LAPOX®

Atul

# AEROSPACE

## EPOXY RESINS, CURING AGENTS AND REACTIVE DILUENTS

**Energising possibilities...**
**Stimulating growth...**


First manufacturing site, Atul, India

## LEGACY

Founded in 1947 by a legendary Indian, Kasturbhai Lalbhai, Atul Ltd (Atul), is amongst the first companies of independent India. It has the distinction of being the first private sector company of India inaugurated by its first Prime Minister, Pandit Jawaharlal Nehru. Atul is part of Lalbhai Group, one of the oldest diversified business houses of the country engaged in manufacturing since 1896. Ever since its inception, Atul has been committed to serving society, particularly in the areas of education, empowerment, health, relief, infrastructure and conservation.

## PROFILE

The first site of Atul, spread over 1,250 acres of land, houses one of the greenest and largest chemical complexes of its kind in the world. Starting with just a few textile dyes, the Company now manufactures 900 products and 450 formulations, managing complex chemical processes in a responsible way. It has also established fruitful and time-tested collaborations with leading multinational companies of the world.

Atul serves customers belonging to diverse industries including Adhesives, Agriculture, Animal Feed, Automobile, Composites, Construction, Cosmetic, Defence, Dyestuff, Electrical and Electronics, Flavour, Food, Footwear, Fragrance, Glass, Home Care, Horticulture, Hospitality, Paint and Coatings, Paper, Personal Care, Pharmaceutical, Plastic, Polymer, Rubber, Soap and Detergent, Sports and Leisure, Textile, Tyre and Wind Energy. In order to enhance customer focus, the Company has divided its product portfolio into seven businesses - Aromatics, Bulk Chemicals and Intermediates, Colors, Crop Protection, Floras, Pharmaceuticals and Intermediates and Polymers, and has established subsidiary companies in the USA, the UK, China, Brazil and the UAE.

## PURPOSE

We are committed to significantly enhancing value for our Stakeholders by:

- fostering a spirit of continuous learning and innovation
- adopting developments in science and technology
- providing high quality products and services, thus becoming the most preferred partner
- having people who practice Values and exemplify a high standard of behaviour
- seeking sustained, dynamic growth and securing long-term success
- taking responsible care of the surrounding environment
- improving the quality of life of the communities we operate in



## POLYMERS BUSINESS

Epoxy resins, reactive diluents and curing agents are manufactured and marketed under the trade name 'Lapox®' by the Polymers Business of Atul. The manufacture of epoxy systems began in 1960 in Cibatul Ltd, a joint venture between the erstwhile Ciba-Geigy (Switzerland) and Atul. Following the disintegration of Ciba-Geigy, Cibatul was merged into Atul in 1999.

The state-of-the-art manufacturing facilities for these products are located in Atul complex, 200 km north of Mumbai. In addition to its leadership position within India, Polymers also sells to discerning customers outside the country. The Business has been awarded ISO 9001:2008 and ISO 14001.



### Product range

**Resins**

Bisphenol-A and Bisphenol-F based resins

Cycloaliphatic resins

Epoxy phenol novolac resins

Modified and formulated resins

Multifunctional resins

**Reactive diluents**

Aliphatic and Aromatic (mono, di and trifunctional)

**Curing agents**

Aliphatic amines and their adducts

Aromatic amines and their adducts

Cycloaliphatic amines and their adducts

Phenalkamines

Polyamides and Polyamidoamines

**Accelerators and catalysts**

### Industries served

Adhesives

Aerospace and Defence

Automotive

Composites

Construction

Electrical and Electronics

Food and Beverage packaging

Marine

Paint and Coatings

Sports and Leisure

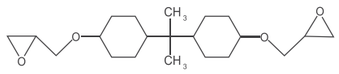
Transport

Wind Energy

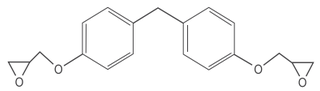
# High performance building blocks

## Epoxy resins

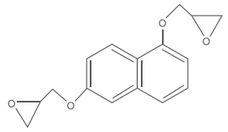
### Bifunctional resins



Diglycidylester of HBPA



Diglycidyl Ether of Bisphenol-F (DGEBF)

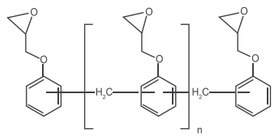


Naphthalene based

| Lapox® | Colour | Epoxy value | Viscosity[1] @ 25°C | Description |
|---|---|---|---|---|
| | Gardner | Eq/kg | mPa s | |
| ARCH-13 | Max 100[2] (APHA) | 4.16 - 4.54 | 2,000 - 4,000 | A low viscosity cycloaliphatic epoxy resin based on hydrogenated Bis-A for UV resistant applications. |
| ARF-15 | Max 2 | 6.00 - 6.40 | 1,200 - 1,600 | A low viscosity, high purity liquid epoxy resin based on Bis-F for advanced applications. |
| ARL-12 | Max 1 | 5.26 - 5.55 | 9,000 - 12,000 | A standard epoxy resin for structural composites. |
| ARL-13 | Max 50[2] (APHA) | 5.71 - 5.95 | 4,000 - 5,000 | A low viscosity, distilled and pure liquid epoxy resin based on Bis-A for advanced applications. |
| ARN-16 | Max 16 | 6.50 - 7.50 | 1,000 - 2,500 @ 50°C | A naphthalene based epoxy resin to achieve high glass transition temperature in formulations. |

[1] Brookfield viscosity
[2] ASTM D1209
*Method: Colour - ASTM D1544; Epoxy value - ASTM D1652; Viscosity - ASTM D2196

### Epoxy phenol novolac resins



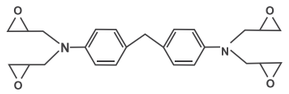
Epoxy Phenol Novolac (EPN)

| Lapox® | Colour | Epoxy value | Viscosity[1] @ 25°C | Description |
|---|---|---|---|---|
| | Gardner | Eq/kg | mPa s | |
| ARPN-25 | Max 3 | 5.59 - 5.81 | 1,100 - 1,700 @ 52°C | A low viscosity resin with average 2.5 functionality for composite applications. |
| ARPN-36 | Max 2 | 5.50 - 5.70 | 20,000 - 50,000 @ 52°C | A standard semi-solid resin having average 3.6 functionality for composite applications. |
| ARPN-36 M 80 | Max 2 | 4.40 - 4.60 | 150 - 350 | A solution of resin ARPN-36 in MEK for composite applications. |
| ARPN-36 X 80 | Max 2 | 4.40 - 4.60 | 800 - 1,500 | A solution of resin ARPN-36 in xylene for composite applications. |

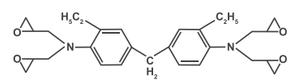
[1] Brookfield viscosity
*Method: Colour - ASTM D1544; Epoxy value - ASTM D1652; Viscosity - ASTM D2196



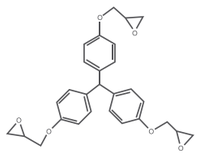
### Multifunctional resins



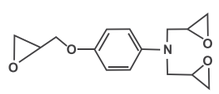
MDA based



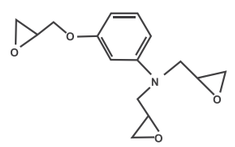
Ethyl substituted MDA based



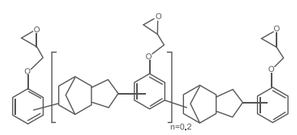
Triphenol methane based



*p*-amino phenol based



*m*-amino phenol based



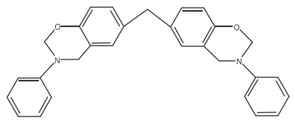
Dicyclopentadiene based

| Lapox® | Colour | Epoxy value | Viscosity[1] @ 25°C | Description |
|---|---|---|---|---|
| | Gardner | Eq/kg | mPa s | |
| ARTF-13 | Max 12 | 7.46 - 8.55 | 7,000 - 11,000[2] @ 50°C | Medium viscosity variants of tetrafunctional resins based on MDA for aerospace and high performance composites. |
| ARTF-14 | Max 12 | 7.46 - 8.55 | 10,000 - 12,000[2] @ 50°C | |
| ARTF-15 | Max 12 | 7.46 - 8.55 | 10,000 - 12,000[2] @ 50°C | |
| ARTF-16 | Max 12 | 7.46 - 8.55 | 10,000 - 12,000[2] @ 50°C | |
| ARTF-17 | Max 12 | 7.46 - 8.55 | 17,000 - 19,000[2] @ 50°C | A high viscosity, tetrafunctional resin based on MDA for aerospace and high performance composites. |
| ARTF-18 | Max 12 | 7.46 - 8.55 | 7,000 - 19,000[2] @ 50°C | A general purpose tetrafunctional resin based on MDA for aerospace and high performance composites. |
| ARTF-23 | Max 12 | 8.55 - 9.00 | 3,000 - 6,000 @ 50°C | A low viscosity, tetrafunctional resin based on MDA for aerospace and high performance composites. |
| ARTF-33 | Max 7 | 7.52 - 8.47 | 7,000 - 12,000 | A tetrafunctional resin based on ethyl substituted MDA for aerospace and high performance applications. The product offers low viscosity and reactivity. |
| ARTF-34 | Max 13 | 5.88 - 6.66 | 30 - 55[2] @ 150°C | A trifunctional resin based on triphenol methane for aerospace and high performance composites. The product offers high glass transition temperature. |
| ARTF-35 | – | 8.70 - 9.50 | 2,000 - 5,000 | A trifunctional unmodified resin based on *p*-amino phenol to achieve low viscosity and high glass transition temperature. |
| ARTF-36 | – | 9.40 - 10.50 | 550 - 850 | A distilled trifunctional unmodified resin based on *p*-amino phenol to achieve very low viscosity and reactivity. |
| ARTF-37 | – | 9.10 - 9.80 | 7,000 - 13,000 | A trifunctional unmodified resin based on *m*-amino phenol to achieve low viscosity and high glass transition temperature. |
| ARTF-38 | – | 9.80 - 10.6 | 1,500 - 4,800 | A distilled trifunctional unmodified resin based on *m*-amino phenol for aerospace and high performance applications. |
| ARTF-50 | Max 16 | 4.17 - 4.44 | 1,000 - 1,500[2] @ 85°C | A multifunctional resin based on Dicyclopentadiene (DCPD). The product offers excellent resistance to moisture and provides high thermal stability. |
| ARTF-32 | Max 18 | 7.40 - 8.50 | 2,000 - 4,000 @ 50°C | A low viscosity, tetrafunctional resin based on substituted MDA for aerospace and high performance composites. |
| ARTF-39 | Max 10 | 7.00 – 8.00 | 2,500 - 4,000 @ 50°C | A modified low viscosity, multifunctional resin for aerospace and high performance composites. |

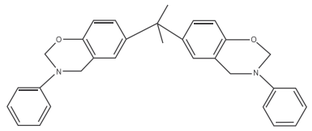
[1] Brookfield viscosity
[2] Viscosity by CAP 2000 (ASTM D4287)
*Method: Colour - ASTM D1544; Epoxy value - ASTM D1652; Viscosity - ASTM D2196

## Other specialty resins

### Benzoxazines



Bisphenol-F based

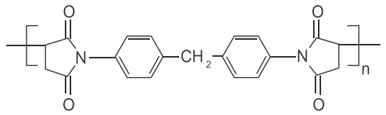


Bisphenol-A based

| Lapox® | Appearance | Softening point | Viscosity[1] @ 25°C | Description |
|---|---|---|---|---|
| | – | °C | mPa s | |
| ARBZ-10 | Yellowish solid | 60 - 80 | 1,000 - 7,000[2] @ 100°C | A Bis-F based benzoxazine resin for high performance composites. The product offers excellent resistance to moisture, has low shrinkage and provides flame retardancy. |
| ARBZ-10 A 75 | Yellowish liquid | 74 - 76% (solid content) | 100 - 400 | A Bis-F based benzoxazine resin ARBZ-10 solution in acetone with 75% solids. The product offers excellent resistance to moisture, has low shrinkage and provides flame retardancy. |
| ARBZ-11 | Yellowish solid | 60 - 80 | 50 - 500[2] @ 125°C | A Bis-A based benzoxazine resin for high performance composites. The product offers excellent resistance to moisture and low shrinkage. |

[1]Brookfield viscosity
[2]Viscosity by CAP 2000 (ASTM D4287)
*Method: Viscosity - ASTM D2196

### Bismaleimides

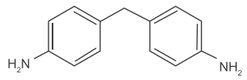


Bismaleimide

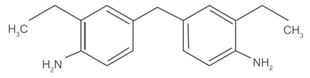
| Lapox® | Appearance | Melting point | Description |
|---|---|---|---|
| | – | °C | |
| ARBMI-11 | Fine yellow powder | 155 - 158 | A bismaleimide resin for composite applications. The product offers excellent thermal stability. |
| ARD-63 | Yellow to amber liquid | – | A co-reactant to use along with ARBMI-11. The product offers excellent processability and achieves high mechanical properties. |

*Method: Melting point - ASTM D1519

## High performance epoxy curing agents



DDM based

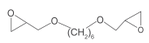
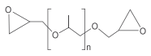
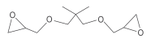
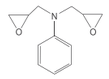
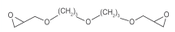
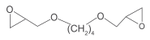


Ethyl substiuted DDM based

| Lapox® | Chemistry | Appearance | Melting point | Viscosity[1] @ 25°C | Description |
|---|---|---|---|---|---|
| | – | – | °C | mPa s | |
| AH-667 | 4,4'-Diaminodiphenyl methane | Brown viscous liquid | – | 1,400 - 2,000 @ 60°C | A semi-solid aromatic amine curing agent based on DDM. The product offers high glass transition temperature and easy processing. |
| K-5 | 4,4'-Diaminodiphenyl methane | White to tan pastilles | 88 - 92 | – | A pure aromatic amine curing agent-4,4'-Diaminodiphenyl methane recommended to cure epoxy resins at elevated temperatures. |
| K-450 | 3,3'-Diethyl-4,4'-diaminodiphenyl methane | Dark brown liquid | – | 250 - 400 @ 40°C | A liquid aromatic amine curing agent with very low reactivity recommended to use along with accelerator for composite applications. |
| AH-422 | 3,3'-Dimethyl-4,4'-diaminodicyclohexyl methane | Colourless transparent liquid | – | 100 - 140 | An unmodified low viscosity cycloaliphatic amine curing agent for achieving a long pot life and high glass transition temperature. |
| AH-442 | 4,4'-Diaminodicyclohexyl methane | Colourless transparent liquid | 35 - 37 | – | A cycloaliphatic liquid MDA for achieving a long pot life and high glass transition temperature. |
| AH-618 | Aromatic amine | Yellow to brown liquid | – | 100 - 300 | A hot curing aromatic amine curing agent recommended for achieving a long pot life and high glass transition temperature. |

[1]Brookfield viscosity
*Method: Melting point - ASTM D1519; Viscosity - ASTM D2196

## Reactive diluents

| Lapox® | Colour | Epoxy value | Viscosity[1] @ 25°C | HyCl | Structure | Description |
|---|---|---|---|---|---|---|
| | Gardner | Eq/kg | mPa s | % | | |
| ARD-52 | Max 1 | 6.20 - 6.80 | 15 - 30 | Max 0.15 |  | A difunctional aliphatic reactive diluent based on 1,6-hexanediol to modify resins used for composite applications. |
| ARD-54 | Max 2 | 2.90 - 3.20 | 40 - 90 | Max 0.15 |  | A difunctional aliphatic reactive diluent based on polypropylene glycol that imparts higher flexibility to epoxy resins. |
| ARD-56 | Max 1 | 6.90 - 8.00 | 12 - 18 | Max 0.10 |  | A difunctional aliphatic reactive diluent based on neopentyl glycol recommended for composite formulations. |
| ARD-57 | Max 16 | 8.15 - 9.50 | 100 - 200 | – |  | A difunctional aromatic reactive diluent based on aniline recommended for high performance composite formulations. |
| ARD-59 | Max 1 | 5.20 - 6.20 | 20 - 50 | Max 0.20 |  | A difunctional aliphatic reactive diluent based on dipropylene glycol recommended for composite formulations. |
| ARD-60 | Max 1 | 8.00 - 9.00 | 10 - 22 | Max 0.15 |  | A high purity difunctional aliphatic reactive diluent based on 1,4-butanediol recommended to modify resins used for composite applications. |

[1]Brookfield viscosity

*Method: Colour - ASTM D1544; Viscosity - ASTM D2196; HyCl - ASTM D1726

## Accelerators and catalysts

| Lapox® | Appearance | Colour | Viscosity[1] @ 25°C | Amine value | Description |
|---|---|---|---|---|---|
| | – | Gardner | mPa s | mg KOH/g | |
| AC-10 | White crystals | – | 154 - 156 (melting point,°C) | – | An accelerator recommended for benzoxazine resins to reduce cure temperature. |
| AC-11 | White crystals | – | Min 127 - 134 (melting point,°C) | – | A faster accelerator for benzoxazine resins to reduce cure temperature. |
| AC-13 | Clear liquid | Max 2 | Max 10 | – | A liquid triamine accelerator recommended to accelerate anhydrides, polyamides for composite applications. |
| AC-14 | Clear yellow brown liquid | Max 6 | 150 - 300 | 580 - 635 | A liquid tertiary amine accelerator recommended to accelerate anhydrides, polyamides and amines for composite applications. |
| AC-19 | Clear liquid | Max 1 | 10 - 30 | – | A low reactive liquid triamine accelerator recommended to accelerate anhydrides, polyamides and amines for composite applications. |
| AC-20 | Brown liquid or solid | – | Max 100 | 36 - 42 (melting point,°C) | An accelerator recommended to accelerate anhydrides, polyamides and amines for composite applications. |
| K-86 (AC-15) | White crystalline powder | – | Min 75 (melting point,°C) | – | A solid polyamine complex recommended to accelerate aromatic amines. |
| K-112 | Clear brown liquid | – | 1,000 - 1,800 | – | A modified viscous tertiary amine accelerator recommended to accelerate anhydrides, polyamides and amines for composite applications. |

[1]Brookfield viscosity

*Method: Colour - ASTM D1544; Viscosity - ASTM D2196; Amine value - ASTM D2073

# High performance epoxy systems

## Hot melt prepreg systems

| Lapox® | Mixing ratio | Gel time | Tg[1] | Shelf life | Description |
|---|---|---|---|---|---|
| | Parts by weight | minutes | °C | weeks | |
| ARL-159 / AH-619 | 100 : 40 | 30 @ 150°C | 180 - 200 | 24 @ < 5°C | A hot curing epoxy system for manufacturing structural components requiring high temperature performance in aerospace, defence and engineering applications. |
| ARL-160 / AH-357 / AC-22 | 100 : 15 : 1-3 | 8 - 9 @ 120°C | 110 - 120 | 24 @ < 5°C | A hot melt prepreg system for structural components for sporting goods, defence, aerospace, infrastructure and general engineering applications. |

[1]Tg: Glass transition temperature
*Method: Gel time - DIN 16945

## Infusion systems

| Lapox® | Mixing ratio | Mix viscosity[1] @ 25°C | Pot life[2] @ 25°C | Tg[3] | Description |
|---|---|---|---|---|---|
| | Parts by weight | mPa s | minutes | °C | |
| ARL-125 / AH-332 | 100 : 32 | 600 - 800 | 8 - 14 | 80 - 90 | Medium viscosity epoxy systems with short pot life recommended for Resin Infusion (RI) and Resin Transfer Moulding (RTM) for making small to large composite components. |
| ARL-125 / AH-333 | 100 : 32 | 600 - 750 | 14 - 20 | 80 - 90 | |
| ARL-125 / AH-334 | 100 : 32 | 600 - 750 | 25 - 35 | 80 - 90 | Medium viscosity epoxy systems with moderate pot life recommended for Resin Infusion (RI) and Resin Transfer Moulding (RTM) for making small to large composite components. |
| ARL-125 / AH-335 | 100 : 32 | 300 - 700 | 50 - 60 | 75 - 85 | |
| ARL-125 / AH-336 | 100 : 32 | 300 - 700 | 80 - 100 | 75 - 85 | A medium viscosity epoxy system with long pot life recommended for Resin Transfer Moulding (RTM) and Resin Infusion (RI) for making small to large composite components. |
| ARL-125 / AH-365 GL | 100 : 32 | 300 - 700 | 50 - 60 | 75 - 85 | GL certified low viscosity epoxy systems recommended for Resin Infusion (RI) and Resin Transfer Moulding (RTM) for making small to large composite components. |
| ARL-125 / AH-367 GL | 100 : 32 | 200 - 300 | 300 - 380 | 75 - 85 | |
| ARL-125 / AH-368 | 100 : 32 | 200 - 300 | 350 - 450 | 75 - 85 | A low viscosity epoxy system recommended for Resin Infusion (RI) and Resin Transfer Moulding (RTM) for making small to large composite components. |
| ARL-135 LV / AH-422 | 100 : 35 | 400 - 600 | 300 - 350 | 110 - 120 | A medium viscosity epoxy system with long pot life and high glass transition temperature recommended for Resin Infusion (RI) of large components. |
| ARL-158 / AH-419 | 100 : 42 | 300 - 500 | 600 - 700 | 170 - 200 | A low viscosity epoxy system offers high glass transition temperature for dimensional stability even at high temperatures. |
| L-12 / AH-411 | 100 : 22 | 800 - 1,200 | 90 - 120 | 140 - 155 | A moderate viscosity ambient curing epoxy system recommended for very high glass transition temperature. |
| L-552 / K-552 | 100 : 38 | 600 - 700 | 110 - 160 | 115 - 130 | A low viscosity epoxy system offers high glass transition temperature with superior chemical resistance. |

[1]Brookfield viscosity
[2]Pot life of 100 g mix mass
[3]Tg: Glass transition temperature
*Method: Mix viscosity - ASTM D5478; Pot life - ASTM D2471; Tg - ISO 11375-2



## Hand lay-up systems

| Lapox® | Mixing ratio | Mix viscosity[1] @ 25°C | Pot life[2] @ 25°C | Tg[3] | Description |
|---|---|---|---|---|---|
| | Parts by weight | mPa s | minutes | °C | |
| ARL-135 / AH-332 | 100 : 32 | 700 - 1,200 | 8 - 14 | 80 - 90 | Medium viscosity epoxy systems with short pot life recommended for hand lay-up and Resin Transfer Moulding (RTM) for making small to large composite components. |
| ARL-135 / AH-333 | 100 : 32 | 700 - 1,200 | 14 - 20 | 80 - 90 | |
| ARL-135 / AH-334 GL | 100 : 32 | 700 - 1,200 | 25 - 35 | 80 - 90 | A GL certified moderate viscosity with moderate pot life epoxy system recommended for hand lay-up and Resin Transfer Moulding (RTM) for making small to large composite components. |
| ARL-135 / AH-335 | 100 : 32 | 500 - 700 | 50 - 60 | 75 - 85 | A medium viscosity epoxy system with moderate pot life recommended for hand lay-up and Resin Transfer Moulding (RTM) for making small to large composite components. |
| ARL-135 / AH-336 | 100 : 32 | 500 - 700 | 80 - 100 | 75 - 85 | Medium viscosity epoxy systems with long pot life recommended for hand lay-up and Resin Transfer Moulding (RTM) for making small to large composite components. |
| ARL-135 / AH-337 | 100 : 32 | 300 - 700 | 300 - 380 | 75 - 85 | |

[1]Brookfield viscosity
[2]Pot life of 100 g mix mass
[3]Tg: Glass transition temperature
*Method: Mix viscosity - ASTM D5478; Pot life - ASTM D2471; Tg - ISO 11375-2

## Tooling systems

| Lapox® | Mixing ratio | Mix viscosity[1] @ 25°C | Pot life[2] @ 25°C | Tg[3] | Description |
|---|---|---|---|---|---|
| | Parts by weight | mPa s | minutes | °C | |
| ARL-138 / AH-339 | 100 : 30 | 400 - 600 | 120 - 180 | 130 - 140 | A standard tooling system with excellent glass transition temperature, suitable to make tools with hand lay-up and infusion processes of varying sizes. |
| ARL-138 / AH-417 | 100 : 30 | 200 - 300 | 90 - 120 | 100 - 110 | A low viscosity ambient curing epoxy system offers high glass transition temperature, facilitates superior wetting of fiber enabling higher productivity. |
| ARL-140 / AH-419 | 100 : 42 | 2,500 - 3,000 | 600 - 700 | 190 - 220 | A tooling system with high glass transition temperature for dimensional stability even at high temperatures. |
| ART-22 / AH-326 | 100 : 6 | Paste (grey) | 15 - 20 | 85 - 95 | A gel coat with high thermal conductivity, excellent hardness and surface finish. |
| L-552 / K-552 | 100 : 38 | 600 - 700 | 110 - 160 | 115 - 130 | A low viscosity epoxy system offers high glass transition temperature with superior chemical resistance. |

[1]Brookfield viscosity
[2]Pot life of 100 g mix mass
[3]Tg: Glass transition temperature
*Method: Mix viscosity - ASTM D5478; Pot life - ASTM D2471; Tg - ISO 11375-2Zv

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