LAPOX®

Atul

COMPOSITES

EPOXY RESINS, CURING AGENTS AND REACTIVE DILUENTS

Energising possibilities...
Stimulating growth...

First manufacturing site, Atul, India

Profile

Atul Ltd (Atul) is an integrated chemical company belonging to the Lalbhai Group, serving about 6,000 customers in 85 countries across the world. The Company manufactures about 900 products and 450 formulations, and owns over 100 retail brands. It has established subsidiary companies in the USA, the UK, China, Brazil and the UAE to serve its customers and thus enhance the breadth and depth of its business.

Atul was founded on September 15, 1947 – exactly a month after Indian independence – by Kasturbhai Lalbhai, an institution builder par excellence and a legendary Indian of his times. The Company was a manifestation of his dream to generate large-scale employment, create wealth in rural India and make the country self-sufficient in its requirements of chemicals.

The Company has its production facilities in Ankleshwar, Atul and Panoli in Gujarat, Tarapur in Maharashtra, India and Somerset, UK. The first manufacturing site of the Company in Atul, Gujarat is spread over 1,250 acres and is amongst the largest and greenest chemical complexes of its kind in the world. The Company has its registered office in Ahmedabad and head office at Atul, both in Gujarat, India. The shares of Atul Ltd are listed both on National Stock Exchange and Bombay Stock Exchange.

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 Performance Materials

Epoxy resins, reactive diluents and curing agents are manufactured and marketed under the trade name 'Lapox®' by the Polymers Performance Materials Business of Atul. The Manufacturing 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 at the first manufacturing site of the Company at Atul. In addition to its leadership position within India, Atul Polymers also sells its products 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

Adhesive

Aerospace and Defence

Automotive

Composite

Construction

Electrical and Electronics

Food and Beverage packaging

Marine

Paint and Coatings

Sport and Leisure

Transport

Wind Energy

FILAMENT WINDING AND PULTRUSION SYSTEMS

Atul offers several epoxy resin systems for filament winding and pultrusion applications. Suitable epoxy systems may be selected as per the process and performance requirements. These systems may be processed with a variety of reinforcements at ambient and elevated temperatures. Components manufactured with epoxy systems offer excellent mechanical, electrical, chemical, thermal and physical properties for various filament winding and pultrusion applications.

Ambient cure systems

Lapox®	Mixing ratio	Mix viscosity[1] @ 25°C	Pot life[2] @ 25°C	Tg[3]	Recommendations
	Parts by weight	mPa s	minutes	°C	
ARL-12 | AH-714	100 : 50	1,200 - 1,500	120 - 150	55 - 65	An ambient cure epoxy system that offers superior adhesion with toughness. This system is good for high pressure vessels.
ARL-135 LV | AH-335	100 : 32	300 - 500	50 - 60	75 - 85	A low viscosity epoxy system with variable pot life recommended for filament winding and pultrusion applications.
ARL-135 LV | AH-336	100 : 32	300 - 500	80 - 100	75 - 85	
ARL-135 LV | AH-337	100 : 32	200 - 300	300 - 380	75 - 85	
ARL-138 | AH-417	100 : 30	200 - 300	90 - 150	100 - 110	A low viscosity ambient curing epoxy system that offers high Tg. This system facilitates superior wetting of fibre enabling higher productivity.
ARL-167 | AH 385	100 : 40	800 - 1,000	10 - 15	45 - 50	An ambient curing flexible epoxy system with very fast reactivity. This system offers amine blush free components.
L-12 | AH-315	100 : 32	500 - 800	7 - 9 hr	85 - 95	A low viscosity ambient curing epoxy system with a long pot life for the manufacture of large components.
L-12 | AH-335	100 : 32	600 - 1,200	50 - 60	90 - 105	An ambient curing epoxy system with variable pot life and higher Tg.
L-12 | AH-336	100 : 32	600 - 1,200	80 - 100	90 - 105	
L-12 | AH-337	100 : 32	400 - 700	300 - 380	90 - 105	
L-12 | AH-411	100 : 22	800 - 1,200	90 - 120	140 - 155	A moderate viscosity ambient curing epoxy system recommended for very high Tg.
L-12 | AH-422	100 : 32	1,500 - 2,500	300 - 350	130 - 140	An ambient curing epoxy system that offers a long pot life with high Tg.

[1]Brookfield viscosity
[2]Pot life of 100 g mix mass
[3]Tg: Glass transition temperature
*Method: Mix viscosity - ASTM D2196; Pot life - ASTM D2471; Tg - ISO 11375-2



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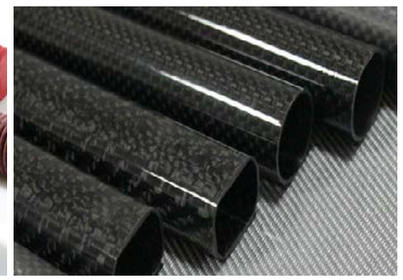
FILAMENT WINDING AND PULTRUSION SYSTEMS

Hot cure systems

Lapox®	Mixing ratio	Mix viscosity[1] @ 25°C	Gel time @ 120°C	Tg[2]	Recommendations
	Parts by weight	mPa s	minutes	°C	
ARCH-11 | K-3 | K-13	100 : 90 : 0.5 - 2.0	200 - 500	4 - 5	105 - 115	A hot curing cycloaliphatic epoxy resin based system recommended for outdoor applications and UV resistance.
ARF-11 | K-918 | K-13	100 : 85 : 0.1 - 2.0	300 - 500	8 - 11	115 - 130	A low viscosity hot curing epoxy system offering excellent chemical resistance. The resin part is non-crystallisable.
ARL-136 | AH-126	100 : 90	300 - 600	4 - 6	115 - 125	A hot curing epoxy system that offers superior fibre wetting property giving higher productivity. Optimum curing delivers excellent mechanical and electrical properties with good surface finish.
L-12 | AH-113 | K-13	100 : 95 : 0.1 - 2.0	1,900 - 2,100	13 - 15	165 - 185	A hot curing epoxy system for manufacturing laminates subjected to continuous operations at 170°C.
L-12 | AH-667	100 : 27	3,000 - 5,000 @ 50°C	8 - 10	165 - 175	A hot curing epoxy system recommended for high chemical and abrasion resistance.
L-12 | K-12 | K-13	100 : 100 : 0.1 - 2.0	400 - 700	10 - 12	85 - 95	A standard hot curing epoxy system with fast reactivity. This system offers good cantilever strength to components.
L-12 | K-918 | K-13	100 : 85 : 0.1 - 2.0	600 - 900	10 - 12	130 - 140	A hot curing epoxy system recommended for general purpose composite applications.
L-12 | K-5200	100 : 24	4,000 - 6,000	60 - 65	170 - 180	A hot curing epoxy system that offers a long pot life and very high Tg.
L-247 | K-918 | K-13	100 : 65 : 1 - 3	-	8 - 10	110 - 120	A hot curing general purpose composite system providing fire retardant properties.

[1]Brookfield viscosity
[2]Tg: Glass transition temperature
*Method: Mix viscosity - ASTM D2196; Gel time - DIN 16945; Tg - ISO 11375-2





PREPREGS AND LAMINATION SYSTEMS

Atul offers a wide range of epoxy resin systems for manufacturing of B-stage prepregs and laminates which meet process and performance requirements. These lamination systems offer excellent impregnation and compatibility with a variety of reinforcements, excellent mechanical strength, high thermal resistance and a varying shelf life of prepregs.

Compressed laminate systems (for electrical and general engineering)

Lapox®	Mixing ratio	Gel time @ 120°C	Tg[1]	Recommendations
	Parts by weight	minutes	°C	
ARPN-36 | K-10 | K-86	100 : 40 : 1 - 3	7 - 12	200 - 210	A hot curing epoxy system that delivers stable B-stage prepregs with a very high Tg. This system is recommended for MICA paper impregnation.
ARPN-36 | K-86	100 : 3 - 6	8 - 12	230 - 235	
L-12 | K-5	100 : 27	8 - 10	150 - 160	A hot curing epoxy system recommended for prepregs with a shorter shelf life for G-10 and G-11 laminates.
L-12 | K-10 | K-86	100 : 35 : 1 - 3	19 - 21	150 - 160	A hot curing epoxy system delivers stable prepregs after B-staging with a shelf life of up to 6 months. This system is recommended for G-11 laminates.
L-67 | K-66 | K-13	100 : 23 : 0.1 - 3.0	7 - 9 @ 150°C	130 - 140	A hot curing epoxy system recommended for manufacturing B-stage prepregs and G-10 laminates.
L-68 | K-66 | K-13	100 : 32 : 1 - 3	7 - 9 @ 150°C	130 - 140	A hot curing epoxy system recommended for manufacturing B-stage prepregs and FR-4 laminates.

Prepreg systems

Lapox®	Mixing ratio	Gel time @ 120°C	Tg[1]	Recommendations
	Parts by weight	minutes	°C	
ARL-159 | AH-357 | AC-22	100 : 30 : 1 - 3	7 - 9	155 - 165	A hot melt prepreg system for 150°C Tg. The product can also be used in a solution form by adding a suitable solvent.
ARL-159 | AH-619	100 : 40	30 @ 150°C	180 - 200	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	110 - 120	A hot melt prepreg system for structural components for sporting goods, defence, aerospace, infrastructure and general engineering applications.
ARL-162 | AH-380	100 : 1.5	10 - 15	85 - 95	A solvent based prepreg system for glass fibres, carbon prepregs and sporting goods.

[1]Tg: Glass transition temperature
*Method: Gel time - DIN 16945; Tg - ISO 11375-2



RTM AND HAND LAY-UP SYSTEMS

Atul offers an exhaustive range of epoxy resin systems with variable pot life, cure time, glass transition temperature (Tg) and physical properties. These systems are suitable for various processes including Resin Transfer Moulding (RTM) and hand lay-up. The variable pot life of these resin systems make them ideal for manufacturing small to very large components, including wind turbine blades. Our range includes GL approved epoxy systems for composite applications.

Lapox®	Mixing ratio	Mix viscosity[1] @ 25°C	Pot life[2] @ 25°C	Tg[3]	Recommendations
	Parts by weight	mPa s	minutes	°C	
ARL-125 | AH-365[GL]	100 : 32	300 - 700	50 - 60	75 - 85	A GL certified low viscosity epoxy system recommended for RTM, hand lay-up, vacuum and pressure bag techniques. This system is suitable for Resin Infusion of small components.
ARL-135 | AH-332	100 : 32	700 - 1,200	8 - 14	80 - 90	A moderate viscosity epoxy system with a short pot life recommended for RTM and hand lay-up 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 a moderate pot life epoxy system recommended for RTM and hand lay-up for making small to large composite components.
ARL-135 | AH-335	100 : 32	500 - 700	50 - 60	75 - 85	An epoxy system with a moderate pot life recommended for RTM and hand lay-up for making small to large composite components.
ARL-135 | AH-336	100 : 32	500 - 700	80 - 100	75 - 85	A medium viscosity epoxy system with a long pot life recommended for RTM and hand lay-up for making small to large composite components.
ARL-135 | AH-337	100 : 32	300 - 500	300 - 380	75 - 85	
ARL-135 LV | AH-332	100 : 32	600 - 800	8 - 14	80 - 90	An epoxy system with variable pot life to achieve desired cure speed and productivity. The system is recommended for RTM and Resin Infusion processes for making small to large components, including wind turbine blades.
ARL-135 LV | AH-333	100 : 32	600 - 750	14 - 20	80 - 90	
ARL-135 LV | AH-334	100 : 32	600 - 750	25 - 35	80 - 90	
ARL-135 LV | AH-335	100 : 32	300 - 500	50 - 60	75 - 85	
ARL-143 | AH-319	100 : 15	3,500 - 5,000	18 - 25	95 - 105	A moderate viscosity modified epoxy system with variable pot life to suit different processing techniques. This system is recommended for fire retardant applications.
ARL-143 | AH-335	100 : 15	3,500 - 5,000	85 - 95	95 - 105	
L-552 | K-552	100 : 38	600 - 700	110 - 160	115 - 130	A low viscosity epoxy system that offers high Tg with superior chemical resistance recommended for high performance composites.

[1]Brookfield viscosity
[2]Pot life of 100 g mix mass
[3]Tg: Glass transition temperature
*Method: Mix viscosity - ASTM D2196; Pot life - ASTM D2471; Tg - ISO 11375-2



INFUSION SYSTEMS

Atul offers epoxy resin systems with variable pot life, cure time, glass transition temperature (Tg) and physical properties. These systems are suitable for Resin Infusion (RI) processes. The variable pot life of these resin systems make them ideal for manufacturing small to very large components, including wind turbine blades.

Lapox®	Mixing ratio	Mix viscosity[1] @ 25°C	Pot life[2] @ 25°C	Tg[3]	Recommendations
	Parts by weight	mPa s	minutes	°C	
ARL-125 | AH-367[GL]	100 : 32	200 - 300	300 - 380	75 - 85	A GL certified low viscosity epoxy system recommended for RI of medium to large components.
ARL-135 LV | AH-336	100 : 32	400 - 650	80 - 100	75 - 85	A low viscosity epoxy system with a long pot life recommended for RI process for making small to large components, including wind turbine blades.
ARL-135 LV | AH-337	100 : 32	200 - 300	300 - 380	75 - 85	
ARL-135 LV | AH-411	100 : 24	250 - 400	90 - 120	125 - 135	A very low viscosity epoxy system for high Tg recommended for RI process.
ARL-135 LV | AH-422	100 : 32	400 - 600	300 - 350	110 - 120	A low viscosity epoxy system with a long pot life and high Tg recommended for RI of large components.
ARL-163 | AH-381	100 : 33	200 - 300	250 - 300	125 - 135	A very low viscosity epoxy system with a long pot life and high Tg.

[1]Brookfield viscosity
[2]Pot life of 100 g mix mass
[3]Tg: Glass transition temperature
*Method: Mix viscosity - ASTM D2196; Pot life - ASTM D2471; Tg - ISO 11375-2



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TOOLING SYSTEMS

Atul offers various gel coats and laminating systems for manufacturing prototypes and moulds. Laminating systems are available with variable pot life and viscosity to manufacture small to large moulds. The variable pot life of these epoxy systems make them suitable for hand lay-up and Resin Infusion (RI) processes.

Gel coat systems

Lapox®	Mixing ratio	Mix viscosity[1] @ 25°C	Pot life[2] @ 25°C	Tg[3]	Recommendations
	Parts by weight	mPa s	minutes	°C	
ART-21 | AH-326 (T-73)	100 : 15	Paste (white)	25 - 30	75 - 85	A general purpose gel coat for all types of moulds.
ART-22 | AH-326 (T-94)	100 : 8	Paste (grey)	15 - 20	85 - 95	A gel coat with high thermal conductivity, excellent hardness and surface finish.
ART-23 | AH-326 (T-96)	100 : 10	Paste (blue)	15 - 20	75 - 85	A gel coat with exceptionally high hardness and abrasion resistance coupled with a good finish.
ART-24 | AH-326	100 : 15	Paste (colourless)	15 - 30	95 - 115	A colourless gel coat which can be suitably tinted.

Laminating systems

Lapox®	Mixing ratio	Mix viscosity[1] @ 25°C	Pot life[2] @ 25°C	Tg[3]	Recommendations
	Parts by weight	mPa s	minutes	°C	
ARL-135 LV | AH-411	100 : 24	250 - 400	90 - 120	125 - 135	A very low viscosity epoxy system for high Tg, recommended for RI, hand lay-up and tooling applications.
ARL-138 | AH-339	100 : 30	400 - 600	120 - 180	130 - 140	A standard tooling system with excellent Tg suitable to make tools with hand lay-up and infusion process of varying sizes.
ARL-138 | AH-417	100 : 30	200 - 300	90 - 150	100 - 110	A low viscosity ambient curing epoxy system that offers high Tg and facilitates superior wetting of fibre enabling higher productivity.
ARL-140 | AH-419	100 : 42	2,500 - 3,000	600 - 700	190 - 220	A tooling system with high Tg for dimensional stability even at high temperatures.
L-552 | K-552	100 : 38	600 - 700	110 - 160	115 - 130	A low viscosity epoxy system that offers high Tg with superior chemical resistance recommended for high performance composites.

[1]Brookfield viscosity
[2]Pot life of 100 g mix mass
[3]Tg: Glass transition temperature
*Method: Mix viscosity - ASTM D2196; Pot life - ASTM D2471; Tg - ISO 11375-2



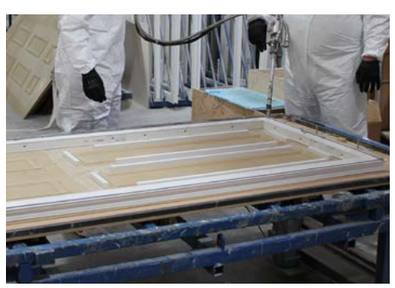
ADHESIVE SYSTEMS

The range of adhesives offered by Atul are suitable for joining similar and dissimilar substrates for high performance applications using different processes.

Lapox®	Mixing ratio	Mix viscosity[1] @ 25°C	Pot life[2] @ 25°C	Recommendations
	Parts by weight	mPa s	minutes	
A-16 | AH-800	100 : 100	10,000 - 13,000	3 - 7	A rapid cure adhesive suitable to bond similar or dissimilar substrates quickly (in 5 - 7 minutes).
A-31 | AH-717	100 : 80	30,000 - 35,000	75 - 90	An adhesive used in bonds where high shear strength (120 kgf/cm²) is required. The system is recommended for glass, metal, FRP and wood.
A-83 | K-83	100 : 40	10,000 - 20,000	60 - 80	A standard adhesive with thixotropic properties to fill gaps of up to 5 mm thickness.
ARA-32 | AH-733	100 : 45	-	55 - 65 @ 30°C	A thixotropic structural adhesive with high lap shear strength for joining wind turbine blades.
ARA-32 | AH-735	100 : 45	-	120 - 180 @ 30°C	
ARA-41 | AH-448	100 : 50	60,000 - 75,000	55 - 65	A moderate cure adhesive offering high Tg for laminate-to-laminate bonding.
ARA-42 | AH-746	100 : 50	20,000 - 50,000	85 - 95	A long pot life general purpose adhesive for metal-to-laminate bonding.
XR-110 | XH-68	100 : 100	2,500 - 5,000	30 - 45	A special adhesive used for flexible cable joints.

[1]Brookfield viscosity
[2]Pot life of 100 g mix mass
*Method: Mix viscosity - ASTM D2196; Pot life - ASTM D2471





GLOSSARY

B-stage
B-stage is an intermediate reaction stage of thermosetting resins. A material in this stage softens when heated and swells when it comes in contact with certain solvents. However, it does not fuse or completely dissolve.

Cross-linking
Reactive sites of the resin and curing agent make chemical bonds and form a three-dimensional network. Cross-linking starts as soon as the resin and curing agent come into physical contact. The speed of the reaction (i.e. of cross-linking) depends on the type of resin, curing agent and temperature.

Cure time
Cure time is the amount of time required for a liquid resin-curing agent mix to convert into a completely cross-linked solid mass. It depends on various factors including the type of resin, curing agent and temperature.

Elastic modulus
Every object deforms elastically when force is applied. This deformation is completely reversed when the applied force is removed. Elastic modulus is a measure of stiffness of the material or object.

Elongation
Elongation is defined as the change in length of a specimen or object when load is applied under tension, bending or any other mode.

Epoxide Equivalent Weight (EEW)
EEW is the weight of the resin in grams that contains one gram-equivalent of epoxy. An interchangeable term, Epoxy Value (EV) may also be used. EV represents the fractional number of epoxy groups contained by 1,000 grams of resin. EEW can be obtained if 1,000 is divided by EV.

Gel time
Gel time is the amount of time required for a resin-curing agent mix to convert into a jelly-like mass. It depends on the type of resin and curing agent, the quantity of the mix and temperature.

Glass Transition Temperature (Tg)
This is the critical temperature at which a polymer transitions from a hard, glassy material to a soft, rubbery material.

Post curing
When a resin and curing agent react, cross-linking takes place and a solid, cured mass is obtained. In certain epoxy systems, even though the material appears cured and hard, optimum mechanical properties are not achieved. This happens due to the presence of free reactive sites of the resin and curing agent that can be completely cross-linked by heating (post curing) at appropriate temperatures.

Pot life
The amount of time taken to retain processable (i.e. usable) viscosity of a resin-curing agent mix. Mix viscosity increases with time. Pot life is dependent on the type of resin and curing agent, quantity of mix and temperature.

Shrinkage
Shrinkage is defined as the change in dimension that occurs in a polymer(s) when cross-linking takes place. Volume shrinkage is expressed as a percentage while linear shrinkage is measured in millimetres or inches.

Stiffness
This is the measure of an object's resistance to deform when under stress. A material with high stiffness is brittle and displays high modulus.

Toughness
Toughness is a material's resistance to fracture when under stress. It is measured as the amount of energy absorbed by unit volume of material before disintegration.

Viscosity
The internal resistance of a liquid to flow, viscosity can also be defined as 'fluid friction'.

KEY MARKETS

EUROPE
Belgium, Czech Republic
Finland, France, Germany
Hungary, Italy, Norway, UK

NORTH AMERICA
Canada
USA

MIDDLE EAST
Bahrain, Iran, Kuwait, Oman, Qatar
Saudi Arabia, Turkey, UAE

FAR EAST
China, Hong Kong
Japan, Korea, Taiwan

SOUTH AMERICA
Argentina
Brazil
Colombia
Peru

AFRICA
Algeria
Egypt
Kenya
Morocco
Nigeria
Tunisia

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Lalbhai Group