order basis.
(1) Gardner-Holdt Viscosity - 70% in Butyl Carbitol

▸EPALLOY® Specialty Epoxy Resins (cont.)

Resin Solutions

	Product Name	NV%	Viscosity at 25°C, cP	EEW on Solids, g/eq	HCC, max %	Gardner Color, max	Description / Use
EPALLOY 7200 SOLUTIONS *Modifying resin for high solids primers with fast tack free time.*							
Modified Bisphenol A Epoxy Resin Solutions	EPALLOY 7200 MIBK90	89 - 91	3,000 - 8,000	195 - 215	0.5	2	90% solids in Methyl Isobutyl Ketone
	EPALLOY 7200 X90	89 - 91	3,500 - 7,500	195 - 215	0.5	2	90% solids in Xylene
EPALLOY 8330 SOLUTIONS *Solutions of high functionality epoxy novolacs in solvents for film coatings.*							
Epoxy Phenol Novolac Solutions	EPALLOY 8330 A85	84 - 86	500 - 1,200	171 - 183	0.10	3	85% solids in Acetone
	EPALLOY 8330 MAK80	79 - 81	800 - 1,300	171 - 183	0.10	3	80% solids in Methyl n-Amyl Ketone
	EPALLOY 8330 MEK85	84 - 86	800 - 1,400	171 - 183	0.10	3	85% solids in Methyl Ethyl Ketone
EPALLOY 8350 SOLUTIONS							
Epoxidized Phenol Novolac Solutions	EPALLOY 8350 X80	79 - 81	1,200 - 3,000	175 - 184	0.1	3	80% solids in Xylene
EPALLOY 8370 SOLUTIONS							
Epoxidized Phenol Novolac Solutions	EPALLOY 8370 A85	84 - 86	5,000 - 7,000	205 - 212	—	3	85% solids in Acetone

Other resin solutions available upon request on a made-to-order basis.

▸ERISYS™ Epoxy Functional Reactive Modifiers

ERISYS GE Series glycidyl ether modifiers are low molecular weight epoxy functional products based on alcohols, glycols and phenols. The product line covers a broad range of TSCA approved modifiers from monofunctional to multifunctional materials. Classified at right.

- Aliphatic Monoglycidyl Ethers (ERISYS GE 5, 6, 7 and 8 Series)
- Aromatic Monoglycidyl Ethers (ERISYS GE 10 Series)
- Aliphatic Diglycidyl Ethers (ERISYS GE 20 Series)
- Aliphatic Triglycidyl Ethers (ERISYS GE 30 Series)
- Glycidyl Esters (ERISYS GS Series)
- Glycidyl Amines (ERISYS GA Series)
- Aliphatic Polyglycidyl Ethers (ERISYS GE 40 and 60)

Monofunctional - Glycidyl Ethers

	Product Name	Viscosity at 25°C, cP	EEW, g/eq	Specific Gravity at 25°C, g/cc	HCC, max %	APHA Color, max	Flash Point °F	Description / Use
Aliphatic	ERISYS GE-5	2 max	145 - 155	0.91 - 0.92	0.10	100	>129	n-Butyl Glycidyl Ether. Most efficient epoxy functional diluent available.
	ERISYS GE-6	1 - 4	205 - 235	0.90 - 0.93	0.10	100	197	2-Ethylhexyl Glycidyl Ether. Excellent replacement for Butyl Glycidyl Ether as a low viscosity reactive diluent.
	ERISYS GE-7	1 - 6	220 - 235	0.89 - 0.91	0.05	100	>200	C_8-C_{10} Aliphatic Glycidyl Ether. Natural alcohol based. Used for high solids coatings, tooling and civil engineering applications.
	ERISYS GE-8	5 - 10	275 - 300	0.88 - 0.90	0.05	100	>200	C_{12}-C_{14} Aliphatic Glycidyl Ether. Natural alcohol based. Used in flooring, aggregate bonding and adhesives.
Aromatic	ERISYS GE-10	5 - 10	170 - 195	1.07 - 1.09	0.10	1 Gardner	>250	o-Cresyl Glycidyl Ether. Viscosity modifier for construction, flooring and casting. Excellent moisture tolerance.
	ERISYS GE-11	20 - 30	215 - 240	1.01 - 1.03	0.10	1 Gardner	>250	p-tertiary Butyl Phenyl Glycidyl Ether. Modifier for Bisphenol A resins to eliminate crystallization. Good electrical properties. Easier to handle vs. GE-10 or GE-13.
	ERISYS GE-12	100 - 140	300 - 325	0.97 - 1.00	0.15	2 Gardner	482	Nonyl Phenyl Glycidyl Ether. Excellent compatibilizer for aliphatic curing agents. Reduced induction time with non-reactive modifier.
	ERISYS GE-13	4 - 7	150 - 165	1.10 - 1.13	0.10	2 Gardner	237	Phenyl Glycidyl Ether. Lowest viscosity aromatic modifier. Excellent for electrical applications and for preparing resin/curing agent adducts.

▸ERISYS™ Epoxy Functional Reactive Modifiers (cont.)

Difunctional- Glycidyl Ethers

- Reduce viscosity – maintain physical properties better than monofunctional diluents
- Use higher concentrations

	Product Name	Viscosity at 25°C, cP	EEW, g/eq	Specific Gravity at 25°C, g/cc	HCC, max %	APHA Color, max	Flash Point °F	Description / Use
Aliphatic Diglycidyl Ether	ERISYS GE-20	10 - 18	125 - 137	1.05 - 1.07	0.10	100	>230	Neopentyl Glycol Diglycidyl Ether. Aliphatic difunctional modifier for filament winding, coatings and electrical applications.
	ERISYS GE-21	10 - 18	120 - 130	1.09 - 1.11	0.10	100	>230	1,4-Butanediol Diglycidyl Ether. Aliphatic difunctional modifier for improved flexibility over GE-20 at comparable viscosity.
	ERISYS GE-22	45 - 75	145 - 165	1.07 - 1.09	0.10	100	>230	Cyclohexanedimethanol Diglycidyl Ether. Cycloaliphatic difunctional modifier with outstanding weatherability. Excellent for machinery grouts and adhesives.
	ERISYS GE-25	15 - 23	143 - 156	1.06 - 1.08	0.05	100	300	1,6-Hexanediol Diglycidyl Ether. Aliphatic difunctional epoxy reactive diluent.
	ERISYS GE-29	275 - 500	250 - 300	1.46 - 1.51	0.50	5 Gardner	>230	Dibromo Neopentyl Glycol Diglycidyl Ether. High bromine containing, low viscosity, difunctional epoxy for flame retardant adhesives and encapsulants.
	ERISYS EGDGE	13 - 30	116 - 132	1.14 - 1.16	—	100	>266	Ethylene Glycol Diglycidyl Ether. Used as a crosslinker for acid functional acrylic polymers.

Flexibilizers

- Reduce viscosity, increase flexibility and elongation – improve impact resistance & toughening
- Lower T_g and modulus

	Product Name	Viscosity at 25°C, cP	EEW, g/eq	Specific Gravity at 25°C, g/cc	HCC, max %	Gardner Color, max	Flash Point °F	Description / Use
	ERISYS GE-23	30 - 60	175 - 205	1.13 - 1.15	0.10	100 APHA	>300	Dipropylene Glycol Diglycidyl Ether. Standard grade for higher tensile elongation and flexibility. GE-23LV is a lower viscosity and lower chloride version of GE-23.
Aliphatic Di & Triglycidyl Ethers	ERISYS GE-24	60 - 70	310 - 330	1.05 - 1.07	0.10	60 APHA	>300	Polypropylene Glycol Diglycidyl Ether. Diepoxide of an aliphatic polyglycol used as a diluent and/or flexibilizer in high viscosity, brittle epoxy formulations.
	ERISYS GE-35	300 - 500	550 - 650	1.01 - 1.03	—	8	>200	Castor Oil Triglycidyl Ether. Low viscosity trifunctional flexibilizer. Provides increased impact and thermal shock resistance to epoxy formulations. Low moisture pick-up.
	ERISYS GE-35H	300 - 500	550 - 650	1.01 - 1.08	—	8	>200	Castor Oil Glycidyl Ether. Lower modulus version of GE-35.
	ERISYS GE-36	200 - 320	620 - 680	1.02 - 1.04	0.10	2	>200	Propoxylated Glycerin Triglycidyl Ether. Aliphatic trifunctional flexibilizer. Used in severe thermal cycling conditions.
	ERISYS GE-38	1,070 - 1,390	160 - 180	1.21 - 1.25	0.7	3	200	Polyglycerol-3-Polyglycidyl Ether. Flexible epoxy. Not TSCA registered.

▸ERISYS™ Epoxy Functional Reactive Modifiers (cont.)

Multifunctional- Glycidyl Ethers

- Increase cross-link density and lower viscosity
- Use at much higher levels

	Product Name	Viscosity at 25°C, cP	EEW, g/eq	Specific Gravity at 25°C, g/cc	HCC, max %	Gardner Color, max	Flash Point °F	Description / Use
Aliphatic Triglycidyl Ether	ERISYS GE-30	100 - 200	135 - 150	1.14 - 1.16	0.10	100 APHA	>200	Trimethylolpropane Triglycidyl Ether. Low viscosity, high functional epoxy modifier. Excellent for 100% solids adhesives and coatings.
Aliphatic Triglycidyl Ether	ERISYS GE-31	200 - 300	150 - 170	1.19 - 1.21	0.10	4	>200	Trimethylolethane Triglycidyl Ether. Low viscosity high functional epoxy modifier. Use to increase crosslink density and enhance chemical resistance.
Polyfunctional Glycidyl Ether	ERISYS GE-40	900 - 1,200	156 - 170	1.27 - 1.33	1.5	3	>300	Pentaerythritol Glycidyl Ether. Medium viscosity tetrafunctional reactive modifier. Compatible with most standard epoxy resins at all concentrations. Not TSCA registered.
Polyfunctional Glycidyl Ether	ERISYS GE-60	8,000 - 18,000	160 - 195	1.27 - 1.30	0.50	2	>320	Sorbitol Polyglycidyl Ether. Aliphatic polyfunctional modifier to impart higher reactivity and crosslink density to epoxy resin formulations and crosslink acid functional polymers. Bis-A replacement alternative.

Glycidyl Esters

	Product Name	Viscosity at 25°C, cP	EEW, g/eq	Specific Gravity at 25°C, g/cc	HCC, max %	Gardner Color, max	Flash Point °F	Description / Use
Glycidyl Esters	ERISYS GS-110	5 -15	238 - 256	0.95 - 0.97	0.30	50 APHA	>250	Glycidyl Ester of Neodecanoic Acid. Efficient and economical diluent for viscosity reduction.
Glycidyl Esters	ERISYS GS-120	400 - 900	390 - 470	0.97 - 1.00	2.0	9	>200	Diglycidyl Ester of Dimer Acid. Flexibilizing modifier for rigid epoxy resin systems.

Glycidyl Amine

	Product Name	Viscosity at 25°C, cP	EEW, g/eq	Specific Gravity at 25°C, g/cc	HCC, max %	Gardner Color, max	Flash Point °F	Description / Use
Glycidyl Amine	ERISYS GA-240	1,600 - 3,000	95 - 110	1.14 - 1.16	0.3	5	>420	Epoxidized meta-Xylenediamine. Will increase crosslink density of modified systems. An alternative to MY-720 in tetra-functional epoxy matrix. Safer alternative to polyaziridines in acrylic emulsions.

▸Hypro™ Reactive Liquid Polymers (RLP)

Hypro Reactive Liquid Polymers (RLP) are synthetic rubber with chemical functionality. They incorporate rubber properties into brittle thermoset resins, adhesives, coatings and composites.

Hypro RLP combine the benefits of a low molecular weight butadiene-acrylonitrile rubber with terminal chemical functionality. They impart toughness, improve adhesion, and extend performance to low temperatures. The toughness shows in many attributes: crack resistance, fracture toughness, impact resistance, resilience, interlaminar adhesion, peel adhesion and thermal cycling.

▸The Hypro RLP Toughening Mechanism

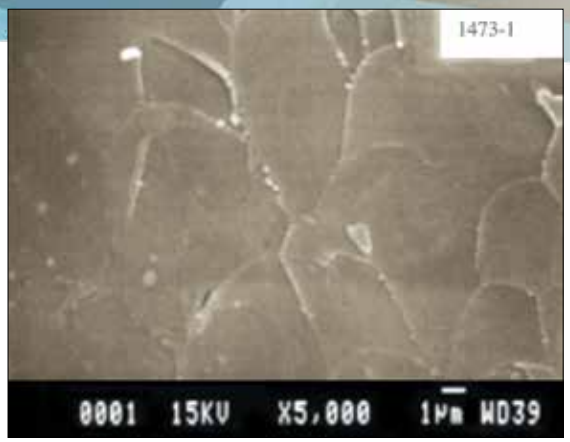
With the proper selection of acrylonitrile content, RLP will be soluble with thermoset resins. When the resin system cures, the Hypro RLP terminal functionality reacts into the thermoset resin, and the synthetic rubber precipitates to form discreet rubber particles. These micron-scale particles absorb strain energy. **Picture 1** shows a magnification of cured epoxy resin. It is a brittle, glassy resin. **Picture 2** shows the same epoxy modified with Hypro RLP. The discrete rubber particles provide the toughening and the epoxy matrix maintains the strength of the unmodified epoxy.

▸Typical Levels – Hypro RLP Toughened Systems

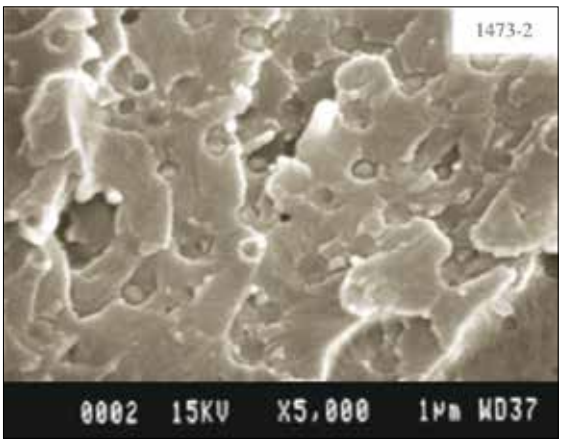
The optimum Hypro RLP level varies with the type of resin. The general guidelines are that most systems require 5 phr to provide enough rubber particles for significant toughening and that above 20 phr enough RLP remains soluble with the resin, and it acts as a flexibilizer in addition to a toughening agent.

Epoxy composites and structural adhesives typically have < 15 phr, and sealants and coatings typically have >25 phr. Unsaturated polyester composites tend to have < 3 phr, and vinyl ester tends to have 5-to-10 phr. Acrylic adhesives and sealants tend to have multiple toughening agents and the Hypro RLP may be up to 20 phr.

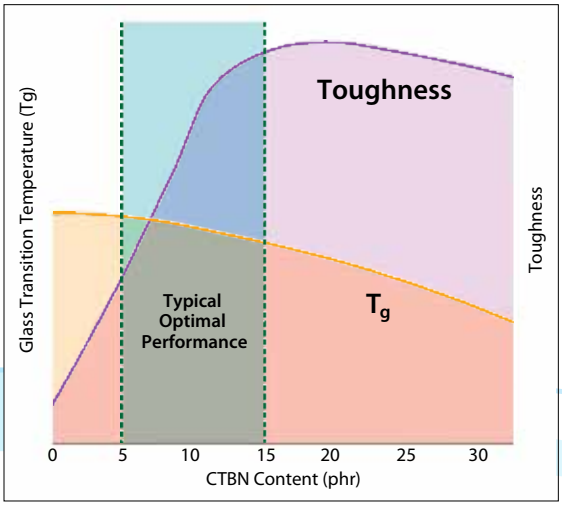
Figure 1 graphically depicts the general guideline for RLP incorporation, demonstrating the relationships between CTBN content, T_g and toughness.



Picture 1. *Cured, Unmodified Epoxy Resin*



Picture 2. *Hypro RLP-Modified Epoxy Resin*



Reference bibliography #12, 19 and 23

Figure 1. *General Guideline for Hypro RLP incorporation*

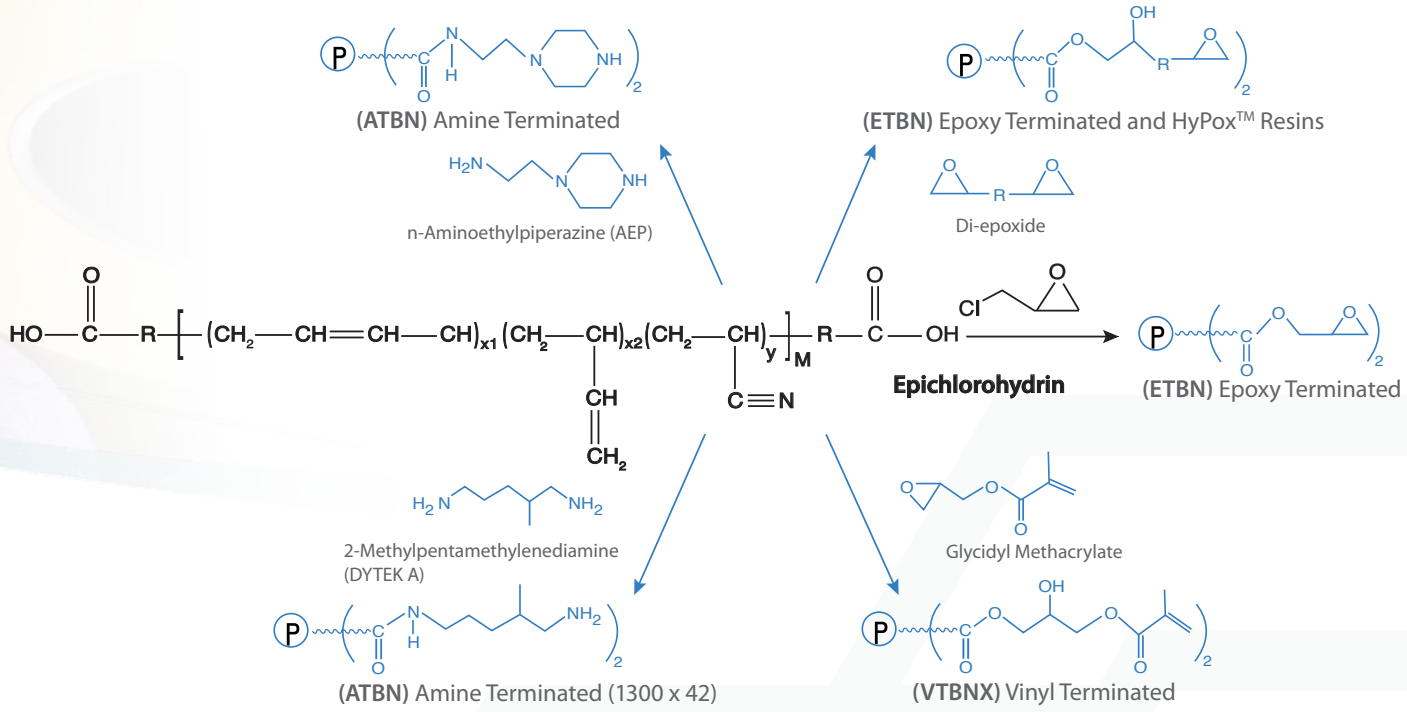


Figure 2. *Hypro CTBN and Derivitives Chemical Structure*

▸Hypro™ Reactive Liquid Polymers (cont.)

Hypro CTBN typically requires chemical modification for effective incorporation into thermoset chemistries. Choice of terminal chemistry will depend on the application and end-use.

CVC Thermoset Specialties offers CTBN with alternative terminal reactivity (**Figure 2**) and the HyPox elastomer-modified epoxy resins for easy incorporation by formulators.

The Hypro CTBN can be used directly in epoxy-anhydride systems and in unsaturated polyester. Other thermoset systems require chemical modification.

Amine Terminated Butadiene-Acrylonitrile (ATBN) are typically used as co-curatives to epoxies and isocyanates in ambient-cure adhesives, coatings, sealants and in some heat-cured composites.

Methacrylate (Vinyl) Terminated Butadiene-Acrylonitrile (VTBNX) can be the primary toughening agent in acrylic adhesives, sealants, and composites and as complementary toughening agents in vinylester and in unsaturated polyester composites and adhesives.

Epoxy-Terminated Butadiene-Acrylonitrile (ETBN) include both glycidyl esters of a CTBN and epoxy adducts of CTBN. Some of these are sold as HyPox Elastomer-Modified Epoxy Resins. The Hypro ETBN and the HyPox resins are toughening agents for epoxy coatings, adhesives and composites. Other specialty applications are as toughening agents for cyanate esters and for unsaturated polyester. Many formulators perform custom reactions with the Hypro CTBN to meet the requirements of their systems.

Hydroxyl-Terminated Butadiene (HTB) is principally used for polyurethane potting compounds, coatings, sealants and other thermosets, providing excellent moisture resistance, electrical insulation, low glass transition temperature and extraordinary compatibility with fillers (**Figure 3**).

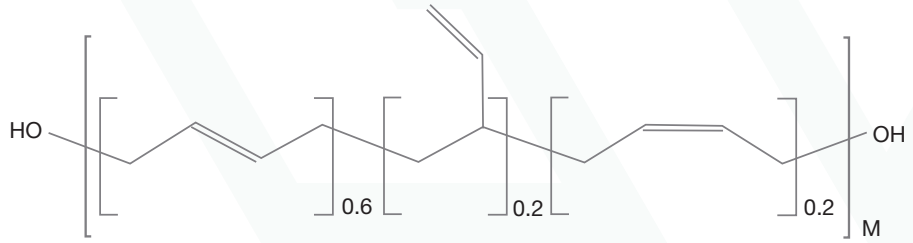


Figure 3. *Hypro HTB Chemical Structure*

Guidelines for Pre-Reacting Hypro™ RLP Adducts

The Hypro CTBN synthetic rubbers are butadiene polymers and butadiene-acrylonitrile copolymers with carboxyl groups at the polymer chain ends. Most formulators use a pre-reacted CTBN to attain the optimum benefits. The pre-reaction may be a simple modification of the carboxyl to another reactive moiety or a reaction with resins (typically epoxy or vinyl ester) to make a master batch ready for dilution.

The typical process steps

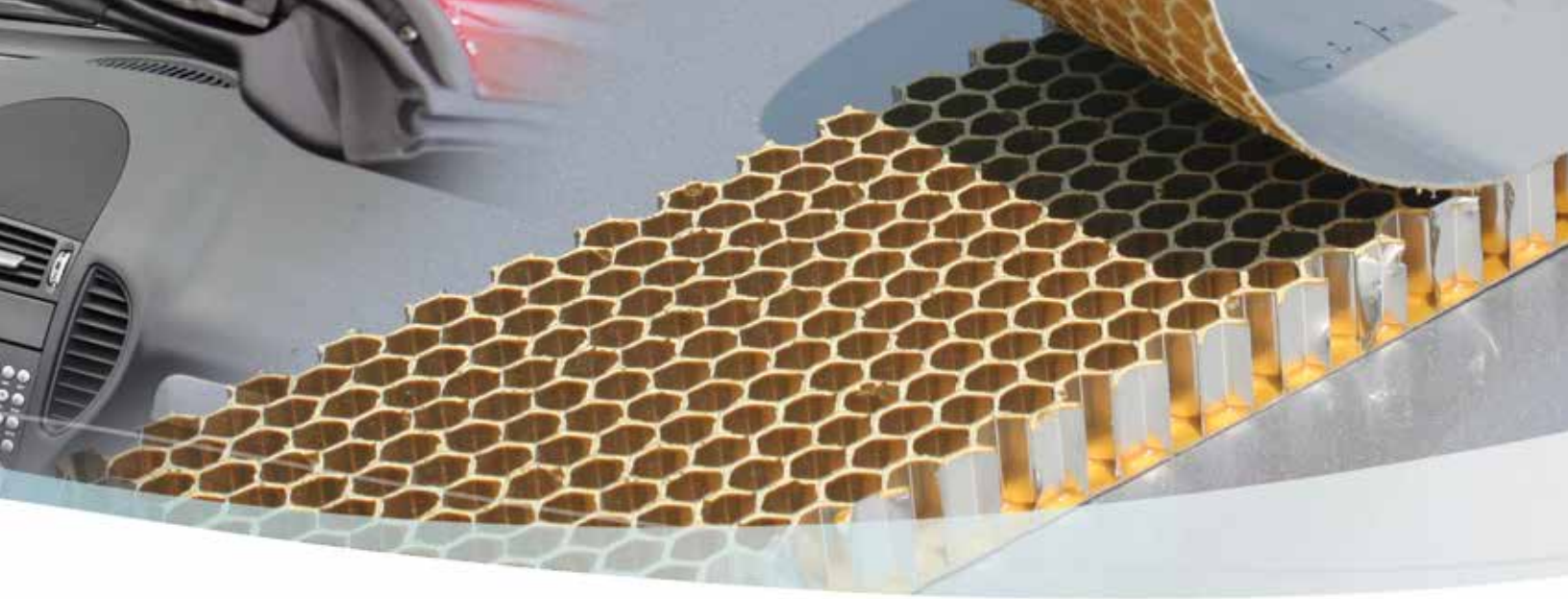
1. Choose the epoxy resin most compatible with the final product.
2. Choose the Hypro CTBN for the desired compatibility and performance.
3. Combine a molar excess (10:1) or weight excess (60:40) of epoxy to CTBN
4. Heat and react under dry nitrogen with agitation until the acid number is <1.
    a. Typical temperatures range from 60°C with catalyst to 175°C for solid resins
    b. Typical time is 30 minutes-to-7 hours and varies with temperature and catalyst
5. Dilute with additional epoxy resin to the desired CTBN concentration, typically 6-to-12phr for composites and structural adhesives.

Processing options

- Catalysts increase the reaction rate, and the resultant adduct tends to increase in viscosity with time. Catalyst options include triphenyl phosphine (preferred), ethyltriphenylphosphoniumiodide, benzyl dimethyl amine, and other esterification catalysts.
- Epoxy resin can be co-reacted with CTBN to form an adduct. Addition of these adducts in the epoxy matrix increases ductility and toughness after cure.

Other processing notes

- Solid epoxy-CTBN adducts can be made by adducting solid epoxy resin or by advancing liquid epoxy and CTBN with BPA or by vulcanizing CTBN-epoxy adducts.
- Vinyl ester-CTBN adducts can be one step—combine epoxy resin, CTBN, and methacrylic acid and react or multi-step—react epoxy and CTBN before adding and reacting methacrylic acid. This typically requires a stabilizer.
- Water-dispersed CTBN-epoxy adducts for electrodeposition coating require several subsequent steps after producing the CTBN-epoxy adduct.



▸Hypro™ Reactive Liquid Polymers (cont.)

Carboxyl-Terminated Butadiene (CTB) and Butadiene-Acrylonitrile (CTBN) Polymers

Carboxyl-terminated butadiene (CTB) and butadiene-acrylonitrile (CTBN) copolymers improve toughness, low-temperature properties, chemical and water resistance in epoxy, coating, vinyl ester, SMC/BMC, acrylic, plasitisol and other thermoset systems. Global standard as a chemical intermediate for adducts for thermoset systems.

Product Name	Acrylonitrile %	Viscosity* at 27°C, cP	Carboxyl Equiv. phr	Acid Number, mgKOH/g	Molecular Weight	Functionality	Gardner Color, max	Glass Transition, T_g, °C	Specific Gravity at 25°C, g/cc	Solubility Parameter, $(cal/cm^3)^{1/2}$	Description / Use
Hypro 2000X162 CTB	0	50,000	0.045	25	4,200	1.9	3	-77	0.907	8.14	Chemical intermediate to incorporate polybutadiene into other resins.
Hypro 1300X31 CTBN	10	65,000	0.050	30	3,800	1.9	5	-66	0.924	8.46	Copolymer with 10% acrylonitrile, increased compatibility with filled systems.
Hypro 1300X47 CTBN	10	6,750	0.050	30	3,800	1.9	5	-66	0.920	--	Hypro 1300X31 with 18% styrene, increased toughness, crack resistance, and adhesion promoter in UPE.
Hypro 1300X8 CTBN	18	135,000	0.052	29	3,550	1.9	9	-52	0.948	8.82	Most popular balance of compatibility, viscosity, and toughening.
Hypro 1300X13 CTBN	26	500,000	0.057	32	3,150	1.9	5	-39	0.960	9.15	Higher level of acrylonitrile, good compatibility with Bis-A, Bis-F, and phenol-novolac epoxies.
Hypro 1300X9 CTBNX	18	160,000	0.067	38	3,600	2.4	4	-52	0.955	8.87	CTBN with 2.4 functionality, excellent for composites and vinyl ester resins.
Hypro 1300X18 CTBNX	22	350,000	0.070	39	3,400	2.4	5	-46	0.961	8.99	CTBN with 2.4 functionality, excellent for composites and vinyl ester resins.

Note 1 - Hypro 1300X8 is also available as Hypro 1300X8F with an FDA compliant stabilizer.
Note 2 - Hypro 1300X13 is also available as Hypro 1300X13F with an FDA compliant stabilizer and as 1300X13NA (lower sodium version) and 1300X13CL (lower chloride version).
* Viscosity reflects mid-point.

▸Hypro™ Reactive Liquid Polymers (cont.)

Amine-Terminated Butadiene (ATB) and Butadiene-Acrylonitrile (ATBN) Polymers

Amine-terminated butadiene (ATB) and butadiene-acrylonitrile (ATBN) copolymers enhance toughness, flexibility, low-temperature properties and adhesion to substrates in two part amine cured epoxies, and impact resistance and adhesion to substrates in two part coatings. Typical uses include structural adhesives, coatings and linings for improved corrosion resistance, construction joint sealers and mastics, powder coatings and filament-wound pressure vessels.

Product Name	Acrylonitrile %	Viscosity* at 27°C, cP	AHEW, g/eq	AEW,* g/eq	Amine Value, mgKOH/g	Molecular Weight	Functionality	Gardner Color, max	Glass Transition, T_g, °C	Specific Gravity at 25°C, g/cc	Free Amine, %	Description / Use
Hypro 2000X173 ATB	0	185,000	950	950	59	4,450	1.9	3	-80	0.915	4.0	Amine-terminated polybutadiene, lowest polarity, excellent compatibility with fillers, cross-links at double bonds, reacts at terminal amine moiety.
Hypro 1300X21 ATBN	10	160,000	1,200	1,200	47	4,050	1.9	8	-65	0.938	2.0	Co-curative in polyurethane and epoxy adhesives and sealants. Excellent low-temperature properties.
Hypro 1300X16 ATBN	18	200,000	900	900	62	3,800	1.8	8	-51	0.956	3.5	Most popular balance of compatibility, viscosity, and toughening. Excellent in adhesives, composites and coatings.
Hypro 1300X35 ATBN	26	500,000	700	700	80	3,500	1.8	10	-38	0.978	7.0	Highest level of acrylonitrile, best compatibility with polar components.
Hypro 1300X45 ATBN	18	375,000	1,850	1,850	30	3,800	1.8	8	-55	0.955	<0.1	Hypro 1300X16 with no residual amine (AEP), designed for electrodeposition and powder coatings.
Hypro 1300X42 ATBN	18	100,000	225	450	125	3,800	1.8	10	-59	0.942	10.0	Similar to Hypro 1300X16 with primary amine (2-methylpentamethylenediamine)–No AEP.

For Hypro 1300X42 ATBN, a primary amine terminated material, Weight per Active Hydrogen is AEW/2.

* Viscosity and AEW reflect mid-point.

▸Hypro™ Reactive Liquid Polymers (cont.)

Epoxy-Terminated Butadiene (ETB) and Butadiene-Acrylonitrile (ETBN) Glycidyl Ester Polymers

Glycidyl-esters of butadiene (ETB) and butadiene-acrylonitrile (ETBN) copolymers incorporate 100% rubber toughening into epoxy matrix without pre-reaction or additional epoxy resin. Excellent for epoxy composites and adhesives. Contains no Bisphenol A or Bisphenol A Diglycidyl Ether (BADGE).

Product Name	Acrylonitrile %	Viscosity* at 27°C, cP	Viscosity* at 52°C, cP	EEW,* g/eq	Acid number, mgKOH/g	Molecular Weight	Gardner Color, max	Glass Transition, T_g, °C	Solids, %	Description / Use
Hypro 2000X174 ETB	0	20,000	3,500	2,800	<0.1	4,350	7	-77	100	Lowest viscosity epoxy-functional rubber toughener, good compatibility with fillers.
Hypro 1300X68 ETBN	18	300,000	20,000	2,500	<0.1	3,700	8	-52	100	Balanced viscosity and compatibility, excellent for mix-and-use epoxy adhesives and for composites.
Hypro 1300X63 ETBN	26	725,000	40,000	2,000	<0.1	3,300	11	-39	100	Best compatibility with Bis-A, Bis-F, and novalac epoxies for shelf stable systems.

Hypro 2000X174, 1300X68 and 1300X63 are developmental products and specification ranges are subject to change based on manufacturing history.
* Viscosity and EEW reflect mid-point.

Epoxy-Terminated Butadiene-Acrylonitrile (ETBN) Resin Adducts

Epoxy-terminated butadiene-acrylonitrile (ETBN) resin adducts with no excess epoxy. The Hypro ETBN have much higher rubber content when compared to HyPox CTBN-modified epoxies.

Product Name	Acrylonitrile %	Viscosity* at 25°C, cP	Viscosity* at 50°C, cP	EEW,* g/eq	Acid number, mgKOH/g	Molecular Weight	Specific Gravity at 25°C, g/cc	Elastomer Content, %	Solids, %	Description / Use
Hypro 1300X40 ETBN	18	1,450	N.A.	2,300	<1.5	4,230	0.945	40	50 (styrene)	Toughening agent for vinyl ester, acrylic, UPE resins and composites. Improves crack-resistance and appearance in Sheet Molding Compounds (SMC).
Hypro 1300X44 ETBN	18	N.A.	1350k	2,300	<3	4,230	—	80	100	Excellent toughening agent for cyanate ester resins, adhesives and composites.

* Viscosity and EEW reflect mid-point.

▸Hypro™ Reactive Liquid Polymers (cont.)

Methacrylate (Vinyl) Terminated Butadiene (VTB) and Butadiene-Acrylonitrile (VTBNX) Polymers

Methacrylate (vinyl) terminated butadiene (VTB) and butadiene-acrylonitrile (VTBNX) liquid rubber for low temperature toughness, impact resistance and improved resilience in acrylic adhesives, sealants and coatings and in vinyl ester composites. The new, LC versions have less color and are more stable for longer shelf life.

Product Name	Acrylonitrile %	Acid Number, mgKOH/g	Viscosity* @ 27°C, cP	Molecular Weight	Functionality	Gardner Color, max	Glass Transition, T_g, °C	Specific Gravity at 25°C, g/cc	Solubility Parameter, $(cal/cm^3)^{1/2}$	Solids, %	Description / Use
Hypro 2000X168LC VTB	0.0	4.0	80,000	4,450	1.9	3	-80	0.929	8.40	100	Lowest T_g, lowest viscosity, most effective for lower temperature properties. More stable, less color.
Hypro 1300X33LC VTBNX	18.0	4.0	250,000	3,900	2.4	4	-49	0.967	8.90	100	Best balance of viscosity, low temperature properties and improved adhesion. More stable, less color.
Hypro 1300X43LC VTBNX	21.5	4.0	400,000	3,700	2.4	5	-45	0.981	9.09	100	Excellent improvement in adhesion, resilience, toughness. More stable, less color.

Hypro 2000X168LC is a developmental product and specification ranges are subject to change based on manufacturing history. Properties in the table reflect target properties only.
* Viscosity reflects mid-point.

Hydroxyl-Terminated Polybutadiene (HTB), Polybutadiene Polyol

Polybutadiene polyols (HTB) feature hydrophobicity, low glass-transition temperature, electrical resistivity, compatibility with fillers and extenders, and hydroxyl functionality for reaction in polyurethane systems or as chemical intermediates.

These are much lower viscosity than the other Hypro polymers. They are the industry standard polymer for polyurethane potting compounds and for the inclusion of polybutadiene properties into thermoset formulations.

Product Name	Viscosity* at 30°C, cP	OH Value*, meq/g	OH Equiv. wt., g/eq.	OH No., mg KOH/g	Molecular Weight	Functionality	Gardner Color, max	Glass Transition, T_g, °C	Specific Gravity at 25°C, g/cc	Solubility Parameter, $(cal/cm^3)^{1/2}$	1,2-Vinyl, %	Description / Use
Hypro 2800X95 HTB	5,000	0.83	1,205	46	2,800	2.5	< 1	-75	0.904	8.12	20	Industry standard grade
Hypro 1200X90 HTB	1,400	1.80	556	101	1,200	2.5	< 1	-70	0.913	8.27	20	Lower viscosity

* Viscosity and OH Value reflect mid-point.

▸HyPox™ Elastomer Modified Epoxy Resins

Elastomer modification to epoxy resins is a valuable way to merge the benefits of alternate polymer chemistry with the convenience of conventional 1 or 2 part epoxy handling and performance. CVC offers CTBN modification for toughening and chip resistance, Dimer Acid modification for flexibility and Urethane modification for adhesion to difficult surfaces.

These are grouped under the series designation:

- Dimer Acid Modified Epoxy Resins (HyPox D Series)
- Urethane Modified Epoxy Resins (HyPox U Series)
- CTBN Modified Resins (HyPox R Series)

Each resin system is further divided by resin base: "A" for Bisphenol A, "F" for Novolacs and "M" for Glycols

Dimer Acid Modified Epoxies

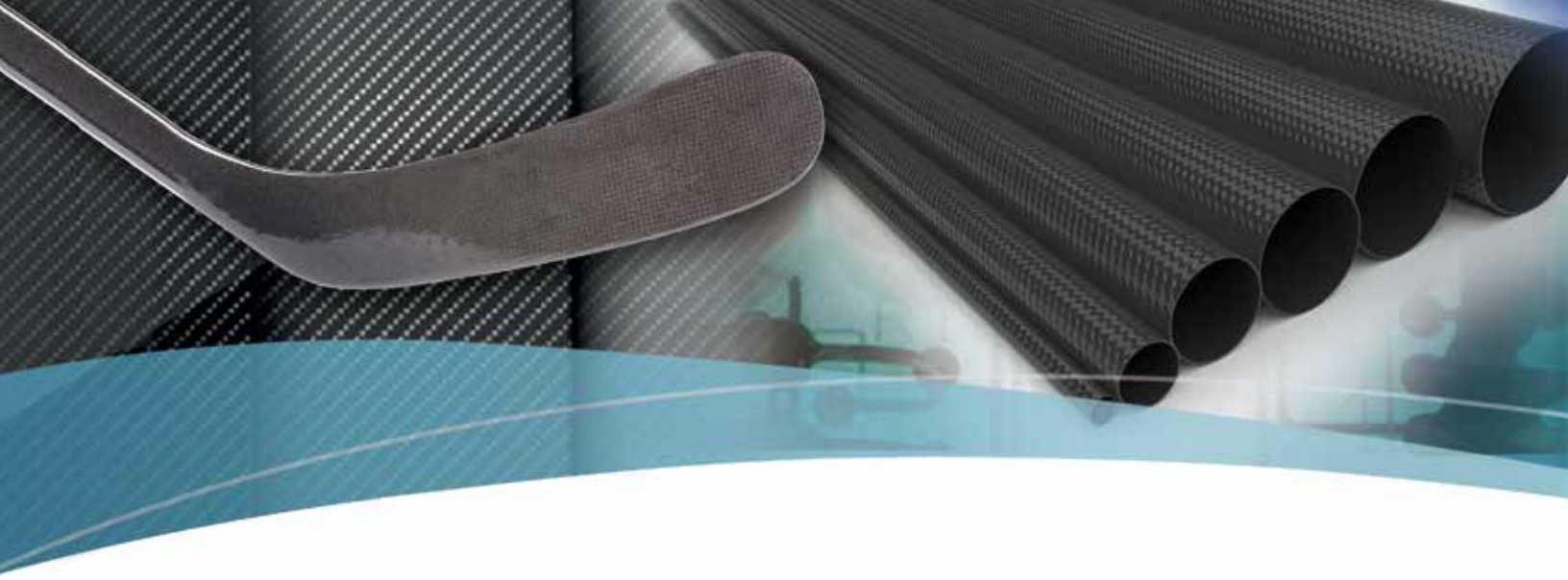
	Product Name	Elastomer Content %	Viscosity* at 52°C, cP	EEW,* g/eq	Gardner Color, max	Acid No., max	Description / Use
Dimer Acid Modified Epoxy Resin	HyPox DA323	40	50,000	660	12	0.1	Bis-A epoxy resin adduct with Dimer Acid. Semi-solid at room temperature. Improves impact resistance, thermal shock and has excellent compatibility with all standard resins and curing agents.

* Viscosity and EEW reflect mid-point.

Urethane Modified Epoxies

	Product Name	Elastomer Content %	Viscosity* at 25°C, cP	EEW,* g/eq	Gardner Color, max	Description / Use
Urethane Modified Epoxy Resin	HyPox UA10	12	650,000	215	2	Improved adhesion to vinyl and other elastomers.
	HyPox UA11	5	35,000	215	2	Improved adhesion to vinyl and other elastomers.

* Viscosity and EEW reflect mid-point.



▸HyPox™ Elastomer Modified Epoxy Resins (cont.)

CTBN Modified Epoxies

	Product Name	Elastomer Content %	Viscosity* at 25°C, cP	EEW,* g/eq	Gardner Color, max	Acid Number, mgKOH/g	Description / Use
Bisphenol A Modified	HyPox RA 95	5 - 7	22,500 @ 52°C	200	4	0.2	Bis-A epoxy resin adduct with solid CTBN for good high-temperature performance and green strength. Is used as a tackifier for adhesives and composites.
	HyPox RA 840	40	190,000	340	10	0.1	Bis-A epoxy resin adduct with 1300X8 CTBN used as a reactive toughener to increase toughness, impact resistance, and peel adhesion in liquid Bis-A systems.
	HyPox RA 1340	40	450,000	350	10	0.1	Bis-A epoxy resin adduct with 1300X13 CTBN used as a reactive toughener to increase toughness, impact resistance, and peel adhesion. Excellent compatibility in liquid Bis-A systems.
	HyPox RA 16213	29	240,000 @ 27°C	265	—	1	Bis-A epoxy resin adduct with 2000X162 CTB and 1300X13 CTBN. Best combination of rubber toughening and solubility with liquid epoxy with excellent properties at -40°C with Dicyandiamide cured adhesives.
Bisphenol F Modified	HyPox RF 1320	20	38,000	215	6	0.1	Bis-F epoxy resin adduct with 1300X13 CTBN to increase toughness, impact resistance, and peel adhesion for low-viscosity epoxy phenol novolac systems.
	HyPox RF 1341	40	225,000	308	—	0.2	Bis-F epoxy resin adduct with 1300X13 CTBN. Higher rubber content for lower dosing level than RF1320 to increase toughness, impact resistance, and peel adhesion for low-viscosity epoxy phenol novolac systems.
	HyPox RF 928	20	55,000	210	10	0.1	Epoxy Phenol Novlac resin adduct with 1300X13 CTBN with 2.3 functionality. Increases toughness, impact resistance, and peel adhesion for medium-viscosity, higher T_g, epoxy phenol novolac systems.
	HyPox RF 933	20	150,000	220	10	0.1	Epoxy Phenol Novlac resin adduct with 1300X13 CTBN with 2.6 functionality. Highest functionality for best chemical and heat resistance to increase toughness, impact resistance, and peel adhesion.
Glycol Modified	HyPox RM 20	50	6,000	290	10	0.1	Neopentyl Glycol Diglycidyl ether adduct with 1300X8 CTBN having lower viscosity than liquid Bis-A epoxy resin. Increases flexibility, impact resistance, resilience to fatigue and improves adhesion.
	HyPox RM 22	50	20,000	340	10	0.1	Cyclohexanedimethanol Diglycidyl ether adduct with 1300X13 CTBN having higher viscosity and better compatibility than RM20. Increases flexibility, impact resistance, resilience to fatigue and improves adhesion.
Solid Bisphenol A Modified	HyPox RK 84L	32	—	1,375	Amber	—	Solid Bis-A epoxy resin modified 1300X13 CTBN useful as a reactive toughener for structural reinforcement in solid Bis-A systems.
	HyPox RK 820	20	—	950	Amber	—	Solid Bis-A epoxy resin modified 1300X13 CTBN useful as a reactive toughener for structural reinforcement in solid Bis-A systems.

* Viscosity and EEW reflect mid-point.

▸OMICURE™ Curing Agents, Accelerators & Catalysts

Accelerating the cure speed or lowering the cure temperature is the role of these versatile additions. Whether the need is for acceleration of Dicyandiamide (Dicy) and anhydrides or catalytic cures of epoxy resins, a CVC product is available to fit your needs for latency or cure profile.

These products include:

- Dicyandiamide (OMICURE DDA Series)
- Substituted Urea Accelerators for Dicyandiamide (OMICURE U Series)
- Boron-Based Catalysts (OMICURE B Series)

Curing Agents

Dicyandiamide Curing Agent – Typical use levels in DGEBA from 5-10 phr.

- Common curative for 1k epoxy systems
  - composites and prepregs
  - automotive, adhesives and coatings

	Product Name	Onset Melting Point (°C)	Particle Size				Color	Typical Flow Control Content	Description / Use
			Mean Particle Size	10%	50%	90%			
Dicyandiamide Curing Agent	OMICURE DDA 5	207- 212	4µ	<2µ	<7µ	<10µ	White	2 to 3%	Ultra-fine particle size Dicyandiamide for the most critical applications. Provides for excellent dispersability, maximum reactivity, uniform cure, and low settling potential.
	OMICURE DDA 10	207- 212	12µ	<4µ	<11µ	<30µ	White	1.5 to 2.5%	Fine particle size with good dispersability, reactivity and uniform cure.
	OMICURE DDA 50	207- 212	21µ	<7µ	<16µ	<40µ	White	1.5 to 2.5%	Intermediate particle size product provides for cost effective, stable, one part systems for elevated temperature cure applications.
	OMICURE DDA 100	207- 212	Coarse Grade				White	0%	Coarse, unground grade of Dicyandiamide for those applications where particle size is not an issue. Contains no flow control agent.

Aromatic Amine Curing Agent

	Product Name	MP, °C	Color	Use Level PHR	Gardner Color, max	Glass Transition, T_g °C	Description / Use
Aromatic Amine/ Curing Agent	OMICURE 33-DDS	162-177	Tan to Off-White	36	—	—	Safer replacement for MDA. 33-DDS cured systems can yield higher compressive strength, higher HDT and less brittleness than MDA.

▸OMICURE™ Curing Agents, Accelerators & Catalysts (cont.)

OMICURE Substituted Urea Accelerators

Accelerators used with Dicyandiamide to lower required cure temperatures and increase speed of reaction

- Lower the reaction temperature and time for dicy-epoxy cure
  - reduces stability (shelf life) of mixed systems
- Optimum level ≈ 1-5 phr

	Product Name	Typical Peak Melting Point (°C)	Color	Use level PHR with Dicyandiamide(1)	Particle Size (percent through 325 screen)		Time to Double in Viscosity @ 25°C(2) (weeks)	Time to Cure to 95% Full Cure(3)		T_g (°C)(2)	Description / Use
					Regular Grade	M Grade (micronized)		at 120°C	at 140°C		
Substituted Urea Accelerators	OMICURE U-405	126 - 136	off-white	1 - 5	80	95	10	22	9	118	Phenyl Dimethyl Urea
	OMICURE U-24	180 - 195	off-white	1 - 5	80	95	10	20	7	127	2,4-Toluene bis Dimethyl Urea - Isomer Grade
	OMICURE U-410	180 - 195	off-white	1 - 5	80	95	10	18	7	123	80/20 Toluene bis Dimethyl Urea - Technical Grade
	OMICURE U-52	220 - 230	off-white	1 - 5	80	95	55	27	12	127	4,4'-Methylene bis (phenyl dimethyl urea) Isomer Grade
	OMICURE U-415	190 - 220	off-white	1 - 5	80	95	20	33	12	128	4,4'-Methylene bis (phenyl dimethyl urea) Technical Grade
	OMICURE U-35	190 - 210	off-white	1 - 5	80	95	134	46	15	124	Cycloaliphatic bisurea
	OMICURE U-210 (Monuron)	172 - 182	off-white	1 - 5	80	95	16	29	15	121	N-(4-chlorophenyl) N, N-Dimethyl Urea

(1) with DGEBA (EEW=190) and dicy
(2) substituted urea @ 3phr; dicy @ 8phr; with DGEBA (EEW=190)
(3) Cure - DSC scan at 20°C/minute to 275°C, substituted urea @ 3phr; dicy @ 8phr, with DGEBA (EEW=190)

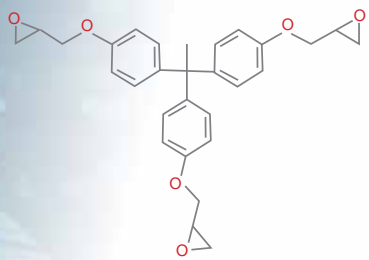
Catalysts

	Product Name	MP, °C	Color	Use Level PHR	Gardner Color, max	Glass Transition, T_g, °C	Description / Use
Curing Agents and Accelerators	OMICURE 24EMI	liquid	Brown	0.1-10(1)	16	—	Accelerator for Anhydrides and catalyst for high temperature epoxies. Faster reactivity vs. BDMA or tertiary amine substituted phenols.
	OMICURE BC-120	25-35	Amber/Brown	0.1-10(1)	—	130(2)	Can be used as sole curing agent or as accelerator for Anhydrides, Dicyandiamide or Aromatic Amines. Clear, compatible formulations. Very long room temperature shelf life.

(1) low levels to accelerate acid anhydrides, mid-range or higher levels as sole curing agent. Determine optimum concentration empirically.
(2) with DGEBA, EEW=190; @ 8phr

Chemical Structures

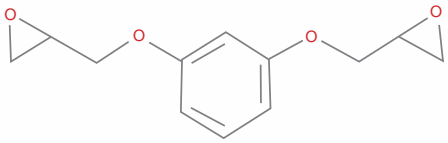
MULTIFUNCTIONAL EPOXY



EPALLOY® 9000

Tris hydroxyl phenyl ethane
CAS no: 87093-13-8

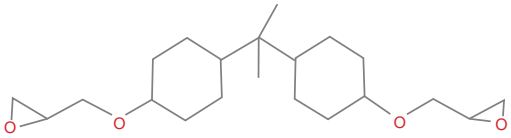
RESORCINOL EPOXY RESIN



ERISYS™ RDGE, RDGE-H

Resorcinol diglycidyl ether
CAS no: 101-90-6

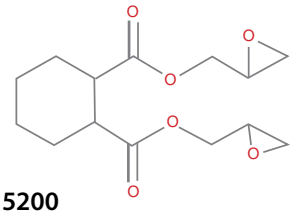
HYDROGENATED BISPHENOL A EPOXY RESIN



EPALLOY® 5000

Hydrogenated Bisphenol-A diglycidyl ether
CAS no: 30583-72-3

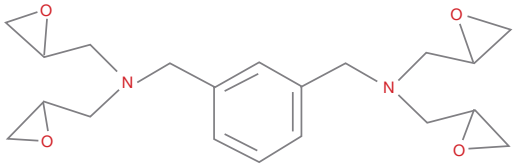
CYCLOALIPHATIC GLYCIDYL ESTER



EPALLOY® 5200

Hexahydro phthalic acid diglycidyl ester
CAS no: 5493-45-8

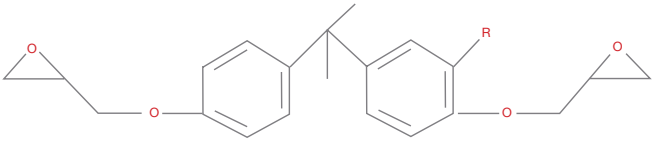
GLYCIDYL AMINE



ERISYS™ GA 240

Glycidyl amine of m-xylenediamine
CAS no: 63738-22-7

MODIFIED BISPHENOL A EPOXY RESIN



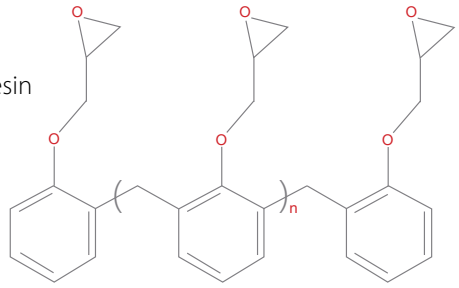
EPALLOY® 7200

Modified Bisphenol-A diglycidyl ether

PHENOL NOVOLAC EPOXY RESINS

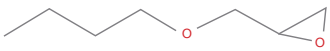
EPALLOY® 8000 Series

Phenol novolac epoxy resin



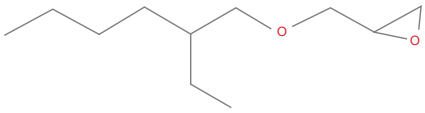
Chemical Structures (cont.)

ALIPHATIC MONOGLYCIDYL ETHERS



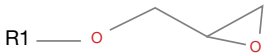
ERISYS™ GE 5

n-Butyl glycidyl ether
CAS no: 2426-08-6



ERISYS™ GE 6

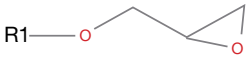
2-Ethyl hexyl glycidyl ether
CAS no: 2461-15-6



R1 = C8-C10

ERISYS™ GE 7

C_8-C_{10}- glycidyl ether
CAS no: 68609-96-1

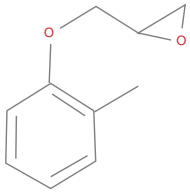


R1= C12-C14

ERISYS™ GE 8

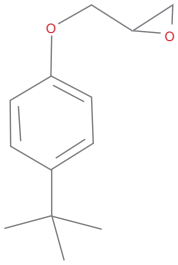
C_{12}-C_{14} glycidyl ether
CAS no: 68609-97-2

AROMATIC MONOGLYCIDYL ETHERS



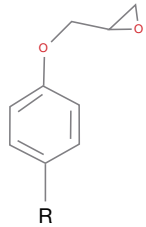
ERISYS™ GE 10

Cresyl glycidyl ether
CAS no: 2210-79-9



ERISYS™ GE 11

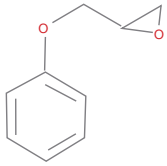
p-tert butyl glycidyl ether
CAS no: 3101-60-8



R = C_9H_{19}

ERISYS™ GE 12

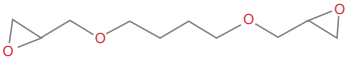
Nonyl phenyl glycidyl ether
CAS no: 147094-54-0



ERISYS™ GE 13

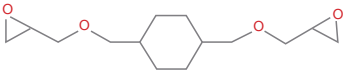
Phenyl glycidyl ether
CAS no: 122-60-1

ALIPHATIC DIGLYCIDYL ETHER MODIFIERS



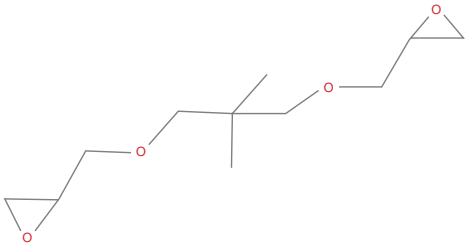
ERISYS™ GE 21

1,4-Butanediol diglycidyl ether
CAS no: 2425-79-8



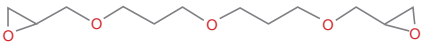
ERISYS™ GE 22 & 22S

1,4-Cyclohexane dimethanol diglycidyl ether
CAS no: 14228-73-0



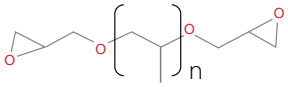
ERISYS™ GE 20

Neopentyl glycol diglycidyl ether
CAS no: 17557-23-2



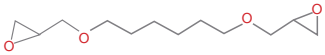
ERISYS™ GE 23

Dipropylene glycol diglycidyl ether
CAS no: 41638-13-5



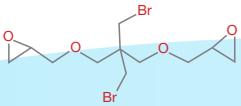
ERISYS™ GE 24

Polypropylene glycol(400) diglycidyl ether
CAS no: 26142-30-3



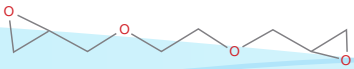
ERISYS™ GE 25

1,6-Hexanediol diglycidyl ether
CAS no: 16096-31-4



ERISYS™ GE 29

Dibromo Neopentyl glycol diglycidyl ether
CAS no: 31452-80-9

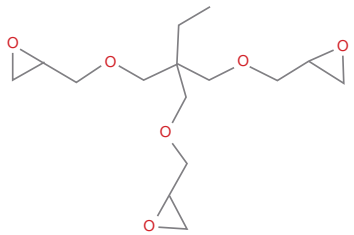


ERISYS™ EGDGE

Ethylene glycol diglycidyl ether
CAS no: 2224-15-9

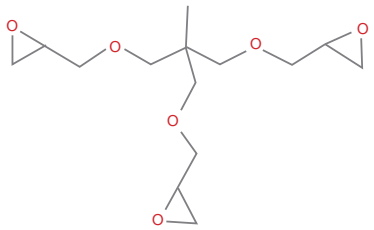
Chemical Structures (cont.)

ALIPHATIC TRIGLYCIDYL ETHER MODIFIERS



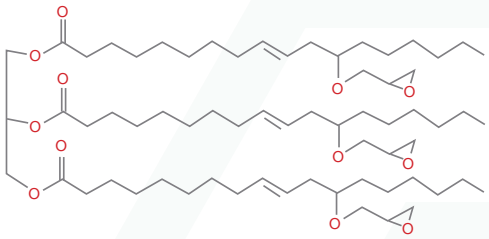
ERISYS™ GE 30

Trimethylol propane triglycidyl ether
CAS no: 30499-70-8



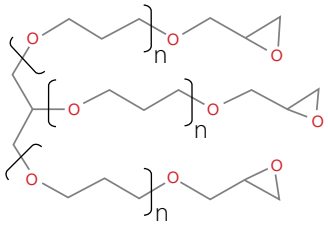
ERISYS™ GE 31

Trimthylol ethane triglycidyl ether
CAS no: 68460-21-9



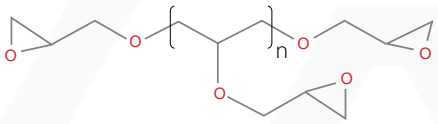
ERISYS™ GE 35 & 35H

Castor oil glycidyl ether
CAS no: 74398-71-3



ERISYS™ GE 36

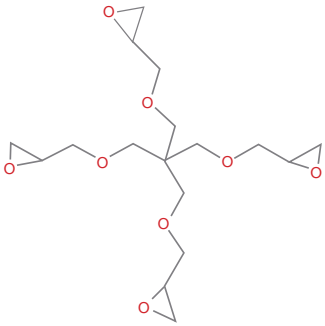
Propoxylated glycol triglycidyl ether
CAS no: 37237-76-6
Approximate MW = 2000



ERISYS™ GE 38

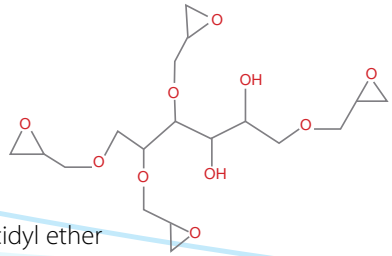
Poly glycerol-3- polyglycidyl ether
CAS no: 118549-88-5

POLYFUNCTIONAL GLYCIDYL ETHER



ERISYS™ GE 40

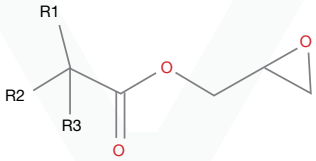
Pentaerythritol polyglycidyl ether
CAS no: 30973-88-7



ERISYS™ GE 60

Sorbitol polyglycidyl ether
CAS no: 68412-01-1

GLYCIDYL ESTER MODIFIERS



R1=1, R2+R3= 7

ERISYS™ GS 110

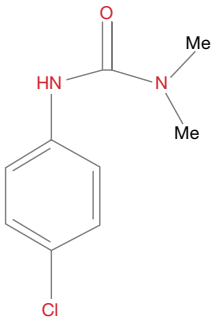
Glycidyl ester of neodecanoic acid
CAS no: 26761-45-5

▸Chemical Structures (cont.)

OMICURE™ SUBSTITUTED UREA ACCELERATORS

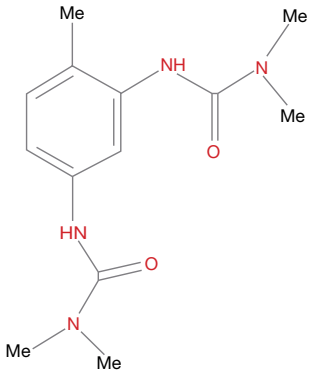
OMICURE™ U-210

CAS no: 150-68-5



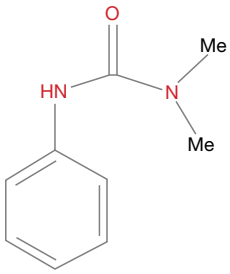
OMICURE™ U-24

CAS no: 17526-94-2



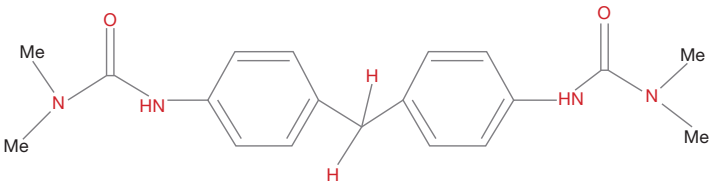
OMICURE™ U-405

CAS no: 101-42-8



OMICURE™ U-52/U-415

CAS no: 10097-09-3



Contact Us

CVC Thermoset Specialties

CVC offers assistance to solve the most demanding applications. Whether you need to develop a 100% solids coating, an impact-resistant composite, one-component structural adhesive or a flexible potting compound, CVC can bring innovative products and technology to meet your need with our strong technical support and a diverse experience base.

Contact us for more information and solutions to your formulating challenges!

website: **www.cvc.emeraldmaterials.com**
phone: (856) 533-3000
toll free: (800) 296-0040
fax: (856) 533-3003

Emerald Performance Materials

Emerald produces a broad portfolio of additives and polymers used in diverse consumer and industrial products around the world. Emerald products play a variety of roles in the products that are consumed and used every day enabling them to last longer, look, smell, taste or perform better. With four business groups and eight manufacturing locations, we serve our customers around the globe in over 70 countries world-wide.

For more information, visit **www.emeraldmaterials.com**

Emerald Shared Services
Emerald Performance Materials, LLC
2020 Front Street, Suite 100 / Cuyahoga Falls, OH 44221
phone: (330) 916-6700
fax: (330) 916-6734

Other Emerald Business Groups

Emerald Performance Materials® Kalama Chemical

360.673.2550 / 800.223.0035

Kalama® Flavors, Fragrance & Preservative ingredients for Food & Beverage; Consumer & Household; K-FLEX® Plasticizers for Coatings, Adhesives & Industrial Applications.

Emerald Performance Materials® Polymer Additives

330.374.2418 / 888.889.9150

Good-rite®, Stalite®, Superlite, Cure-rite® and Nychem™ specialty nitrile latex binders for AO's, stabilizers, accelerators for Rubber, Plastics, Lubricants, and Specialty Industrial Applications.

Emerald Performance Materials® Specialties Group

513.841.4000 / 800.477.1022

Hilton Davis® Colorants, FOAM BLAST® defoamers, Masil® silicones and other performance additives for Food & Beverage; Consumer & Household; Coatings, Graphic Arts & Printing, Adhesives, Paper & Industrial Applications.

CVC Thermoset Specialties Sales & Distribution Network

UNITED STATES

Northeast

Bedford Specialty Sales, Inc.
Shirley, MA
Tel (978) 425-6214
Web: www.bedfordsales.com

E.M. Sullivan Associates, Inc.
Broomall, PA
Tel (610) 725-8717
Web: www.emsullivan.com

Gillen Company, LLC
Cuddy, PA
Tel (412) 257-3300

Southeast

Kohl Marketing
Roswell, GA
Tel (770) 753-4979
Web: www.kohlmarketing.com

Midwest

Cal-Chem
Royal Oak, MI
Tel (248) 268-4652
Web: www.cal-chemusa.com

Cemsac Corporation
Ellisville, MO
Tel (636) 391-2600
Web: www.cemsac.com

Chem/Serv, Inc.
Minneapolis, MN
Tel (612) 379-4411
Web: www.chemserv.com

Dar-Tech, Inc.
Maple Heights, OH
Tel (800) 228-7347
Web: www.dar-techinc.com

Resin Sales, Ltd.
Northbrook, IL
Tel (847) 564-0248
Web: www.resinsalesltd.com

West

Dowd and Guild, Inc.
San Ramon, CA
Tel (925) 820-7222
Web: www.dowdandguild.com

The NP Group, LLC
Dallas, TX
Tel (972) 386-5442
Web: www.npgroupinc.com

CANADA

Chemroy Canada, Inc.
Brampton, Ontario
Tel (905) 789-0701
Web: www.chemroy.com

BRAZIL

Kryll Advanced Materials
São Paulo, Brazil
Tel +55 11 2729 6362
Tel +55 11 2729 6361
Web: www.kryll.com.br

MEXICO

High Chem Specialties
Mexico City, Monterrey,
Guadalajara & Tijuana
Tel +52 55 5321 5700
Web: www.highchem.com.mx

ASIA PACIFIC

Brenntag Australia/New Zealand
Sydney, Australia
Auckland, New Zealand
Tel/Australia (61) 2 9504 2400
Tel/New Zealand (64) 9 275 0745
Web: www.brenntag-asia.com

Heng Hsin Company, Ltd.
Taipei, Taiwan, R.O.C.
Tel (886) 2 2541 8641
Web: www.henghsin.com.tw

Megachem, Ltd.
Singapore/Malaysia/Indonesia
Tel +65 6933 9999
Web: www.megachem.com

MGI Chemicals PVT Ltd.
Mumbai, India
Tel +91 22 4026 0957

PTI Japan, Ltd.
Tokyo, Japan
Tel (81) 3 3213 2542
Web: www.ptij.co.jp

Shenzhen Jiadida Chemical Co., Ltd.
Shenzhen, China
Tel (86) 755 8212 4624
Web: www.jiadida.com

Trachem
Seoul, Korea
Tel (82) 2 2248 6290
Web: www.trachem.com

EUROPE

Azelis Nordics
Lyngby, Denmark
Tel +45 4526 3333
Web: www.azelis.com

Azelis Italia S.p.A.
Milan, Italy
Tel +39 02 484791
Web: www.azelis.it

Hubron Speciality Ltd.
Manchester, UK
Tel +44 (0) 161 681 2691
Web: www.hubronspeciality.com

IMCD Benelux BV
Rotterdam, The Netherlands
Tel +31 10 290 8600
Web: www.imcd.nl

IMCD Benelux NV
Mechelen, Belgium
Tel +32 15 29 49 50
Web: www.imcd.be

IMCD Deutschland GmbH & Co. KG
Cologne, Germany
Tel +49 221 77 65 0
Web: www.imcdgroup.com

IMCD Espana Especialidades Quimicas, S.A.
Barcelona, Spain
Tel +34 93 241 38 58
Web: www.imcd.es

IMCD France SAS
Cedex, France
Tel +33 1 49 33 31 31
Web: www.imcd.fr

IMCD Switzerland AG
Zurich, Switzerland
Tel +41 43 244 80 00
Web: www.imcd.ch

USNER GmbH
Hallein, Austria
Tel +43 6245 81 516

MIDDLE EAST/SOUTH AFRICA

Petrus Chemicals & Materials (1986) Ltd.
Herzelia, Israel
Tel +972 9 9587670, ext. 228
Web: www.petrus.co.il

IMCD SA (Pty) Ltd.
Johannesburg, S. Africa
Tel +27 11 570 4260
Web: www.imcdgroup.com

Division Headquarters

CVC Thermoset Specialties
844 N. Lenola Road
Moorestown, NJ 08057

Tel (856) 533-3000
Fax (856) 533-3003

Regional Sales Offices

ASIA PACIFIC
CVC Thermoset Specialties
1708 Shui On Centre
6-8 Harbour Road
Wanchai, Hong Kong

Tel (852) 2598-7990

EUROPE/MIDDLE EAST/AFRICA
CVC Thermoset Specialties
Mijnweg 1
6167 AC Geleen
Netherlands

Tel +31 88 888 0500

Web: www.cvc.emeraldmaterials.com