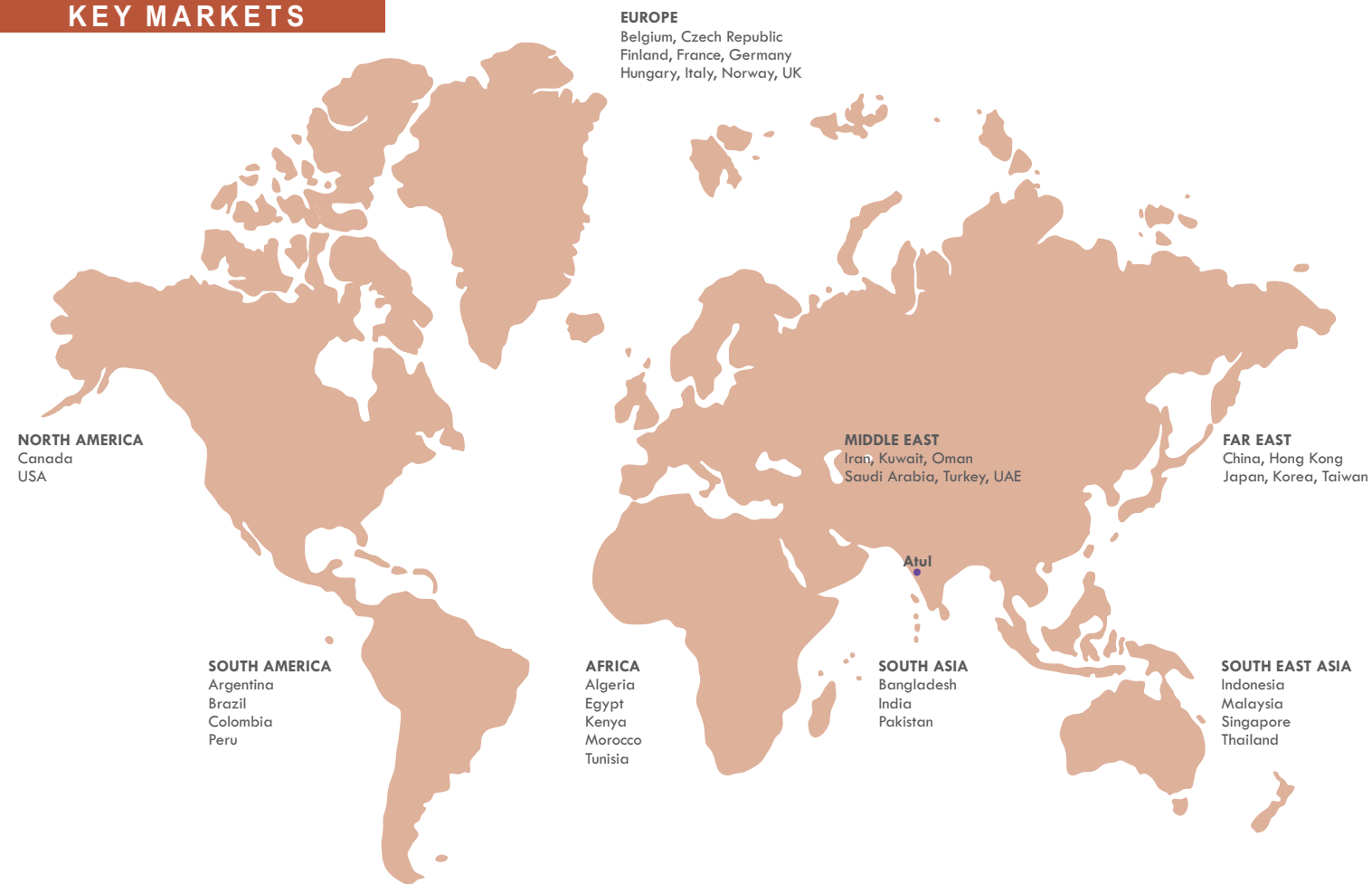


## KEY MARKETS



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Aug 2017



POLYMERS



AROMATICS



BULK CHEMICALS AND INTERMEDIATES



COLORS



CROP PROTECTION



FLORAS



PHARMACEUTICALS AND INTERMEDIATES



Lalshai Group

Disclaimer: Information given in this guide is only for guidance without any responsibility on Atul Ltd (Atul). Results vary depending upon application and various other parameters | conditions for which no guarantee or warranty is given by Atul. Atul will not be liable for any damage | loss which users may suffer.

# LAPOX®

## ELECTRICAL AND ELECTRONICS

EPOXY RESINS, CURING AGENTS AND REACTIVE DILUENTS



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



**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 to be inaugurated by the first Prime Minister of the country, Pandit Jawaharlal Nehru. It is part of the 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 largest and the greenest 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.

Lapox® is a registered trademark of Atul Ltd.

**Epoxy 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**

**Lapox® range of products for electrical and electronics**

Atul's epoxy systems are designed to achieve high performance in the electrical and electronics industry for various process techniques including:

- |                                   |                |
|-----------------------------------|----------------|
| Automatic Pressure Gelation (APG) | Impregnation   |
| Encapsulation                     | Prepregging    |
| Filament winding                  | Pultrusion     |
| Hand lay-up                       | Vacuum casting |





Lapox®				Processing techniques									Physical / Chemical properties				
Systems	Type of system	Nature	Mixing ratio	CVC	APG	Vacuum potting	Filament winding	Pultrusion	Hand lay-up	Impregnation   VPI	Encapsulation	Prepregging	Bonding	Mix viscosity	Pot life	Gel time	Density of components
	Unf   Prf <sup>1</sup>	Hot cure   Cold cure   Outdoor   Indoor	R/CA/Acc/Flx/Flr/Sol <sup>2</sup>											Resin Curing agent			
			pbw												mPa s/°C	hr/°C	min/°C
ARC-15 AH-122	Prf	Hot cure Indoor	R: 100 CA: 100	•	•									40,000/25 10,500/40 2,000/60	-	60/100 20/120	1.70 - 1.90 1.70 - 1.90
ARC-16 AH-118 ADP-11 Silica	Unf	Hot cure Indoor	R: 100 CA: 80 Flx: 0 - 8 Flr: 320 - 350	•	•									5,500/40 3,000/60 1,500/80	24 - 48/25	228/80 12/120	1.13 - 1.18 1.15 - 1.20
ARCH-11 K-3 K-13 Silica	Unf	Hot cure Outdoor	R: 100 CA: 90 Acc: 0.5 - 2.0 Flr: 300	•										10,000 - 15,000/40 3,000 - 5,000/60 1,000 - 1,500/80	3/60 1/80	4/140 3/150 2/160	1.20 - 1.25 1.36 - 1.40
ARCH-11 AH-214 K-13 Silica	Unf	Hot cure Outdoor	R: 100 CA: 90 Acc: 0.5 - 2.0 Flr: 270 - 300	•	•									1,000/80	1/80	12 - 13/100	1.20 - 1.25 1.15 - 1.20
ARCH-11 AH-215 Silica	Unf	Hot cure Outdoor	R: 100 CA: 90 Flr: 270	•	•									1,000/80	1/80	12 - 13/100	1.20 - 1.25 1.15 - 1.20
ARCH-12 AH-214 K-13 Silica	Unf	Hot cure Outdoor	R: 100 CA: 80 Acc: 0.5 - 2.0 Flr: 270	•	•									6400/25 3000/40 700/60	8/40 4/60	122/80 11/120 5/140	1.14 - 1.20 1.15 - 1.20
ARCH-12 AH-215 Silica	Unf	Hot cure Outdoor	R: 100 CA: 80 Flr: 270	•	•									6,400/25 3,000/40 700/60	8/40 4/60	122/80 11/120 5/140	1.14 - 1.20 1.15 - 1.20
ARCH-13 AH-215 Silica	Unf	Hot cure Outdoor	R: 100 CA: 70 Flr: 270	•	•									1,600 - 2,200/80	8/40	90 - 100/100	1.14 - 1.20 1.15 - 1.20
C-17 K-12 K-13 K-14 Silica	Unf	Hot cure Indoor	R: 100 CA: 100 Acc: 0.5 - 1.5 Flx: 0 - 20 Flr: 400	•	•									41,500/40 1,500/80	14/40 1.5/80	90/80 35/100 12/120	1.15 - 1.20 1.15 - 1.22
C-50 K-61 Silica	Unf	Hot cure Indoor	R: 100 CA: 80 Flr: 270	•	•									26,000/40 6,800/60 1,000/80	15/40 2/80	285/80 14/120 5/140	1.10 - 1.20 1.15 - 1.25
C-50 K-225 Silica	Unf	Hot cure Indoor	R: 100 CA: 80 Flr: 270	•	•									50,000/40 11,800/60 2,300/80	48/25	265/80 14/120 4/140	1.10 - 1.20 1.15 - 1.25
C-51 K-6 Silica	Unf	Cold cure Indoor	R: 100 CA: 10 Flr: 120			•					•			8,500/25	0.5/25	-	1.13 - 1.16 0.97 - 0.99
ARC-18 AH-123	Prf	Hot cure Indoor	R: 100 CA: 25	•	•									2,500 - 3,500/25	-	30 - 40/100	1.74 - 1.84 1.18 - 1.22
ARC-30 AH-714	Prf	Cold cure Indoor	R: 100 CA: 25	•	•									1,800/27	2.5/27	90/130 50/140	1.42 - 1.62 0.95 - 0.98
C-2 K-1 Silica	Unf	Hot cure Indoor	R: 100 CA: 30 Flr: 200	•										4,000/120 2,500/140	1/120 0.5/140	100/130 60/140	1.20 - 1.25 1.50 - 1.55
C-59 K-1 Silica	Unf	Hot cure Indoor	R: 100 CA: 30 Flr: 200	•										1,900/120 790/130 500/140	6/120	330/130 150/150	1.20 - 1.25 1.50 - 1.55

<sup>1</sup>Unf - Unfilled; Prf - Pre-filled

<sup>2</sup>Mixing ratio stated in order of Resin/Curing agent/Accelerator/Flexibiliser/Filler/Solvent

**Applications:** SG - Switchgear; Ins - Insulators; Bush - Bushings; IT - Instrument Transformers (CT and PT); DDT - Dry Type Distribution Transformers; RM - Rotating Machines;

Ecomp - Electro composites; Adh - Adhesives; Eass - Electronic assembly

**Processing techniques:** CVC - Conventional Vacuum Casting; APG - Automatic Pressure Gelation; VPI - Vacuum Pressure Impregnation

Processing guideline	Mechanical properties		Thermal properties				Electrical properties			Applications
Cure schedule	Tensile strength Elongation	Flexural strength Surface strain	Glass transition temperature (Tg)	Thermal conductivity	Thermal class	Coefficient of linear thermal expansion	Breakdown strength (BDV)	Dielectric constant / Relative permittivity	Dielectric dissipation factor (Tan D)	SG/Ins/Bush/IT/DDT/RM/Ecomp/Adh/Paper coating/Eass
	ISO 527-2	ISO 178	DIN 11357-2	ISO 8894-1	IEC 60085	ISO 11359-2	IEC 60243-1	DIN 53483	IEC 60250	
	hr/°C	MPa   %	MPa   %	°C	W/mK	-	(°C) <sup>-1</sup>	kV/mm	-	
10/80 + 1/140	75 - 85 0.8 - 1.2	120 - 130 -	110 - 120	0.65 - 0.75	H	27 - 30	18 - 22	4.2	< 2	SG/Ins/Bush
10/140	75 - 85 1.1 - 1.3	135 - 155 1.5 - 1.8	105 - 115	0.85 - 0.95	F	31 - 36	18 - 22	4.1	2 - 3	SG/Ins/Bush/IT/DDT
6/80 + 10/140	90 - 100 1.7 - 1.9	150 - 165 2.0 - 2.5	100 - 110	0.80 - 0.90	F	39 - 41	19 - 21	3.8 - 4.2	1.5 - 2.0	SG/Ins/Bush
10/140	90 - 100 1.7 - 1.9	150 - 165 2.0 - 2.5	100 - 110	0.80 - 0.90	F	-	19 - 21	3.8 - 4.2	2 - 3	SG/Ins/Bush/IT
10/140	90 - 100 1.7 - 1.9	150 - 165 2.0 - 2.5	100 - 110	0.80 - 0.90	F	-	19 - 21	3.8 - 4.2	2	SG/Ins/Bush/IT
6/80 + 10/140	70 - 90 1.0 - 1.5	150 - 170 1.7 - 2.0	75 - 85	-	F	-	18 - 22	-	2 - 3	SG/Ins/Bush
6/80 + 10/140	70 - 90 1.0 - 1.5	150 - 170 1.7 - 2.0	75 - 85	-	F	-	18 - 22	-	2 - 3	SG/Ins/Bush
6/80 + 10/140	60 - 70 0.75 - 1.25	-	100 - 110	-	F	-	19 - 21	-	2 - 3	SG/Ins/Bush
8/80 + 8/130	75 - 85 0.9 - 1.1	125 - 135 1.1 - 1.5	85 - 95	0.80 - 0.90	F	31 - 36	18 - 22	4	1.3	Ins/Bush/SG/IT/DDT
6/80 + 8/140	70 - 80 1.0 - 1.3	110 - 125 1.2 - 1.7	105 - 125	0.80 - 0.90	H	35 - 37	18 - 20	4.3	1.7	SG/Ins/Bush
6/80 + 10/130	70 - 80 1.0 - 1.5	110 - 120 1.2 - 1.7	90 - 105	0.80 - 0.90	H	36 - 40	18 - 20	3.8	1.7	SG/Ins/Bush
6/80	35 - 50 -	50 - 60 -	60 - 70	0.54	B	60 - 65	18 - 22	4.4	2 - 3	Adh/Eass
4/80 + 2/130	60 - 70 -	110 - 120 1.5 - 2.5	122 - 132	0.60	F	34 - 36	25	3 - 4	1.3	SG/Ins/Bush
4 - 6/80 - 100	15 - 25 1.5 - 2.5	60 - 90 1.5 - 2.5	60 - 70	-	B	-	18 - 20	-	2 - 3	IT/Eass
12/140	80 - 100 1.0 - 1.4	130 - 150 2.1 - 2.3	115 - 130	-	F	-	22 - 25	-	2 - 3	Ins/Bush/IT
24/140	85 - 95 1.0 - 1.4	135 - 145 2.1 - 2.3	115 - 130	0.75 - 0.90	F	35 - 38	-	4.1	1.5	Ins/Bush/SG/IT/DDT

Lapox®				Processing techniques								Physical / Chemical properties					
Systems	Type of system	Nature	Mixing ratio	CVC	APG	Vacuum potting	Filament winding	Pultrusion	Hand lay-up	Impregnation   VPI	Encapsulation	Prepregging	Bonding	Mix viscosity	Pot life	Gel time	Density of components
	Unf   Prf <sup>1</sup>	Hot cure   Cold cure   Outdoor   Indoor	R/CA/Acc/ Flx/Flr/Sol <sup>2</sup>											Resin Curing agent			
			pbw											g/cm <sup>3</sup>			
														mPa s/°C	hr/°C	min/°C	
ARL-111 AH-358 ARS-101	Unf	Hot cure Indoor	R: 100 CA: 15	•										1,300/25	> 8/25	45/120 12/140	0.90 - 1.00 1.02 - 1.06
C-1 K-1 Silica	Unf	Hot cure Indoor	R: 100 CA: 30 Flr: 200	•										4,000/120 2,500/140	1/120	90/130 50/140	1.20 - 1.24 1.50 - 1.55
ARF-11 K-918 K-13	Unf	Hot cure	R: 100 CA: 85 Acc: 1 - 3			•	•							300 - 500/25	> 8/25	8 - 11/120	1.17 - 1.18 1.18 - 1.22
L-12 AH-113 K-13	Unf	Hot cure	R: 100 CA: 95 Acc: 0.1 - 2.0			•	•							1,900 - 2,100/25	50 - 55/25	-	1.10 - 1.20 1.36 - 1.40
L-12 K-918 K-13	Unf	Hot cure	R: 100 CA: 85 Acc: 0.1 - 2.0			•	•	•						600 - 900/25	80 - 95/25	10 - 12/120	1.10 - 1.20 1.18 - 1.22
L-247 K-918 K-13	Unf	Hot cure	R: 100 CA: 65 Acc: 1 - 3			•	•							-	> 8/25	8 - 10/120	- 1.18 - 1.22
ARC-31 AH-114 AC-13	Unf	Hot cure Indoor	R: 100 CA: 100 Acc: 0.0 - 0.2						•	•				700 - 750/23	1/80	17/120	1.15 - 1.20 1.15 - 1.22
ARC-35 AH-676	Prf	Hot cure Indoor	R: 100 CA: 26							•				10,000 - 13,000/25	> 8/25	30/120	1.72 - 1.76 1.00 - 1.05
ARPN-36 K-10 K-86 Solvent <sup>3</sup>	Unf	Hot cure	R: 100 CA: 40 Acc: 1 Sol: 125								•			-	> 8/25	7 - 12/120	1.20 - 1.22 1.30
ARPN-36 K-86 Solvent <sup>3</sup>	Unf	Hot cure	R: 100 CA: 3 - 6 Sol: 80								•			-	> 8/25	8 - 12/120	1.20 - 1.22 1.42
L-12 <sup>G-11</sup> K-10 K-86 Solvent <sup>3</sup>	Unf	Hot cure	R: 100 CA: 35 Acc: 1 - 3 Sol: 100 - 150								•			-	6 - 8 weeks/25	-	1.10 - 1.20 1.30
L-67 <sup>G-10</sup> K-66 K-13 Solvent <sup>3</sup>	Unf	Hot cure	R: 100 CA: 23 Acc: 0.2 Sol: 10								•			-	3 - 4 weeks/20	8.5/150 3.5/172	- 1.06 - 1.09
L-68 <sup>FR-4</sup> K-66 K-13 Solvent <sup>3</sup>	Unf	Hot cure	R: 100 CA: 32 Acc: 1 - 3								•			-	3 - 4 weeks/20	8.5/150 3 - 4/172	0.98 - 1.05 1.06 - 1.09
A-31 AH-717	Unf	Cold cure	R: 100 CA: 80									•		25,000 - 40,000	130 - 150/25	-	1.06 - 1.18 0.92 - 0.98
A-35 K-35	Unf	Hot cure	R: 100 CA: 30									•		400 - 600	3 - 4 weeks/25	-	-
A-38 K-99	Unf	Cold cure	R: 100 CA: 40									•		60,000 - 90,000	35 - 45/25	-	1.65 - 1.75 1.65 - 1.75
C-51 K-6	Unf	Cold cure	R: 100 CA: 10					•				•		-	-	-	1.13 - 1.16 0.97 - 0.99

<sup>1</sup>Unf - Unfilled; Prf - Pre-filled  
<sup>2</sup>Mixing ratio stated in order of Resin/Curing agent/Accelerator/Flexibiliser/Filler/Solvent  
<sup>3</sup>Acetone/methyl ethyl ketone/methyl isobutyl ketone/methyl cellosolve

**Applications:** SG - Switchgear; Ins - Insulators; Bush - Bushings; IT - Instrument Transformers (CT and PT); DDT - Dry Type Distribution Transformers; RM - Rotating Machines; Ecomp - Electro composites; Adh - Adhesives; Eass - Electronic assembly  
**Processing techniques:** CVC - Conventional Vacuum Casting; APG - Automatic Pressure Gelation; VPI - Vacuum Pressure Impregnation

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Cure schedule	Tensile strength Elongation	Flexural strength Surface strain	Glass transition temperature (Tg)	Thermal conductivity	Thermal class	Coefficient of linear thermal expansion	Breakdown strength (BDV)	Dielectric constant / Relative permittivity	Dielectric dissipation factor (Tan D)	SG/Ins/Bush/IT/DDT/RM/Ecomp/Adh/Paper coating/Eass	
	ISO 527-2	ISO 178	DIN 11357-2	ISO 8894-1	IEC 60085	ISO 11359-2	IEC 60243-1	DIN 53483	IEC 60250		
	hr/°C	MPa   %	MPa   %	°C	W/mK	-	(°C) <sup>-1</sup>	kV/mm	-		%
6/140	-	-	80 - 90	-	F	-	-	-	-	2.5 - 3.0	Paper coating
16/140	70 - 90 1.0 - 1.4	70 - 100 2.1 - 2.3	115 - 130	-	F	-	22 - 24	-	-	2 - 3	IT/SG/Bush
4/100 + 4/120	75 - 85 4.0 - 5.0	120 - 140 6.0 - 10.0	115 - 130	-	-	-	-	-	-	-	Ecomp
2/100 + 2/120 + 8/180	45 - 60 1.5 - 3.0	100 - 140 4.0 - 7.0	165 - 185	-	-	-	18 - 20	3 - 4	-	2 - 3	Ecomp
2/100 + 2/140	75 - 85 4.0 - 5.0	120 - 140 6.0 - 10.0	130 - 140	-	-	-	20 - 25	3.3	-	0.3	Ecomp
3/80 + 3/120 + 4/160	60 - 80 3.0 - 6.0	120 - 140 5.0 - 10.0	110 - 120	-	-	-	-	-	-	-	Ecomp
6/80 + 3/120	75 - 85 0.9 - 1.1	125 - 135 1.1 - 1.5	90 - 100	-	F	31 - 36	18 - 22	-	-	1.3	DDT/Eass/RM
2/140	-	-	70 - 80	-	F	-	-	-	-	2 - 3	Eass
1 - 2/80 or 15 min/130 (drying) 5/200 (in oven)	-	135 7.0	-	-	-	-	-	-	-	-	Ecomp
1 - 2/80 or 15 min/130 (drying) 4/120 + 16/160 (in oven)	-	-	-	-	-	-	-	-	-	-	Ecomp
10 - 15 min/130 or 6 - 10 min/135 (drying) 5/200 (curing)	-	400 - 500 -	150 - 160	-	-	-	15 - 20	4.7 - 5.2	-	2.0 - 2.5	Ecomp
7 - 9 min/150 or 5 - 6 min/160 or 3 - 5 min/170	≥ 315 (LW)* ≥ 266 (CW)* 2.0 - 3.0	≥ 525 (LW)* ≥ 455 (CW)* 2.0 - 6.0	130 - 140	-	-	-	12 - 14	4.5 - 5.2	-	2.5 - 3.0	Ecomp
7 - 9 min/150 or 5 - 6 min/160 or 3 - 5 min/170	≥ 315 (LW)* ≥ 266 (CW)* 2.0 - 3.0	≥ 525 (LW)* ≥ 455 (CW)* 2.0 - 6.0	130 - 140	-	-	-	12 - 14	4.5 - 5.2	-	2.5 - 3.0	Ecomp
4 - 6/40 or 45 - 60 min/65 or 15 min/100	-	-	-	-	-	50 - 60	-	-	-	-	Adh
24/120 5/140 2/160 1/180	-	-	-	-	-	60	-	-	-	-	Adh
24 - 28/25 or 1/60	42 - 44 -	-	-	-	-	65	-	-	-	-	Adh
24/25 or 6/80	55 - 80 -	-	60 - 70	0.19 - 0.20	-	90 - 95	18 - 22	4	-	2 - 3	Adh

† Manufacturing of prepreg followed by compression moulding, 2 - 6 hr/160°C  
\*CW - Cross wise; LW - Length wise

**COMMON ELECTRICAL PROPERTIES**

**Arc resistance**

It is measure of time in seconds required to make an insulating surface conductive under a high voltage, low current arc.

**Comparative Tracking Index (CTI)**

Numerical value of voltage which specimen withstands during the test period for 50 drops of electrolyte without progressive formation of conducting paths.

**Dielectric strength**

It refers to electrical strength of Insulating materials. It is the measure of dielectric break down resistance of material. Expressed in kV/mm.

**Dissipation factor/Tan δ**

It is the angle by which the phase difference between current and voltage deviates from 90° out of phase.

**Electrical conductivity**

Electrical conductivity is a measure of how well a material accommodates the movement of an electric charge.

**Electrical resistivity**

Electrical resistivity is the reciprocal of conductivity.

**Relative permittivity/Dielectric constant**

It is the ratio of capacitance of a capacitor with insulating material to the capacitance of same configuration of electrodes in vacuum.

**Surface resistivity**

It is the electrical resistance offered to surface current when potential difference is applied between surface mounted electrodes. Measured in ohm per square.

**Volume resistivity**

It is the electrical resistance on an insulating material when electric potential is applied between opposite faces. Measured in ohm-cm.

**CRITICAL PROPERTIES**

**Coefficient of thermal expansion**

The coefficient of thermal expansion describes how the size of an object changes with a change in temperature. Specifically, it measures the fractional change in size per degree change in temperature at a constant pressure. Several types of coefficients have been developed: volumetric, area and linear.

**Elongation at break**

Elongation recorded at the moment of rupture of the specimen, often expressed as a percentage of the original length. It corresponds to the breaking or maximum load.

**Flexural strength**

Flexural strength, also known as modulus of rupture, bend strength, or fracture strength a mechanical parameter for brittle material, is defined as a material's ability to resist deformation under load.

**Heat Deflection Temperature (HDT)**

The heat deflection temperature or heat distortion temperature (HDT, HDTUL, or DTUL) is the temperature at which a polymer or plastic sample deforms under a specified load.

**Impact strength**

The ability of a material to withstand shock loading or say the work done to fracture, under shock loading.

**Tensile strength**

The maximum load applied in breaking a tensile test piece divided by the original cross-sectional area of the test piece. Originally quoted as tons/sq.in. it is now measured as Newtons/sq.mm. Also termed Maximum Stress and Ultimate Tensile Stress.

**Thermal cycling**

Thermal cycling is the alternate heating and cooling of a material. Low frequency thermal cycle is the one in which the time taken for completion of the cycle is large enough to cool the component.

**Thermal shock**

Thermal shock is a sudden variation in temperature which causes stress in a material. It frequently causes breakage in the material, and is most common in brittle materials such as ceramics.

This is a process that takes place abruptly when there is a sudden variation of temperature, either from hot to cold or vice versa. It is most common in materials that are structurally weak as well as those which offer a poor heat conductivity.

**Vapour pressure**

The vapour pressure of a liquid is the equilibrium pressure of a vapour above its liquid (or solid); that is, the pressure of the vapour resulting from evaporation of a liquid (or solid) above a sample of the liquid (or solid) in a closed container. As the temperature of a liquid or solid increases its vapour pressure also increases. Conversely, vapour pressure decreases as the temperature decreases.

**GENERAL PROPERTIES**

**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 the 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 the temperature.

**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 the temperature.

**Post curing**

When 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 the 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 millimeters or inches.

**Viscosity**

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

Thermal classes	Y	A	E	B	F	H	C
Maximum permissible temperature, °C	90	105	120	130	155	180	> 180

