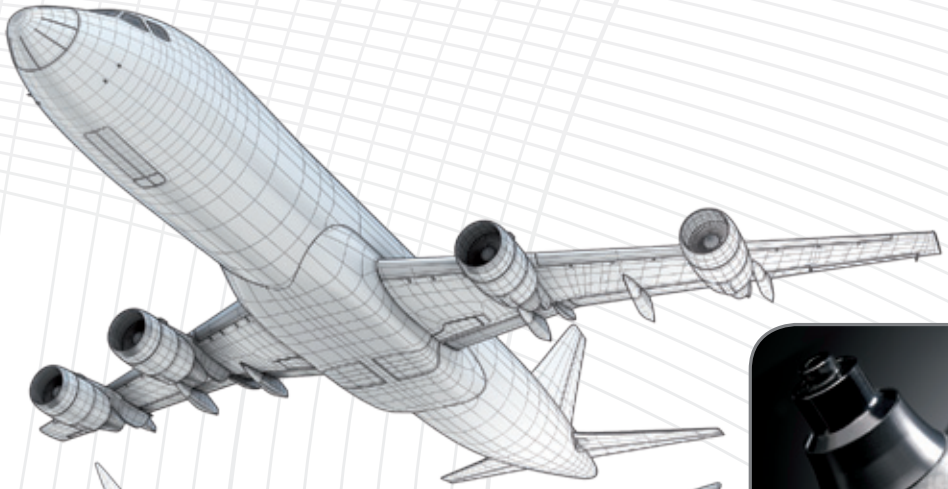
HUNTSMAN

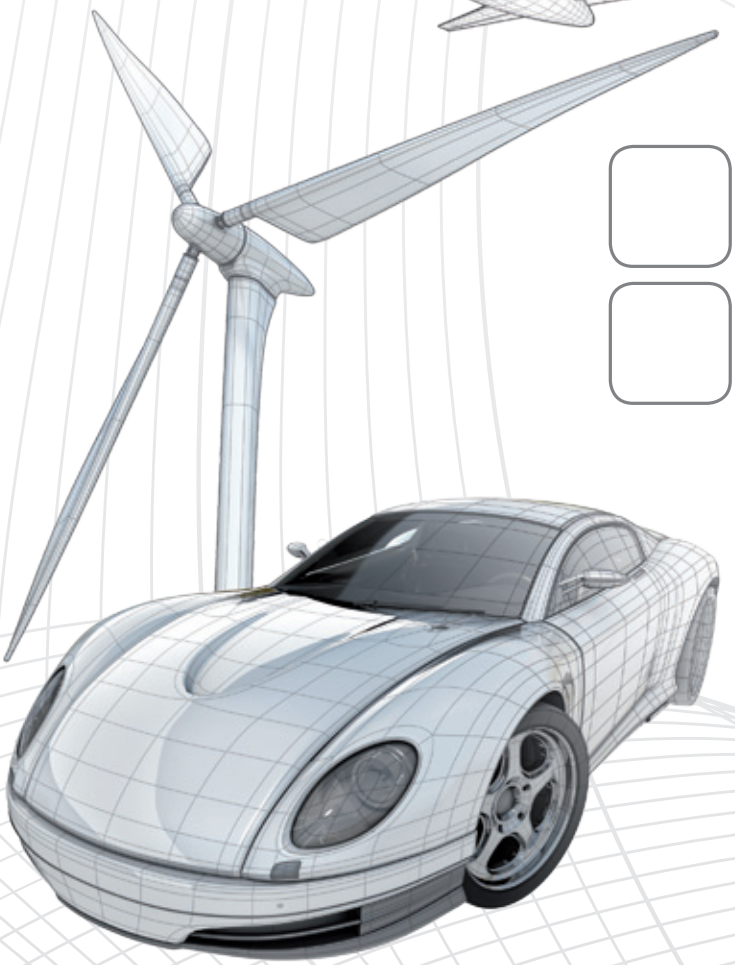
Enriching lives through innovation

Advanced Materials

Light on weight - heavy on strength

Selector guide for composite resin systems





Rely on us with confidence

A global partner

As a global partner and innovator working in close collaboration with all major industries using fiber reinforcement : we offer our customers a unique range of innovative high value thermosetting formulated systems combined with a strong technical support. This comprehensive range is used throughout the world's manufacturing industries but particularly in the automotive, aerospace, marine, wind energy, sport and leisure and consumer electronics.

We deliver more than just products

Our process know-how and over 60 years expertise help us to develop standard products as well as custom-made solutions formulated to answer project requirements.

Huntsman Advanced Materials has a worldwide team of experts

> To identify with you the best system meeting your needs

> To develop when needed new material solutions

> To reduce manufacturing and production costs through process time reduction based on shorter cure cycles

> To help you to improve the quality, the durability and the performance of your products such as lightness but also mechanical, temperature, fire, chemical or corrosion resistance and more

> To quickly bring your product to market through material and process optimization.

Araldite®

The original brand serving worldwide composite industry for more than half a century.

Proven solutions for all major industries

Huntsman leverages its core strengths in synthesis and formulation to produce high performance materials that deliver improved mechanical and thermal performance in the area of composites.

Our application engineers can support you with advice and practical recommendations on how to optimize the use of Huntsman's products in your chosen manufacturing process.

> Wet lay-up
> RTM
> High pressure RTM
> Infusion
> Filament winding
> Pultrusion
> Compression molding
> Prepreg

Germanischer Lloyd statement of approval

"Rules for Classification and Construction, II-Material and Welding technology – Part 2 Non-Metallic materials"

Huntsman's GL approved resin systems received approval for the construction of FRP laminate components in wind and marine applications on condition that the selected fibre reinforcement both complies with Germanischer Lloyd's requirements and is compatible with the resin.

Lloyd's Register certificate of approval

"Rules and Regulation for Classification of Special Service Craft"

Huntsman's resin systems with this logo are certified for the construction of composite components on special service crafts including yachts, pleasure crafts, etc.

Formulated systems for direct liquid processes

Product designation	Wet lay - up	RTM	Infusion	Filament winding	Pultrusion	Pot life	Gel time	Mix viscosity	
Conditions						RT, 100ml	80°C	25°C	
Norm									
Unit						min	min	mPa·s	
Araldite® LY 1564 / Hardener XB 3403	●●●		●●●	●●		870 - 1050	40 - 50	150 - 230	
Araldite® LY 1564 / Aradur® 3405		●●●				47 - 57	6 - 9	420 - 520	
Resin XU 3508 / Hardener XB 3403	●●●	●●				600 - 720	30 - 36	650 - 800	
GL Lloyd's Register Araldite® LY 1568 / Aradur® 3489	●●	●●	●●●	●●	●●	850 - 950	43 - 46	200 - 300	
GL Araldite® LY 1568 / Aradur® 3492	●●	●●	●●●			300 - 350	23 - 25	250 - 350	
GL Araldite® LY 3505 / Hardener XB 3404-1	●●●					80 - 100	11 - 18	550 - 800	
GL Lloyd's Register Araldite® LY 3505 / Hardener XB 3403	●●●					600 - 720	36 - 48	300 - 400	
GL Araldite® LY 3505 / Aradur® 3405	●●●					26 - 36	5 - 11	1 000 - 1 200	
GL Lloyd's Register Araldite® LY 1564 / Aradur® 3486	●●	●●	●●●	●●	●●	560 - 620	33 - 43	200 - 300	
Araldite® LY 3297 / Aradur® 3298	●●●	●●●	●●			120 - 135	18 - 26	850 - 950	
Resin XU 3508 / Aradur® 3486	●●●	●●●	●●	●●	●●	380 - 480	9 - 14 at 100°C	720 - 860	
Araldite® LY 1564 / Aradur® 5003-1	●●	●●●				42 - 52	6 - 8	200 - 260 at 40°C	
Araldite® LY 5052 / Aradur® 5052	●●●	●●	●●			110 - 160	14 - 17	500 - 700	
Araldite® LY 3585 / Aradur® 5003-1	●●●	●●				40 - 48	6 - 8	440 - 500 at 40°C	
RenLam® LY 113 / Ren® HY 98	●●●	●●●	●●●			90 - 100	18 - 20	300 - 320	
Araldite® LY 1564 / Aradur® 917 / Accelerator 960-1			●●	●●●	●●●	80 - 90h	30 - 40	450 - 700	
Resin XB 6469 / Aradur® 2954	●●	●●●	●●●	●●	●●	740 - 810	38 - 42	220 - 240	
Resin XB 3518 / Aradur® 22962	●●	●●●	●●			210 - 290	15 - 20	400 - 500	
Araldite® LY 1564 / Aradur® 22962	●●	●●●	●●●			110 - 150	20 - 30	400 - 600	

Continued on next page

●●● Highly recommended

●● Recommended

GL OPERATING 24/7 Germanischer Lloyd (GL) certified

Lloyd's Register Lloyd's Register certified

	Applied cure schedule	Tg	Flexural strength	Ultimate flexural elongation	Fracture properties K_{1C} G_{1C}	Description / comments
		DSC, 10 K/min				
		ISO 11357-2	ISO 178		ISO 13586	
		°C	MPa	%	MPa√m J/m²	
	8h at 80°C	68 - 72	104 - 115	10.5 - 11.5	1.0 - 1.1 360 - 380	Hardener XB 3403 and Aradur® 3405 can be mixed to adjust reactivity at constant resin/hardener mix ratio.
	8h at 80°C	68 - 72	116 - 130	9.0 - 10.0	1.1 - 1.3 460 - 480	High toughness.
	4h at 60°C + 6h at 80°C	70 - 75	100 - 125	9.0 - 11.0	2.1 - 2.3 1250 - 1400	Latent, very high toughness.
	8h at 80°C	78 - 80	120 - 130	9.0 - 10.0	0.7 - 0.8 170 - 210	Aradur® 3489 and Aradur® 3492 can be mixed to adjust reactivity at constant resin/hardener mix ratio.
	8h at 80°C	80 - 85	125 - 135	7.0 - 7.5	0.7 - 0.8 210 - 230	Aradur® 3489 based system provides low exothermic behavior.
	4h at 60°C + 6h at 80°C	76 - 81	125 - 145	6.5 - 9.5	0.8 - 1.0 160 - 200	
	4h at 60°C + 6h at 80°C	78 - 83	110 - 130	10.5 - 13.0	0.9 - 1.1 250 - 280	Hardener XB 3404-1, XB 3403 and Aradur® 3405 can be mixed to adjust reactivity at constant resin/hardener mix ratio.
	4h at 60°C + 6h at 80°C	87 - 92	135 - 155	7.0 - 9.0	0.8 - 0.9 150 - 190	
	8h at 80°C	80 - 84	118 - 130	10.5 - 12.5	0.9 - 1.1 260 - 310	Latent, low viscosity.
	8h at 80°C	92 - 98	125 - 130	7.0 - 8.0	0.8 - 1.0 215 - 245	Good mechanical properties after 23°C curing.
	5h at 100°C	95 - 102	110 - 125	10.0 - 12.5	2.2 - 2.4 1500 - 1700	Very high toughness.
	30 min at 80°C + 2h at 120°C	108 - 115	108 - 118	7.0 - 9.0	0.9 - 1.0 230 - 290	Very fast.
	8h at 80°C	114 - 122 (max 120 - 134)	116 - 122	8.5 - 13.5	0.7 - 0.9 192 - 212	Very good mechanical properties after 23°C curing. Aerospace qualified.
	30 min at 80°C + 2h at 120°C	120 - 130	115 - 125	6.0 - 9.0	0.8 - 0.9 180 - 230	Medium Tg, very fast.
	24h at 23°C + 4h at 120°C	120 - 125	127 - 130	7.0 - 8.0	0.8 - 0.9 220 - 250	Suitable for tooling application: free stand post-cure after 23°C pre-cure conditions.
	4h at 80°C + 4h at 120°C	122 - 130	140 - 150	6.0 - 7.0	0.6 - 0.7 100 - 125	Low temperature cure anhydride curing system.
	90 min at 80°C + 1h at 150°C	125 - 135	100 - 110	6.5 - 7.5	0.95 - 1.0 350 - 390	Low viscosity, long pot life. Alternative to anhydride for filament winding and pultrusion when hot/wet performance is key.
	1h at 100°C + 2h at 140°C	128 - 138	120 - 135	8.5 - 10.0	0.6 - 0.8 160 - 180	Medium Tg, high elongation at break.
	15 min at 120°C + 2h at 150°C	130 - 140	124 - 132	9.0 - 11.0	0.8 - 1.0 200 - 260	Medium Tg, high elongation at break.

Formulated systems for direct liquid processes

Continued

Product designation	Wet lay-up	RTM	Infusion	Filament winding	Pultrusion	Pot life	Gel time	Mix viscosity	
Conditions						RT, 100ml	80°C	25°C	
Norm									
Unit						min	min	mPa·s	
Araldite® LY 556 / Ren® HY 5212		●●		●●	●●●	260 - 280	110 - 120	11 500 - 12 500	
Araldite® LY 1564 / Aradur® 2954	●●	●●●	●●	●●	●●	480 - 600	35 - 45	500 - 700	
Resin XU 3508 / Aradur® 22962	●●	●●●				90 - 150	24 - 40	1 800 - 2 100	
Araldite® LY 1564 / Ren® HY 5211	●●●	●●	●●●	●●	●●	27 - 31h	200 - 220	1 350 - 1 550	
Araldite® LY 556 / Aradur® 917 / Accelerator DY 070*			●●	●●●	●●●	95 - 105h	140 - 160	600 - 900	
Araldite® LY 556 / Aradur® 22962	●●●	●●				120 - 180	18 - 22	1 800 - 2 000	
RenLam® LY 120 / Ren® HY 99	●●●	●●●	●●●			210 - 230	20 - 25	300 - 350	
Resin XU 3508 / Aradur® 2954	●●	●●●	●●			320 - 380	9 - 14 at 100°C	2 600 - 3 300	
Araldite® LY 1564 / Hardener XB 3473	●●●	●●	●●●	●●●	●●	84 - 88h	410 - 430	1 000 - 1 200	
Araldite® LY 556 / Aradur® HY 906 / Accelerator DY 070*			●●	●●●	●●●	50 - 55h	200 - 280	1 900 - 2 100	
Araldite® LY 556 / Hardener XB 3473		●●	●●	●●	●●	32 - 37h	> 600	5 200 - 6 000	
Resin XB 3292 / Hardener XB 3473	●●	●●●		●●		78 - 86h	360 - 420	1 600 - 2 000	
Araldite® CY 179 / Aradur® 917 / Accelerator DY 070*			●●	●●	●●	> 48h	60 - 80	100 - 200	
Araldite® LY 8615 / Hardener XB 5173		●●●	●●●			300 - 400	24 - 28	270 - 370	
Araldite® LY 8615 / Aradur® 8615	●●	●●	●●●	●●	●●	14 - 16h	34 - 38	480 - 580	
Araldite® LY 8615 / Ren® HY 5212		●●		●●	●●●	460 -480	58 - 62	2 000 - 2 100	
Resin XB 9721 / Aradur® 917 / Accelerator DY 070*				●●	●●●	110 - 130h	6 - 9 at 120°C	550 - 750	
Resin XB 9721 / Hardener XB 3473		●●		●●	●●	80 - 95h	80 - 100 at 120°C	14 000 - 17 000	

*Adjustable reactivity with DY 070 ratio

●●● Highly recommended

●● Recommended

	Applied cure schedule	Tg	Flexural strength	Ultimate flexural elongation	Fracture properties K_{1c} G_{1c}	Description / comments
		DSC, 10 K/min				
		ISO 11357-2	ISO 178		ISO 13586	
		°C	MPa	%	$MPa\sqrt{m}$ J/m^2	
	2h at 80°C + 2h at 120°C + 4h at 150°C	140 - 150	130 - 140	6.0 - 7.0	0.6 - 0.65 140 - 150	Good chemical resistance. Ren® HY 5212: faster version of Ren® HY 5211.
	1h at 80°C + 8h at 140°C	143 - 148	120 - 124	6.5 - 7.5	0.7 - 0.8 150 - 180	Medium Tg, alternative to anhydride for filament winding and pultrusion when hot/wet performance is key.
	1h at 80°C + 2h at 150°C	144 - 154	120 - 135	8.0 - 10.0	0.9 - 1.2 340 - 380	Medium Tg, toughened.
	30 min at 130°C + 12h at 160°C	145 - 155	120 - 130	7.0 - 8.0	0.6 - 0.7 120 - 130	Good chemical resistance. Ren® HY 5211: faster version of XB 3473.
	4h at 80°C + 8h at 140°C	148 - 153	125 - 135	6.0 - 8.5	0.5 - 0.6 85 - 95	Medium Tg, very latent anhydride curing system.
	15 min at 120°C + 2h at 150°C	148 - 158	130 - 136	7.5 - 10.0	0.7 - 0.8 140 - 175	Good balance between Tg and elongation at break.
	8h at 40°C + 8h at 150°C	150 - 155	120 - 126	6.5 - 7.5	0.6 - 0.7 170 - 185	Suitable for tooling application: free stand post-cure after 40°C pre-cure conditions.
	1h at 80°C + 8h at 160°C	150 - 158	125 - 135	7.0 - 8.0	0.8 - 1.0 250 - 290	High Tg, toughened.
	30 min at 130°C + 12h at 160°C	165 - 175	100 - 110	5.5 - 6.5	0.7 - 0.8 170 - 190	Good chemical resistance.
	2h at 120°C + 8h at 160°C	165 - 175	100 - 140	4.0 - 7.0	0.6 - 0.8 100 - 125	High Tg, very latent anhydride curing system.
	2h at 120°C + 4h at 180°C	185 - 194	110 - 120	5.5 - 6.5	0.7 - 0.9 190 - 220	High chemical resistance.
	2h at 100°C + 1h at 140°C + 1h at 180°C + 2h at 200°C	195 - 203	98 - 108	4.0 - 4.5	0.5 - 0.6 70 - 75	Very high Tg, high chemical resistance.
	1h at 100°C + 6h at 180°C	200 - 205	75 - 95	2.0 - 3.5	0.4 - 0.5 65 - 75	Very high Tg, very latent anhydride curing system.
	90 min at 80°C+ 1h at 150°C + 1h at 180°C	200 - 207	113 - 117	4.0 - 5.0	0.5 - 0.7 130 - 165	Suitable for tooling application: free stand post-cure after 40°C pre-cure conditions.
	90 min at 80°C + 1h at 150°C + 1h at 180°C	200 - 210	82 - 86	2.5 - 4.0	0.6 - 0.8 130 - 165	Suitable for tooling application: free stand post-cure after 40°C pre-cure conditions.
	90 min at 80°C + 1h at 150°C + 1h at 200°C	205 - 215	135 - 140	5.5 - 6.0	0.6 - 0.65 125 - 135	Very high Tg, good chemical resistance. Ren® HY 5212: faster version of Ren® HY 5211.
	2h at 120°C + 2h at 160°C + 2h at 200°C + 4h at 220°C	205 - 215	85 - 100	2.5 - 3.0	0.4 - 0.50 45 - 60	Very high Tg, very latent anhydride curing system.
	2h at 120°C + 2h at 160°C + 2h at 200°C + 4h at 220°C	232 - 238	105 - 125	3.0 - 4.5	0.6 - 0.7 95 - 100	High chemical resistance.

Preforming epoxy binders for RTM process

Product designation	Softening point	Tg	
Conditions		DSC, 10 K/min	
Norm	DIN 51920	ISO 11357-2	
Unit	°C	°C	
Araldite® LT 3366	ca. 150	75 - 85	

Expandable Epoxy Systems (EES) for fast* compression molding

Product designation	Maximum Tg	Density of composites **	
Conditions	DSC, 10 K/min		
Norm	IEC 1006		
Unit	°C	g/cm^3	
Araldite® LY 1135-1A / Aradur® 1135-1B	135 - 145	0.65 - 0.85	
Araldite® LY 5310 / Aradur® 1135-1B	135 - 145	0.65 - 0.85	
Araldite® LY 5054 / Foaming agent DY 5054 / Aradur® 5003-1	120 - 130	0.50 - 0.70	

* Typical processing time: 45-60 seconds at 150 - 160°C

** With natural fiber mats density: ~ 1.4 g/cm^3 - Epoxy resin rate in weight: ~ 35 %

	Typical applications	Typical preforming cycle
	High pressure RTM	20±10 sec at 180± 20°C + cold stamping

process

	Key characteristics
	High Tg.
	High Tg, low emission system.
	Higher foaming effect, recommended for sandwich composites - foaming agent concentration adjustable.

Formulated systems for pre-impregnation (Prepregs)

Product designation	Mix viscosity	B-Staging or solvent evaporation	Shelf-life	Gel time*	Applied cure schedule	
Conditions	25°C		23°C	120°C		
Norm						
Unit	mPa·s			min		
Solvent based process						
Araldite® LZ 5021 / Aradur® 1571 / Accelerator 1573	550 - 850	6 - 10 min at 90°C	9 - 12 months	8 - 15	25 min at 125°C	
Araldite® LZ 3540 / Aradur® 1571 / Accelerator 1573	1 700 - 2 300	7 - 10 min at 90°C	> 4 weeks	15 - 20	30 min at 90°C + 1h at 120°C	
Chemical B-stage process						
Araldite® LY 1556 / Aradur® 1571 / Accelerator 1573 / Hardener XB 3403	4 000 - 6 000	24 - 48h at 23°C	> 6 weeks	6 - 11	2h at 120°C	
Araldite® LY 1556 / Aradur® 1571 / Accelerator 1573 / Hardener XB 3471	5 000 - 5 900	2 - 3 min at 80 - 90°C	> 6 weeks	5 - 12	2h at 120°C	
Resin XU 3508 / Aradur® 1571 / Accelerator 1573 / Hardener XB 3403	6 650 - 7 450	24h at 23°C	> 4 weeks	4 - 12	4h at 120°C	
Resin XU 3508 / Aradur® 1571 / Accelerator 1573 / Hardener XB 3471	5 900 - 6 200	2 - 3 min at 90°C	> 4 weeks	4 - 8	4h at 120°C	
Araldite® LY 5150 / Aradur® 1571 / Accelerator 1573 / Hardener XB 3471	3 500 - 4 500 at 50°C	1 - 3 min at 80 - 90°C	> 8 weeks	10 - 28	1h at 140°C	
Hot-melt process						
Araldite® LY 3514 / Aradur® 1571 / Accelerator 1573	14 000 - 15 000 at 70°C	n.a.	> 5 weeks	17 - 21	30 min at 90°C + 2h at 120°C	
Resin XB 3515 / Aradur® 1571 / Accelerator 1573	24 000 - 28 000 at 55°C	n.a.	> 5 weeks	10 - 13	1h at 120°C + 2h at 140°C	

GL

* Adjustable reactivity with Accelerator 1573 ratio
n.a.: not applicable / n.m.: not measured

GL OPERATING 24/7 Germanischer Lloyd (GL) certified

	Tg	Flexural strength	Ultimate flexural elongation	Fracture properties K_{1C} G_{1C}
	DSC, 10 K/min			
	ISO 11357-2	ISO 178		ISO 13586
	°C	MPa	%	$MPa\sqrt{m}$ J/m^2
	85 - 115	118 - 120	13.0 - 16.0	n.m.
	115 - 125	135 - 150	8.0 - 9.5	0.8 - 0.9 210 - 240
	105 - 115	125 - 140	7.0 - 10.0	0.7 - 0.9 130 - 250
	115 - 125	125 - 145	5.5 - 8.5	0.7 - 0.9 210 - 390
	115 - 125	110 - 120	5.5 - 8.0	1.4 - 1.7 850 - 1000
	120 - 140	110 - 133	6.0 - 10.0	1.2 - 1.5 500 - 800
	140 - 155	130 - 160	4.0 - 8.0	0.6 - 0.8 100 - 140
	120 - 130	135 -150	6.0 - 9.0	0.8 - 0.9 280 - 320
	140 - 145	120 - 140	4.5 - 6.5	1.2 - 1.3 400 - 440

With innovation

Every day, all over the world, our Technical Competence centers engage in intensive research and development focusing on one goal : to deliver innovative solutions by working hand-in hand with our business partners. Together through a continual exchange of ideas, supported by an experienced team of sales and technical specialists, we strive to deliver innovative and regulatory compliant (eg REACH compliant) solutions.

We track both new market expectations and changing regulations. Protection of the environment, as well as health and safety are paramount concerns, playing an integral part in our development projects.

By providing unique, certified or patented technologies, combined with high quality and reliability, our chemists and experts bring enhanced value to our customers, ensuring their success.

With customer intimacy

We market a unique product portfolio and a broad range of forward-looking solutions for our customers. Customers and partners benefit from an advanced level of service in:

> Product development and quality
> Product trials in-house and with customers
> Customer seminars and training
> Trouble-shooting and problem-solving

Partnership with our customers is more than simply «putting them first». It requires long-term commitment to forging close relationships that create synergies of knowledge, security and adaptability to create a successful, shared future.

With care

Sustainability is a fundamental part of our corporate and business strategy. We see a better world in which our innovations help reduce consumption of natural resources and improve the quality of life for people everywhere. We are identifying the long - term trends that affect our markets and looking to see how products and applications can play a part in supporting and providing solutions to the challenges those markets face.

We value your challenge

Huntsman Advanced Materials

Our Advanced Materials division is a leading global chemical solutions provider with a long heritage of pioneering technologically advanced epoxy, acrylic and polyurethane-based polymer products.

Our capabilities in high-performance adhesives and composites, delivered by more than 1 600 associates, serve over 2 000 global customers with innovative, tailor-made solutions and more than 1 500 products which address global engineering challenges.

Global presence – 13 manufacturing sites

Mobile App from Huntsman Advanced Materials

Download our mobile App and easily find the product to fulfill your need.

Available on the App Store

ANDROID APP ON Google play

HUNTSMAN

Enriching lives through innovation

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Responsible Care®
OUR COMMITMENT TO SUSTAINABILITY

Registered for REACH

Concept and design by Zygmund SARL