



Cardolite

Chemistry for Tomorrow

Coatings Portfolio

Renewable Technology

The World Leader in Cashew
Nutshell Liquid Technology

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ABOUT US



LOCATIONS

-  R&D, Management, and Sales
-  Manufacturing, R&D, and Sales
-  Sales

Cardolite uses Cashew Nutshell Liquid (CNSL) derivatives as key building blocks for most of its products to achieve unprecedented performance that solves today's problems in a sustainable manner.

Over 35 years supplying high quality specialty chemicals derived from Cashew Nutshell Liquid (CNSL), a renewable, non-food chain material.

Dedicated sales force with local representation in over 30 countries. Warehouses set up in the USA, Latin America, Europe, China and India.

The most advanced CNSL manufacturing facilities in the world located in Zhuhai (Guangdong), China and Mangalore, India.

PRODUCTS & MARKETS

To support our customers in solving industry challenges, Cardolite continues to invest heavily on innovation that leverages the unique properties of CNSL technology. Cardolite operates three advanced research and technical service laboratories in the USA, China and India that use CNSL as a primary building block to develop specialty materials with demonstrated advantages over some traditional coating chemistries.

COATINGS MARKETS

- Marine & Protective
- Industrial Applications
 - OEM and general industrial
 - Transportation primers
 - Potable water and food contact
 - Tank and pipe linings
- Concrete Flooring
 - Primers and self-levelers
 - Top coats

FOR EPOXY

- Epoxy Curing Agents
 - Phenalkamines
 - Phenalkamides
 - Polyamides
 - Modified Cycloaliphatic Amines
- CNSL Epoxy Resins and Modifiers
- CNSL Reactive and Non-reactive Diluents

FOR POLYURETHANE

- Polyols (mostly CNSL-based)
 - Mono-, di-, and multi-functional
 - Polyester
 - Polyether
 - Mannich
 - Novolac/Aromatic
- CNSL NCO Blocking Agents
- Reactive Diluents

CNSL SPECIALTIES

- Ethoxylated Surfactants
- Polymer Building Blocks
- Hydrogenated Monomers
- Hydrocarbon Resins
- Friction Particles and Resins
- Acrylates
- FormuLITE™

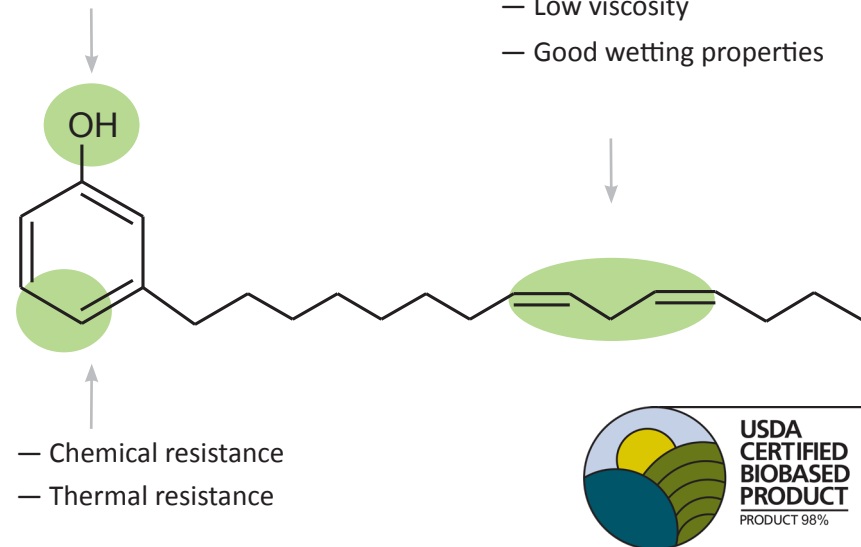
CNSL TECHNOLOGY

From the beginning, Cardolite products have been based on cashew nutshell liquid (CNSL), a natural, non-food chain, and annually renewable biomaterial. The technology has been widely adopted because there are inherent performance benefits gained from using this starting raw material without sacrificing performance or cost.

Cardanol is a unique natural phenolic material obtained by distilling CNSL and serves as the primary building block for Cardolite curing agents. The molecule is composed of an aromatic ring with a hydroxyl group and a long aliphatic side chain, which bring valuable intrinsic benefits to coating materials.

- Fast cure
- Low temperature cure
- Enhanced adhesion

- Water resistance
- Corrosion protection
- Flexibility
- Low viscosity
- Good wetting properties



Annually renewable with high biocontent



Low viscosity for low or zero V.O.C.



Cost effective



Does not interfere with the food chain



High performance



Better labeling compared to phenol-based materials

PHENALKAMINE

CNSL-BASED EPOXY CURING AGENTS

The Mannich reaction of CNSL, formaldehyde, and certain amines is called a phenalkamine. Phenalkamines share some similar advantages to other Mannich base curing agents, such as: extremely fast cure, low temperature cure (even below 0°C), good chemical resistance, good surface appearance, good moisture tolerance, and non-blushing properties. However, due to the long aliphatic side chain of cardanol, phenalkamines also have very good pot life, good flexibility, surface tolerance, and excellent water and salt water resistance for improved long-term corrosion protection. Many Cardolite phenalkamines are also approved for use in food contact and potable water coatings.



Surface tolerance and corrosion protection



Lower application failure risks



Chemical resistance and durability



Quick return-to-service for increased productivity

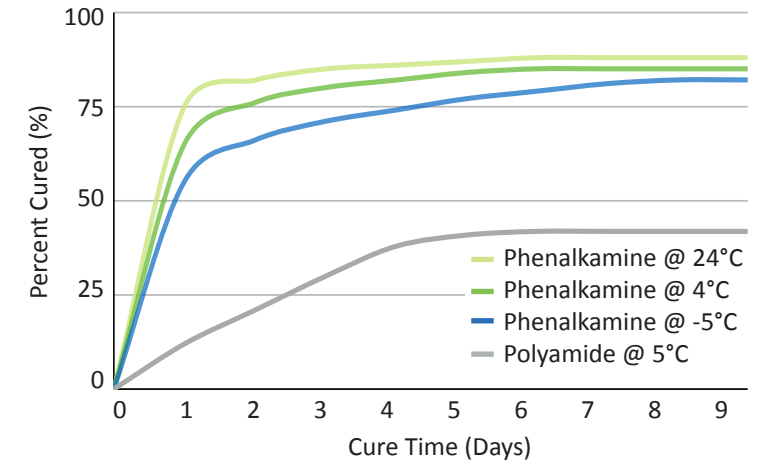


Fast cure even at low temperatures

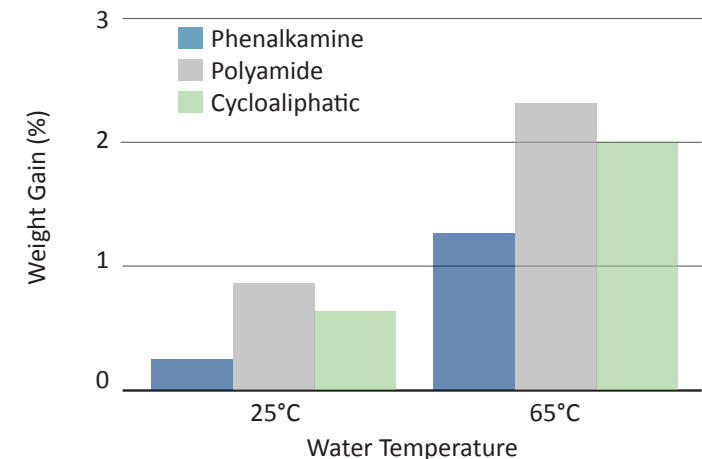


Adhesion to various substrates, and to wet/oil contaminated concrete

Phenalkamine Low Temperature Cure Data Comparison



Comparative Water Resistance of Phenalkamines



PHENALKAMINE CURING AGENTS TYPICAL PROPERTIES

Product	Type	Color ¹ (Gardner)	Viscosity ² @ 25°C (cPs)	Solids ³ (%)	Amine Value ⁴ (mg KOH/g)	AHEW	Thin Film*			Key Properties & Applications
							Dry Hard Times (hours)			
							25°C	5°C	0°C	
NC-541	Unmodified	16	28,000	Solvent-free	330	130	5	15.5	23	Standard phenalkamine. M&P, IC, FDA 175.300
NC-641	Unmodified	16	25,000	Solvent-free	304	130	4	13.5	21	Low free EDA version of NC-541, with better film appearance. M&P, IC
NX-6070	Unmodified	17	10,000	Benzyl alcohol	276	143	4.2	20	20.5	High solids in benzyl alcohol. M&P, IC
LITE 2001	Unmodified	10	28,000	Solvent-free	330	132	3	12.5	19	Light color standard phenalkamine. M&P, IC
NC-541X90	Solvent cut	16	4,000	90	300	144	5	17	21	NC-541 solvent cut version for better handling. M&P, IC, FDA 175.300
NC-641X90	Solvent cut	16	4,500	90	295	144	4	14	18	NC-641 solvent cut version for better handling. M&P, IC
NC-6641X90	Solvent cut	16	3,000	90	268	144	5	17	21	NC-541X90 version with < 0.1% residual EDA. M&P, IC
LITE 2001X90	Solvent cut	10	3,800	90	300	144	9	17	31	LITE 2001 solvent cut version for better handling. M&P, IC
NX-2041	Solvent cut	10	475	75	255	150	6	25	n/a	Very low viscosity phenalkamine. M&P, IC
NC-541LV	Unmodified	15	2,300	Solvent-free	340	125	6	24	29	Low viscosity for high solids coatings. M&P, IC, FDA 175.300
NC-641LV	Unmodified	16	2,500	Solvent-free	370	125	3.5	18	21	EDA-free version of NC-541LV. M&P, IC
NC-6641LV	Unmodified	16	2,300	Solvent-free	320	125	5	21	25	NC-541LV version with < 0.1% residual EDA. M&P, IC
LITE 2001LV	Unmodified	10	2,500	Solvent-free	340	125	7	17	29	Low viscosity for high solids, light color. M&P, IC
LITE 2010LV	Unmodified	10	4,100	Solvent-free	247	125	3	13.5	19	Low viscosity, light color, excellent film at extreme conditions. M&P, IC

*200 micron with liquid epoxy (EEW 190), ¹ASTM D1544, ²ASTM D2196, ³ASTM D2369-98, ⁴ASTM D2074

M&P - Marine & Protective (immersed), TP - Transportation Primers, IC - Industrial Coatings, CF - Solvent-free Concrete Floors, TC - Top Coats

PHENALKAMINE CURING AGENTS TYPICAL PROPERTIES

Product	Type	Color ¹ (Gardner)	Viscosity ² @ 25°C (cPs)	Solids ³ (%)	Amine Value ⁴ (mg KOH/g)	AHEW	Thin Film*			Key Properties & Applications
							Dry Hard Times (hours)			
							25°C	5°C	0°C	
NC-562	Adduct	14	1,300	65	185	174	3	9	11	Fast cure, non-blushing, excellent corrosion protection and adhesion. M&P, TP, IC
LITE 2562	Adduct	9	1,500	65	180	174	2.5	7.5	11.5	Light color version of NC-562. M&P, TP, IC
NC-556X80	Adduct	14	4,500	80	330	135	3.5	12	19.5	Fast cure and hardness development, high solids. TP, IC, FDA 175.300
NX-2015	Adduct	10	13,000	75	210	151	6	12	n/a	Light color, fast cure, excellent anticorrosion properties. M&P, TP, IC
NX-2016	Adduct	15	12,000	75	208	151	2	6.5	11	Fast cure, higher viscosity, excellent anticorrosion properties. M&P, TP, IC
NX-2018	Adduct	16	8,400	75	218	151	3	9	14	Fast cure, cost effective. M&P, TP, IC
NX-5459	Adduct	15	1,650	70	205	164	4	12	18	Fast cure, high solids. M&P, IC, FDA 175.300
NX-5050	Adduct	18	770	80	165	190	2	7.5	11	Very fast cure, high solids, low viscosity. M&P, TP
NX-5556M	Adduct	15	2,500	80	245	165	2	11	16	Excellent corrosion protection, similar properties to NC-562. M&P, TP, IC
NX-5110	Adduct	8	2,500	80	245	165	3.1	9.6	23.5	Light color version of NX-5556M. M&P, TP, IC
GX-5135	Adduct	8	2,500	80	245	165	3	8	11	Faster version of NX-5110, high solids. M&P, TP, IC
LITE 5262	Adduct	8	2,800	≤ 5% buta- nol	385	114	2.75	11	16	Very high solids, fast cure, excellent corrosion protection. M&P, TP, IC
NX-5444	Adduct	8	4,300	80	218	190	1.5	6	6	Fast hardness development, good flexibility, high solids. M&P, TP, IC
NX-5445	Adduct	18	1,800	78	155	256	2	6.5	14.5	Very fast cure, high solids, low viscosity. M&P

PHENALKAMINE CURING AGENTS TYPICAL PROPERTIES

Product	Type	Color ¹ (Gardner)	Viscosity ² @ 25°C (cPs)	Solids ³ (%)	Amine Value ⁴ (mg KOH/g)	AHEW	Thin Film*			Key Properties & Applications
							Dry Hard Times (hours)			
							25°C	5°C	0°C	
NC-540	Unmodified	15	2,000	Solvent-free	535	81	3.5	13	19	Low viscosity, surface tolerant. CF
NC-558	Unmodified	14	900	Solvent-free	340	95	10	27	32	Low viscosity, excellent adhesion to unprepared substrates. M&P, IC, CF
NC-658	Unmodified	14	1,000	Solvent-free	300	95	6.5	22	28	NC-558 version with < 0.1% residual EDA. M&P, IC, CF
NC-557	Unmodified	14	1,100	Solvent-free	355	95	7	16.5	27.5	Fast cure, excellent adhesion. CF
NX-2003	Unmodified	10	620	Solvent-free	360	95	4.5	18.5	22	Fast cure, excellent adhesion, light color. M&P, IC, CF
NX-2003D	Unmodified	13	700	Solvent-free	357	95	4.5	15	24	Fast cure, excellent adhesion. M&P, IC, CF
NX-5454	Unmodified	11	1,080	Solvent-free	275	133	2	7.5	10	Very fast cure, excellent film appearance. M&P, IC, CF
NX-6019	Unmodified	11	1,100	Solvent-free	275	133	2.5	10	11.5	Better labeling version of NX-5454. M&P, IC, CF
NX-5653	Unmodified	11	1,100	Solvent-free	366	132	2.1	6.6	10.3	Phenol-free version of NX-5454. M&P, IC, CF
NX-6654	Unmodified	11	1,500	Solvent-free	325	132	2.3	8.8	12.6	NX-5653 version with < 0.1% residual EDA. M&P, IC, CF
NX-5198	Unmodified	11	140	90	300	179	2.4	13	n/a	Fast cure, very low viscosity, cost effective. IC
LITE 2002	Unmodified	10	450	Solvent-free	360	104	6	20	30.5	Low viscosity, light color, excellent anticorrosion. M&P, IC
LITE 2002LP	Unmodified	10	700	Solvent-free	360	104	7	21	39	LITE 2002 with improved pot life. M&P, IC

*200 micron with liquid epoxy (EEW 190), ¹ASTM D1544, ²ASTM D2196, ³ASTM D2369-98, ⁴ASTM D2074

M&P - Marine & Protective (immersed), TP - Transportation Primers, IC - Industrial Coatings, CF - Solvent-free Concrete Floors, TC - Top Coats

PHENALKAMINE CURING AGENTS TYPICAL PROPERTIES

Product	Type	Color ¹ (Gardner)	Viscosity ² @ 25°C (cPs)	Solids ³ (%)	Amine Value ⁴ (mg KOH/g)	AHEW	Thin Film*			Key Properties & Applications
							Dry Hard Times (hours)			
							25°C	5°C	0°C	
NX-2007	Unmodified	4	265	Benzyl alcohol	310	113	2	16	23.5	Fast cure and hardness, good flow and yellowing resistance. IC, TC
NX-2009	Unmodified	7	370	Benzyl alcohol	310	95	4	12	20.5	Good film appearance, yellowing resistance, fast cure, cost effective. IC, TC
Ultra LITE 2009	Unmodified	1	330	Benzyl alcohol	277	95	6	22	32	Very light color, excellent film appearance and yellowing resistance. IC, TC
Ultra LITE 2009SF	Unmodified	1	5,900	Solvent-free	404	62	7	22	n/a	Undiluted Ultra LITE 2009. IC, TC
Ultra LITE 2009H	Unmodified	1	150	Benzyl alcohol	355	95	5	19	30	Faster hardness development version of Ultra LITE 2009. IC, TC
Ultra LITE 2009HSF	Unmodified	2	500	Solvent-free	550	62	n/a	n/a	n/a	Undiluted Ultra LITE 2009H. IC, TC
Ultra LITE 2012	Unmodified	1	175	Benzyl alcohol	330	95	6.5	n/a	n/a	Longer pot life version of Ultra LITE 2009 IC, TC
NX-4943	Unmodified	14	1,800	Solvent-free	488	82	4	14	23	Excellent chemical resistance. M&P
NX-5567	Specially modified	15	770	85	561	66	3	10	15	Excellent chemical resistance, fast cure. M&P
NX-5594	Unmodified	14	950	Solvent-free	395	76	2.5	8	11	Very fast cure, excellent cathodic disbondment resistance. M&P, TP, IC
GX-6027	Unmodified	7	950	Solvent-free	395	76	3	8.8	10	Light color version of NX-5594. M&P, TP, IC
GX-5618	Ketimine modified	11	500	≤ 4% butanone	330	104	7.5	n/a	n/a	Fast cure with good pot life, low viscosity. M&P, IC

*200 micron with liquid epoxy (EEW 190), ¹ASTM D1544, ²ASTM D2196, ³ASTM D2369-98, ⁴ASTM D2074, ⁵ASTM D2369-98 at 85°C

M&P - Marine & Protective (immersed), TP - Transportation Primers, IC - Industrial Coatings, CF - Solvent-free Concrete Floors, TC - Top Coats

NON-CNSL CURING AGENTS TYPICAL PROPERTIES

Product	Type	Color ¹ (Gardner)	Viscosity ² @ 25°C (cPs)	Solids ³ (%)	Amine Value ⁴ (mg KOH/g)	AHEW	Thin Film* Dry Hard Times (hours) 25°C	Key Properties & Applications
NT-1541	Polyamide	9	5,000 @ 75°C	Solvent-free	215	198	n/a	Similar to standard high viscosity polyamides M&P, IC, TC
NT-1541X70	Polyamide	8	1,600	70	150	283	10	NT-1541 in xylene M&P, IC, TC
NT-1541I73		8	1,800	73	157	271.5	10	NT-1541 in isopropanol M&P, IC, TC
NT-1515	Polyamide	8	4,000 @ 75°C	Solvent-free	235	198	n/a	Standard high viscosity polyamide M&P, IC, TC
NT-1515X70	Polyamide	8	500 @ 40°C	70	165	283	10	NT-1515 in xylene M&P, IC, TC
NT-1542	Polyamide	7	40,000	Solvent-free	350	103	8	Standard medium viscosity polyamide M&P, IC, TC
NT-1544	Polyamide	8	10,000	Solvent-free	380	97	9	Standard medium-low viscosity polyamide M&P, IC, TC
NT-1545	Polyamide	8	3,000	Solvent-free	380	103	11	Low viscosity polyamide M&P, IC, TC
NT-1550	Polyamide	8	3,500	>95 ⁵	265	133	6	Specially modified polyamide M&P, IC, TC
NX-5701	Modified Mannich Base	8	900	Benzyl alcohol	300	117	3	Low viscosity, excellent chemical resistance M&P, IC
NT-5901	Modified Cycloaliphatic	1	450	Benzyl alcohol	264	113	7.5	Low viscosity, good yellowing resistance IC, TC

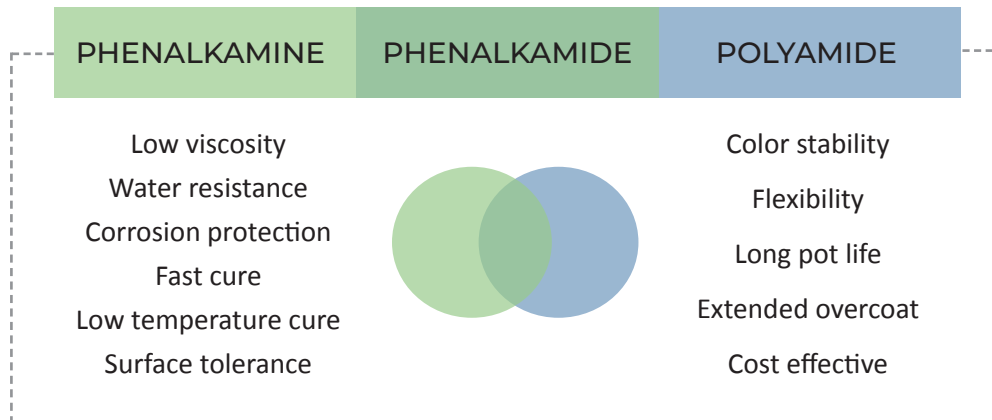
*200 micron with liquid epoxy (EEW 190), ¹ASTM D1544, ²ASTM D2196, ³ASTM D2369-98, ⁴ASTM D2074, ⁵ASTM D2369-98 at 85°C

M&P - Marine & Protective (immersed), TP - Transportation Primers, IC - Industrial Coatings, CF - Solvent-free Concrete Floors, TC - Top Coats

PHENALKAMIDE

CNSL-BASED EPOXY CURING AGENTS

Cardolite phenalkamide technology is a new category of epoxy curing agent that fills a gap between polyamide and phenalkamine technology. By chemically combining the two technologies, phenalkamide curing agents offer the benefits of both while mitigating their limitations.



Universal coatings with wide formulation latitude



Eliminate or reduce use of anticorrosive inhibitors



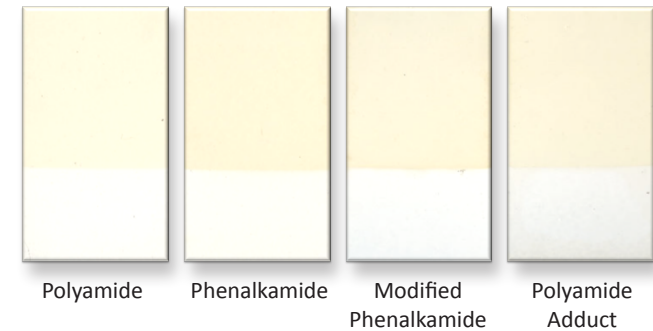
Eliminate or reduce need for accelerators



Cost savings!

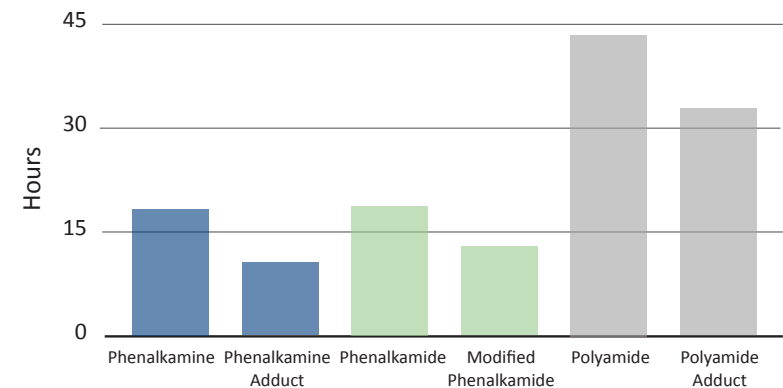
Color Stability after 72 hours QUVB

(8 hours light @ 50°C / 4 hours condensation @ 45°C)



Thin Film Dry Hard Time Comparison

(5°C with Liquid Epoxy Resin, EEW=190)



PHENALKAMIDE CURING AGENTS TYPICAL PROPERTIES

Product	Color ¹ (Gardner)	Viscosity ² @ 25°C (cPs)	Solids ³ (%)	Amine Value ⁴ (mg KOH/g)	AHEW	Thin Film* Dry Hard Times (hours)		Key Properties & Applications
						25°C	5°C	
LITE 3000	8	2,400	70	180	256	5	17	First generation phenalkamide combining and balancing the benefits of phenalkamine and polyamide technologies. M&P, IC, TC
LITE 3000NH	8	1,800	70	185	256	3.5	17	LITE 3000 cut in non-HAPs solvent. M&P, IC, TC
LITE 3005	11	1,700	70	160	256	8	18	Cost effective and direct replacement of standard high Mw polyamide curing agents. NX-5052 is the undiluted version. M&P, IC, TC
LITE 3025	8	34,000	Solvent-free	345	103	8.5	n/a	Direct replacement of standard medium Mw polyamides with faster dry time and hardness development and better UV resistance. M&P, IC, TC
LITE 3040	8	5,000	Solvent-free	380	118	7.3	29	Low viscosity, excellent flexibility and overcoatability. Suitable for high solids coatings. M&P, TP, IC, TC
LITE 3060	8	850	Solvent-free	455	104	5	17.5	Solvent -free, very low viscosity, excellent cathodic disbondment protection and adhesion to metal and concrete. M&P, TP, IC, CF, TC
LITE 3070	8	850	Solvent-free	472	107	5.5	22	Solvent-free, very low viscosity, fast cure with long pot life, excellent corrosion protection. M&P, IC, TC
LITE 3100	8	4,500	80	260	150	4	13	Fast cure speed, high solids, and low use level with excellent corrosion protection. M&P, TP, IC, TC
LITE 3100NH	8	4,200	80	265	150	4	8	LITE 3100 cut in non-HAPs solvent. M&P, TP, IC, TC
LITE 3117	8	4,500	80	270	150	3.5	16	Modified LITE 3100 with excellent intercoat adhesion at low temperatures and high humidity. M&P, TP, IC, TC

*200 micron with liquid epoxy (EEW 190), ¹ASTM D1544, ²ASTM D2196, ³ASTM D2369-98, ⁴ASTM D2074

M&P - Marine & Protective (immersed), TP - Transportation Primers, IC - Industrial Coatings, CF - Solvent-free Concrete Floors, TC - Top Coats

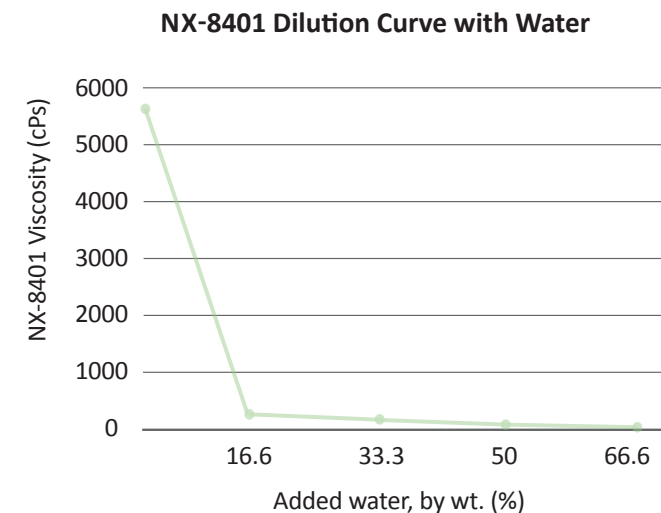
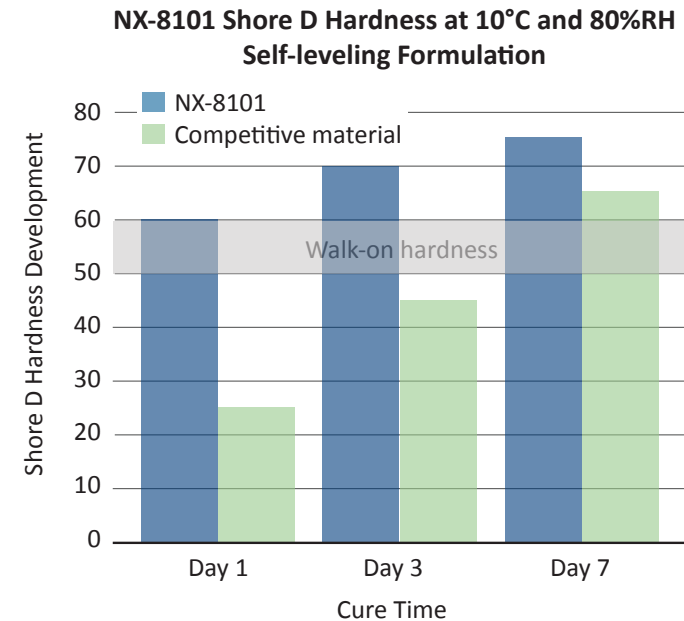
WATERBORNE

EPOXY CURING AGENTS

The NX-8000 Series is the first waterborne product line to include CNSL-derived epoxy curing agents. This new technology enables very hydrophobic polymers to be stably packaged in water without the help of solvents. The hydrophobic side chain of cardanol promotes excellent corrosion protection matching the performance of existing solvent-borne systems. The low temperature molecular mobility of cardanol-derived curing agents helps crosslink density and substrate wetting, which results in outstanding adhesion over various metal substrates.

Moreover, Cardolite's line of waterborne curing agents provides excellent formulation latitude. High PVC (pigment volume concentration) formulations are easily reduced with water to conventional spray viscosities, pigmentation can be done on both epoxy and amine sides, and good compatibility is achieved with solid epoxy dispersions and in the case of NX-8101, also with standard bisphenol A/F liquid epoxy resins.

Cardolite also offers water soluble curing agents diluted in 1-methoxy-2-propanol and other solvents upon request, for use in waterborne zinc rich primers or other water-based applications. They are low in viscosity, show excellent stability with zinc dust, provide excellent adhesion and corrosion protection, and deliver fast cure and recoatability with long pot life.



WATERBORNE CURING AGENTS TYPICAL PROPERTIES

Product	Color ¹ (Gardner)	Viscosity ² @ 25°C (cPs)	Solids ³ (%)	Amine Value ⁴ (mg KOH/g)	AHEW	25°C Thin Film* Dry Hard Times (hours)	Key Properties & Applications
NX-8101	8	35,000	50% in water	160	270	1.5	Fast hardness development, excellent corrosion protection. M&P, TP, IC, CF
NX-8101PM80	11	2,000	80% in 1-methoxy-2-propanol	265	168	1.8	Suitable for zinc rich primers, fast cure and excellent corrosion protection. M&P, TP, IC
NX-8107PM80	9	1,890	80% in 1-methoxy-2-propanol	263	199	3.3	Suitable for zinc rich primers, longer pot life, better zinc dust stability, excellent corrosion protection. M&P, TP, IC
NX-8108PM80	10	3,749	80% in 1-methoxy-2-propanol	219	252	3.3	Suitable for zinc rich primers, longer pot life, better zinc dust stability, excellent corrosion protection. M&P, TP, IC
NX-8110W80	9	7,200	80% in water	295	136	2.2	Fast cure, long pot life, excellent corrosion protection. M&P, TP, IC
NX-8111W80	10	10,800	80% in water	277	144	2.1	Fast cure, long pot life, excellent corrosion protection. M&P, TP, IC
NX-8401	white emulsion	8,000	55% in water	135	290	2.8	Easily reducible in water, excellent corrosion protection, long pot life. M&P, TP, IC
NX-8402	white emulsion	18,000	45% in water	145	316	2	Easily reducible in water, excellent corrosion protection, fast hardness development. M&P, TP, IC, CF
NX-8501	8	5,600	80% in water	204	165	1.8	Excellent corrosion protection to multiple substrates, good color stability. M&P, TP, IC, TC
NX-8502	5	20,000	44% in water	115	424	1.8	Excellent corrosion protection, good dilution and compatibility with various epoxy resins. M&P, TP, IC

*200 micron with epoxy dispersion, stoichiometric ratio: 0.8, use D.I Water diluted mixture to 50% solids content

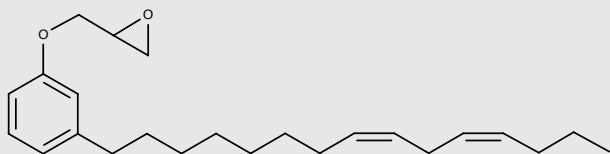
¹ASTM D1544, ²ASTM D2196, ³ASTM D2369-98, ⁴ASTM D2074

M&P - Marine & Protective (immersed), TP - Transportation Primers, IC - Industrial Coatings, CF - Solvent-free Concrete Floors, TC - Top Coats



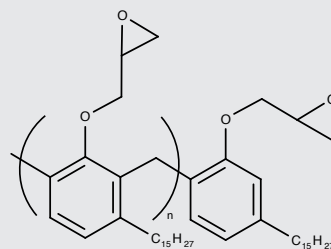
CNSL EPOXY

DILUENTS AND RESINS



NC-513/Ultra LITE 513/LITE 513E

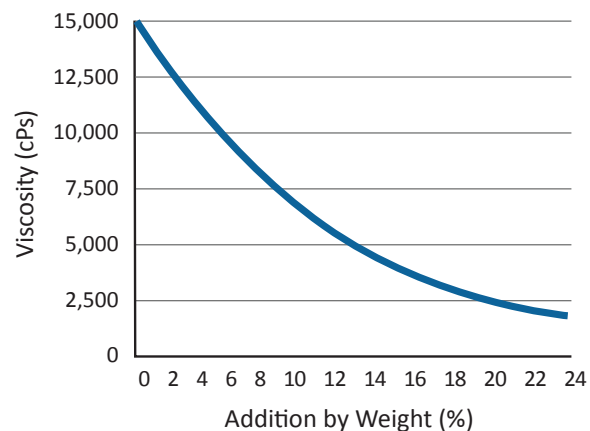
Cardolite NC-513, Ultra LITE 513, and LITE 513E are monofunctional reactive epoxy diluents that can be used to increase the flexibility and impact, and chemical and water resistance of epoxy coatings. These reactive diluents have very low viscosity, which make them ideal for helping formulate high solids and solvent free coatings. Good reactivity means these diluents react completely into the coating network. Ultra LITE 513 is a lower viscosity, higher purity, and very low color version of NC-513; they are both identical in chemical make-up and excellent alternatives to traditional glycidyl ethers. LITE 513E is a very low total chlorine content version of NC-513 suitable for electronic applications.



NC-547

Cardolite NC-547 is a polyglycidyl ether epoxy novolac resin derived from cardanol. This resin can be used in conjunction with standard epoxy resins to bring additional flexibility and longer pot life to coatings without adversely affecting chemical and water resistance.

NC-513 Family Dilution Curve with LER (EEW 190)



Excellent water and moisture resistance



Low viscosity diluents for lower V.O.C.



Toughness, flexibility, increased bond strength

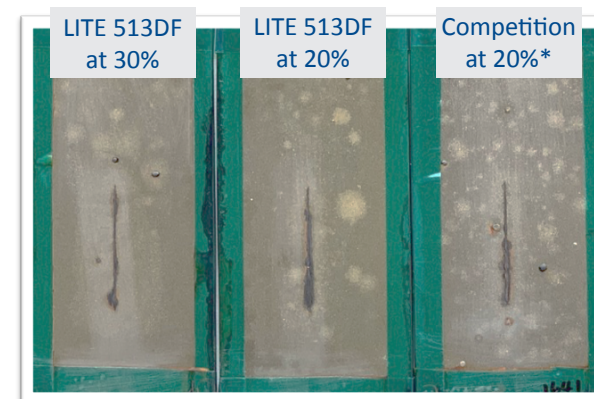


Better labeling compared to phenol-based materials

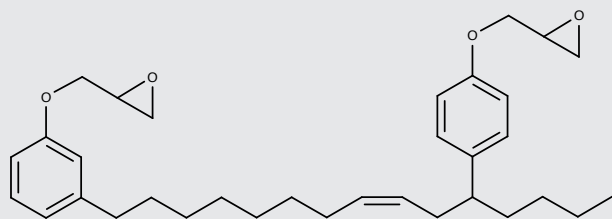
LITE 513DF - CNSL REACTIVE DILUENT & MODIFIER

Cardolite LITE 513DF is a high bio-content diluent and modifier with lower epoxy equivalent weight than standard 513. This material is low in viscosity providing good dilution efficiency to epoxy resins, good water resistance and increased flexibility. In coatings applications, LITE 513DF has demonstrated excellent corrosion protection properties as shown by the pictures of exposed panels after salt spray testing. LITE 513DF is an excellent alternative to petroleum-based difunctional diluents (e.g., 1,6 hexanediol diglycidyl ether and 1,4 butanediol diglycidyl ether).

Salt Spray Results on Blasted Steel after 1640 hrs Exposure (DFT 5.5 mil)



*1,6 hexanediol diglycidyl ether



NC-514/NC-514S

Cardolite NC-514 and NC-514S are flexible difunctional glycidyl ether epoxy resins. NC-514S is lower in viscosity. The chain of 8 carbons separating the aromatic groups allows this resin to be used in conjunction with traditional epoxy resins or as a sole resin to increase coating flexibility, abrasion resistance, and water and chemical resistance without adversely affecting other properties.

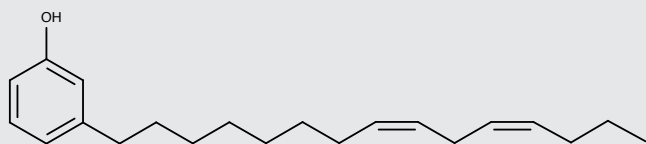
CNSL EPOXY TYPICAL PROPERTIES

Product	Type	Color ¹ (Gardner)	Viscosity ² (cPs)	EEW ³	HyCl ⁴ (%)
NC-513	Reactive diluent	9	40-70	425-575	≤ 2
LITE 513E	Reactive diluent	5	20-40	360-410	≤ 1000ppm
Ultra LITE 513	Reactive diluent	1	20-35	350-425	≤ 0.5
NC-514	Epoxy resin	17	25,000	350-500	≤ 2
NC-514S	Epoxy resin	12	2,000	350-500	≤ 0.5
NC-547	Epoxy novolac resin	18	28,000	550-850	≤ 2.5
LITE 513DF	Reactive diluent	6	90-200	250-300	≤ 2

¹ASTM D1544, ²ASTM D2196 at 25°C, ³ASTM D1652, ⁴ASTM D1726 HyCl (Total Chlorine for LITE 513E)

CNSL DILUENTS & MODIFIERS

FOR EPOXY & POLYURETHANE



NX-202x Product Family

Cardolite NX-202x products are low viscosity multipurpose resin modifiers. The long hydrophobic aliphatic side chain of the cardanol gives these products a very low viscosity and provides excellent water resistance and corrosion protection. Used as epoxy and polyurethane diluents, and as epoxy-amine accelerators, these materials enable coatings formulations to achieve higher solids without sacrificing other performance properties. NX-2021 is the standard modifier grade while NX-2022 is higher in purity. NX-2024 and NX-2025 are the lower odor and lighter initial color versions of NX-2021 and NX-2022, respectively. Ultra LITE 2023, NX-2023(D), and NX-2026 are the wet color stable versions of the NX-202x product family.

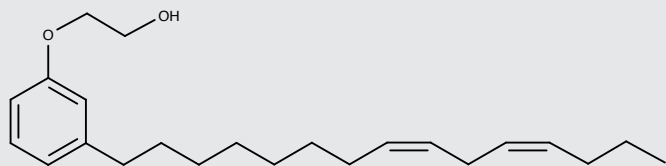
DILUENTS AND MODIFIERS TYPICAL PROPERTIES

Product	Type	Color ¹ (Gardner)	Viscosity ² @ 25°C (cPs)
LITE 2020	Resin diluent and modifier	≤ 14	30-115
Ultra LITE 2020	Resin diluent and modifier	≤ 2	60
LITE 2100	Hydrocarbon resin modifier	≤ 4	450-750
LITE 2100R	Hydrocarbon resin modifier	≤ 4	500-1,500
NX-2021	Resin diluent and modifier	≤ 18	45-75
NX-2022	Resin diluent and modifier	5 - 8	40-60
Ultra LITE 2023	Resin diluent and modifier	≤ 1	40-100
NX-2023	Resin diluent and modifier	≤ 6	40-100
NX-2023D	Resin diluent and modifier	≤ 15	80-140
NX-2024	Resin diluent and modifier	4 - 9	45-60
NX-2025	Resin diluent and modifier	≤ 5	≤ 60
NX-2026	Resin diluent and modifier	≤ 2	≤ 60

¹ASTM D1544, ²ASTM D2196

* LITE 2020/Ultra LITE 2020 and LITE 2100 not approved for sale in Europe.

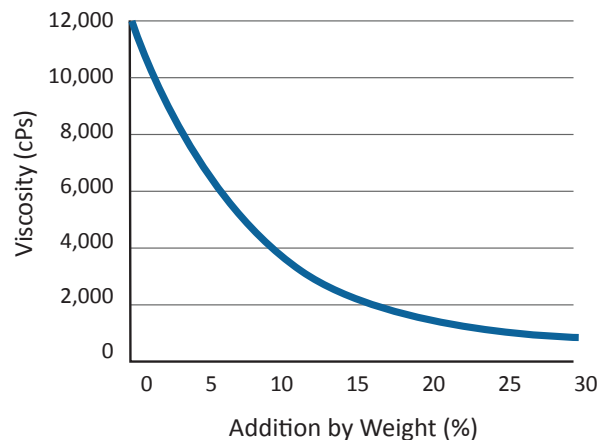
**LITE 2100R is the REACH version of LITE 2100.



LITE 2020/Ultra LITE 2020*

Cardolite LITE 2020 and Ultra LITE 2020 are low viscosity multi-purpose resin modifiers. These resins are ideal for formulating environmentally friendly epoxy and polyurethane high solids or solvent free coatings. Due to their unique chemical structure, they are more efficient than traditional hydrocarbon resins in reducing viscosity and provide good wetting properties. Their hydrophobic nature allows for good corrosion resistance and early water resistance. Ultra LITE 2020 is a lower color version of LITE 2020.

**NX-202x and LITE/UL 2020 Dilution Curve
(25°C with Liquid Epoxy Resin, EEW=190)**



LITE 2100* & LITE 2100R** - HYDROCARBON RESINS

Cardolite LITE 2100(R) are low color and low viscosity CNSL modified hydrocarbon resins. They are designed to enable high solids and solvent-free formulations by lowering the viscosity of epoxy resins more efficiently than typical phenol-based hydrocarbon resins and by improving overall system compatibility for better film formation. These products show good hardness development while providing improved flexibility and impact resistance. Their high hydrophobicity results in excellent water resistance, and more importantly, excellent corrosion protection on immersed and moisture exposed surfaces. Both products show very good UV resistance with excellent gloss retention for use in lighter color coatings.

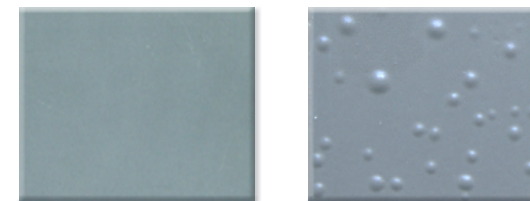
POLYOLS & DIOLS

Cardolite CNSL-based polyols have unique qualities compared to widely known polyester and polyether polyols, and other natural oil based polyols. CNSL polyols are very hydrophobic because of the long aliphatic chain of cardanol compared to typical commercially available polyols. This hydrophobicity provides excellent water resistance and less moisture sensitivity during cure with isocyanate for increased durability of the final polyurethane system. In addition, CNSL polyols show fast cure with isocyanates minimizing the amount of catalysts required and allowing for quick return-to-service.

Different from other renewable polyols obtained from soybean and castor oil, CNSL polyols have an aromatic structure that translates into excellent thermal resistance and chemical resistance to acid and alkaline solutions. Moreover, the combination of aromaticity and long aliphatic chain delivers hydrolytic stability and mechanical strength to CNSL-based polyols.

Cardolite diols offer a wide range of mechanical properties to meet different application requirements. Diol grades suitable as building blocks for prepolymers show excellent compatibility with polyether diols, polyBD, tackifier, and EVA giving formulators greater latitude to achieve desired properties and meet cost targets. For both uses as binders or as part of prepolymers, Cardolite diols provide excellent hydrolytic stability and reduced moisture sensitivity.

Coating Immersion in 10% NaOH



CNSL Polyol - 30 Days Castor oil Polyol - 6 Days

Grades suitable for two-component ambient cured and one-component blocked or moisture cured Polyurethanes and as building block for prepolymers



Excellent water and moisture resistance



Good application and handling properties



Wide range of mechanical properties



Excellent hydrolytic stability and chemical resistance



High bio-content and solvent-free



Good corrosion and cathodic disbondment protection

POLYOL AND DIOLS TYPICAL PROPERTIES

Product	Type	Color ¹ (Gardner)	Viscosity ² @ 25°C (cPs)	Hydroxyl Value ³ (mg KOH/g)	Hydroxyl Eq. Weight ⁴ (g/mole)
NX-9001	CNSL Polyol	18	2,000	175	320
NX-9001LV	Low viscosity CNSL Polyol	18	1,000	175	320
LITE 9001	Low color CNSL Polyol	6	2,000	175	320
NX-9005	Non-CNSL Branched Polyol	≤ 5	3,000	170	330
NX-9007	CNSL Branched Polyol	14	2,900	175	320
NX-9008	High strength CNSL Polyol	10	3,000	320	175
NX-9011	Tough non-CNSL Polyol	≤ 5	1,800	224	250
NX-9014	High UV Resistance non-CNSL Polyol	≤ 5	1,200	256	219
NX-9201	CNSL Polyester Diol	14	1,400	75	748
NX-9203	CNSL Polyester Diol	14	3,000	85	660
NX-9201LP	Lower reactivity NX-9201	14	1,300	70	801
NX-9203LP	Lower reactivity NX-9203	14	2,000	115	488
NX-9207	High strength Non-CNSL Polyester Diol	Pale yellow	Waxy solid	132	425
NX-9208	High strength CNSL Polyester Diol	Pale brown	Waxy solid	78	719
NX-9212	CNSL Polyether Diol	≤ 5	450	55	1020

¹ASTM D1544, ²ASTM D2196 at 25°C, ³ASTM D1957, ⁴Calculated

NCO BLOCKING AGENT
TECHNOLOGY

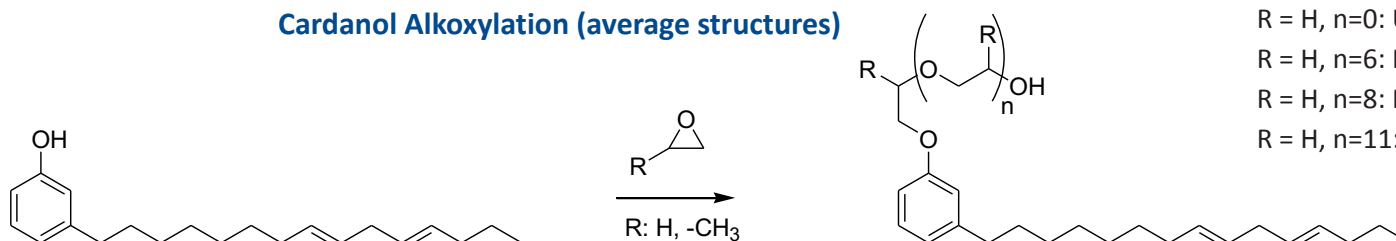
High purity and light color cardanol, NX-2026, is an effective isocyanate blocking agent that can be used to replace petro-based phenols. NX-2026 blocked NCO systems should be lower in viscosity and require lower deblocking temperatures than phenol. Moreover, cardanol can act as a flexibilizer in the final polymer matrix.

Blocking Agent	NCO Type	Deblock Temperature (°C)
NX-2026*	PPG prepolymer (10.4% NCO)	128
Phenol	PPG prepolymer (10.4% NCO)	140

*Properties on page 18

CNSL SURFACTANTS

Cardanol Alkoxylation (average structures)



R = H, n=0: Ultra or LITE 2020, 1 EO cardanol (diluent)

R = H, n=6: NX-7507, 7 EO cardanol

R = H, n=8: NX-7509, 9 EO cardanol

R = H, n=11: NX-7512, 12 EO cardanol

CNSL SURFACTANTS TYPICAL PROPERTIES

Properties	NX-7507 (7 EO)	NX-7509 (9 EO)	NX-7512 (12 EO)
Color (Gardner)	10	10	10
Viscosity at 25°C (cPs)	180	150-300	100-500
pH (5% Aq. Soln.)	9	8.5	7.8
HLB values (calculated)	10.1	11.4	12.8
OH value (mg KOH/g)	100	89	81
Cloud point (2% in BDG 10%)	66	74.5	80
Pour point (°C)	9	3	18
Surface tension (mN/m)	53	50.1	43.7
Foaming efficiency (ml at 0,1 wt.% actives, 25°C, initial/5 minutes)	24/23	28/27	47/42

CNSL SURFACTANTS BENEFITS



High renewable content from non-food chain source



Replacement for nonyl phenol ethoxylates and natural oil-based surfactants



Non-toxic, better labeling

**Cardolite Corporation**

140 Wharton Road
Bristol, PA 19007
United States of America
T: +1-800-322-7365
Email: marketing@cardolite.com

Cardolite Specialty Chemicals Europe NV

Wijmenstraat 21K / 2
B-9030 Mariakerke (Gent)
Belgium
T: +32 (0) 92658820

Cardolite Specialty Chemicals India LLP

Plot No. IP-1 & IP-2, Mangalore Special Economic Zone
Bajpe, Mangalore, 574 142
India
T: +91 (0) 8242888300

Cardolite Chemical Zhuhai Ltd.

1248 Ninth Shihua Road
Gaolan Port Economic Zone
Zhuhai, Guangdong 519050
P.R. China
T: +86-756-726-9066
F: +86-756-726-9067
Email: marketing-cn@cardolite.com

www.cardolite.com

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