

COMPOSITE REINFORCEMENT TECHNOLOGIES

CUSTOMIZED FABRIC, PREPREG & SANDWICH
PANEL SOLUTIONS



THE REINFORCER



KORDSA
THE REINFORCER



Discover how Kordsa develops its innovative and unique intermediate products and applications in composite reinforcement for a variety of industries.

We Reinforce Life

Kordsa, the reinforcer of 1 out of every 3 automobile tires manufactured globally and 2 out of every 3 aircraft tires produced worldwide, operates in tire reinforcement, construction reinforcement and composite technologies. Positioned as “The Reinforcer” with its innovative value-added technologies and expertise on reinforcement technologies, Kordsa has approximately 4,500 employees in 12 facilities throughout 4 continents.

In tire reinforcement technologies, Kordsa contributes to the manufacturing of environmentally friendly tires that reduce fuel use and sustain better grip. Kordsa develops composite technologies for aerospace and automotive industries to reduce fuel consumption and carbon emission. Thanks to its durable and practical reinforcement solutions in the construction industry, Kordsa continues to touch every aspect of life.

Composite Technologies

Kordsa continues to strengthen its name “The Reinforcer” in composite industry with new products. Main focus is to weave high-strength composite reinforcements with carbon, aramid, and glass, develop resin formulations, produce prepregs and develop applications for a variety of industries especially automotive, aerospace, marine, sports & leisure industries.

Kordsa took the first step of its growth strategy in composites with the Composite Technologies Center of Excellence, one of the few integrated production centers in the world. Kordsa’s journey went ahead in aerospace industry with Fabric Development and Textile Products, which produce highly-engineered structural materials; its competency has expanded with the acquisition of Advanced Honeycomb Technologies, which produces advanced materials for cabin interior parts. Acquisition of Axiom Materials paved the way for Kordsa to be the only worldwide qualified manufacturer of Oxide-Oxide ceramic matrix composites.

Composite Technologies Center of Excellence

Composite Technologies Center of Excellence, a technology hub driven by collaborative research and production, was conjointly established by Kordsa and Sabancı University in 2016. At the Composite Center, all processes including R&D, applied research, technology development, product development, prototype production, entrepreneurship and production are executed under the same roof. Thanks to this collaborative ecosystem, Kordsa offers tailor-made services to its customers by involving the stakeholders in all stages of research and development, from basic research to the production of a prototype and finally, to mass production.

Kordsa’s manufacturing facility at Composite Technologies Center of Excellence received BS EN ISO 9001:2015 ve EN 9100:2016 (AS9100D) certification, which is an international standard for quality and risk management in aerospace and defense industry.

About Sabancı Holding

Sabancı Holding is Sabancı Holding is the parent company and manages Sabancı Group’s companies with a strategic portfolio approach. Turkey’s most rapidly growing sectors – including banking, insurance, energy, cement, retail and industrials – are the main business areas of Sabancı Group.

Sabancı Group companies currently operate in 13 countries and market their products in regions across Europe, the Middle East, Asia, North Africa, North and South America.

Globally serving the world with our reinforcement technologies



reinforcing 2 out of every 3 aircraft tires,
and every 1 out of 3 car tires
produced in the world,



and we are getting **stronger for more!**



Composite Reinforcement
Business Unit



Tire Reinforcement
Business Unit



R&D Center



Construction
Reinforcement

Thailand

Indonesia

END TO END APPROACH



Client Challenge

- Specific needs
- Detailed definition of requirements



Our Approach

- Fabric development and characterization
- Resin formulation
- Prepreg development and characterization
- End product design support
- Material library (for mechanical analysis)
- Mechanical analysis support
- Prototyping
- Production support



Results

- One solution partner
- Customized products
- Cost efficient
- Lightweight





Thermoset Prepregs

Kordsa produces thermoset UD, woven and multiaxial fabric forms. The reinforcement material used in prepegs can be carbon, aramid, and glass fiber.

The primary resin matrix used is epoxy for thermoset prepregs.

Kordsa's range of thermoset prepregs include a wide range of resin formulations specially formulated by Kordsa for different applications and production processes.

Kordsa's new production line excels at high precision processes demanded by applications.

Typical features which we supply in the standard products:

- High toughness
- Class A surface
- Rapid cure transparent
- Rapid cure paintable
- High Tg
- Long out life



KORDSA THERMOSET PREPREGS

Resin Code	Tg			Chemical Structure	Recommended Curing Method			Usage Area	Misc
	Low Tg 120-150 °C	Mid Tg 150-180 °C	High Tg Above 180 °C		Press	Autoclave	Oven		
EF 13	-	-	-	PVB	✓	✓		Ballistic Applications, Hard Body Armor	High Toughness, High Energy Transfer
EF 14	-	-	-	Phenolic Modified PVB	✓	✓		Ballistic Applications, Hard Body Armor	Flame Retardant, High Toughness, High Energy Transfer
OM 12	120			Epoxy		✓	✓	Structural	Opaque White when cured, OOA Moldable (Vacuum bagging in oven)
OM 11	130			Epoxy	✓	✓		Structural; Fatigue Applications	Translucent When Cured, good fatigue performance
OM 10	140			Epoxy	✓	✓		Structural Composites, Al Sandwich Panels	High toughness, Opaque White When Cured, Tacky Version is Available
OM 13	120			Epoxy	✓	✓	✓	Structural, Visual	Translucent When Cured, Tacky Version is Available
YT10*	120			Epoxy			✓	Visual composites	Translucent when cured, OOA Moldable (Vacuum bagging in oven)
AV12*		150		Epoxy	✓			Visual composites	Translucent when cured; DICY free formulation water spot/white wash free composites
CM 11		150		Epoxy	✓			Visual composites, Semi Structural	Fast Isothermally Press Curable, Class A Surface quality for painting, Hot Demoldable, Translucent when cured
CM 12*		140		Epoxy	✓			Metal-Composite Hybrid Structures	Fast Cure, Improved Metal Adhesion Properties, Isothermally press curable and hot demoldable, suitable for Cataphoresis/ Hot Painting/Hot adhesive bonding
EF 12			220	Epoxy	✓	✓		High Tg required applications, Primary/ Secondary aircraft structures, Engines, Helicopters	High damage tolerance and good impact resistance
KY01*			-	Surface film, Epoxy	✓	✓	✓	Class A grade sandable colored surface creation	
Adhesive films*			-	Adhesive film, Epoxy	✓	✓	✓	Metal-metal, metal-thermoset composite and thermoset- thermoset adhesion, Honeycomb, metal honeycomb, honeycomb to metal, honeycomb to thermoset adhesion	Low FST

*Under Development

UD FABRICS

Style	Fiber	Areal Weight (g/m ²)	Warp Density (picks/cm)
KCF3K UD180	CF 3K	180	8,8
KCF6K UD200	CF 6K	200	4,9
KCF12K UD200	CF 12K	200	2,4
KCF12K UD300	CF 12K	300	3,6
KCF12K UD400	CF 12K	400	5,0
KCF24K UD650	CF 24K	650	3,7
KCF50K UD1000	CF 50K	1000	2,7

*Suitable for high strength and high stability requirements.

NON CRIMP - LENO FABRICS

Fabric Code	Warp yarn	Warp Density (picks/cm)	Weft yarn	Weft Density (picks/cm)	Areal Weight (g/m ²)	Weaving Style
KCF6K NC200	CF 6K	2,5	CF 6K	2,5	200	0/90
KCF12K NC400	CF 12K	2,5	CF 12K	2,5	400	0/90

HYBRID FABRICS

Fabric Code	Warp Yarn	Warp Density (picks/cm)	Weft yarn	Weft Density (picks/cm)	Areal Weight (g/m ²)	Weaving Style
KCA6K336 PL221	CF 6K	3,0	AR 3360dtex	3,0	221	Plain
KCA6K336 PL265	CF 6K	3,6	AR 3360dtex	3,6	265	Plain
KCA6K336 TW265	CF 6K	3,6	AR 3360dtex	3,6	265	2X2 Twill
KCG6K410 PL243	CF 6K	3,0	S-Glass	3,0	243	Plain
KCG6K410 PL284	CF 6K	3,5	E-Glass	3,5	284	Plain
KCG6K410 PL292	CF 6K	3,6	E-Glass	3,6	292	Plain
KCG6K410 TW292	CF 6K	3,6	E-Glass	3,6	292	2X2 Twill

* Hybrid fabrics can be designed for cost and performance optimization.

ARAMID FABRICS

Fabric	Fiber	Areal Weight (g/m ²)	Weaving Style	Warp Density (picks/cm)
KAF670 PL160	Aramid 670 dtex	160	Plain	12,2
KAF930 PL200	Aramid 930 dtex	200	Plain	10,6
KAF3140 PL410	Aramid 3140 dtex	410	Plain	6,4
KAF3300 PL440	Aramid 3300 dtex	440	Plain	6,7

Fabrics

Kordsa has a wide range of unidirectional and bidirectional fabrics (plain, twill, harnesssatin and basket). Carbon, glass or aramid fibres can be used as reinforcement materials in traditional and hybrid fabrics. Woven fabrics can be suitable for prepreg production, vacuum infusion, RTM and wet layup.

Carbon fabrics

- Carbon fibres: from 1K to 50K
- Fabric width: 150mm – 1600mm
- Areal weight: 120 gsm – 1500 gsm
- Fabric type: Plain, Twill, Satin, Basket, Leno

WOVEN FABRICS

Fabric Code	Fiber	Areal Weight (g/m ²)	Weaving Style	Warp Density (picks/cm)	Weft Density (picks/cm)
KCF1K PL120	CF 1K	120	Plain	9,0	9,0
KCF3K PL160	CF 3K	160	Plain	4,0	4,0
KCF3K PL193	CF 3K	193	Plain	4,8	4,8
KCF3K PL200	CF 3K	200	Plain	5,0	5,0
KCF3K TW200	CF 3K	200	2X2 Twill	5,0	5,0
KCF3K PL224	CF 3K	224	Plain	5,6	5,6
KCF3K TW245	CF 3K	245	2X2 Twill	6,0	6,0
KCF3K TW285	CF 3K	285	2X2 Twill	7,0	7,0
KCF6K TW280	CF 6K	280	2X2 Twill	3,5	3,5
KCF3K PL288	CF 3K	288	Plain	7,2	7,2
KCF6K 4H380	CF 6K	380	4H Satin	4,7	4,7
KCF6K TW410	CF 6K	410	2X2 Twill	5,0	5,0
KCF12K TW400	CF 12K	400	2X2 Twill	2,5	2,5
KCF12K TW430	CF 12K	430	2X2 Twill	2,7	2,7
KCF12K PL480	CF 12K	480	Plain	3,0	3,0
KCF12K TW480	CF 12K	480	2X2 Twill	3,0	3,0
KCF12K TW600	CF 12K	600	2X2 Twill	3,7	3,7
KCF24K TW800	CF 24K	800	2X2 Twill	2,5	2,5
KCF24K TW1200	CF 24K	1200	2X2 Twill	3,7	3,7

Composite Sandwich Panels

Thanks to their advanced mechanical properties and light weight, composite sandwich panels are of great importance in the aerospace, automotive, railway, mass transportation, marine, sports and leisure, logistics and construction industries.

Kordsa's composite sandwich panels are available in flat geometry, with dimensions up to 1.5 m x 3.0 m. Areal weights and dimensions of panels can be tailored according to customer needs, as can the core material and its thickness.

Typical features of standard sandwich panel products are flame-retardancy with high flexural strength, stiffness, and a lightweight structure.

Honeycomb Sandwich Panels For Aircraft Interiors

Kordsa's honeycomb sandwich panels comply with the necessarily stringent flame-retardant properties, including low heat release, low smoke density and low toxicity, as well as superior thermal insulation. All of these are of course vital for aircraft interior applications.

The core material of a typical sandwich panel for an aircraft interior is Nomex® honeycomb. Advanced Honeycomb Technologies (AHT) supplies Nomex® honeycomb sheets, produced using safe and environmentally-friendly water based sustainable technology. The honeycomb core is covered with stiff prepregs to form a sandwich panel. The facesheets of panels for use in seats, galleys, lavatories, ceilings and walls are generally made from glass/phenolic prepregs, while glass/epoxy or carbon/epoxy prepregs are preferred in floor panels and seats.



Stowage & overhead bins



Sidewalls & panels



Crew rest modules



Galleys



Closets



Class dividers

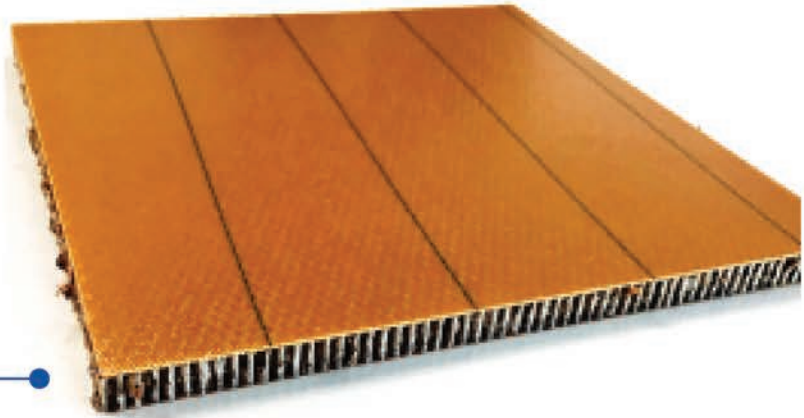
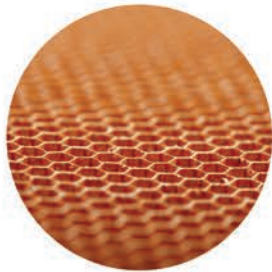


Lavatory



Cockpit door





CORE MATERIAL

AHN4120 Aramid Fiber/Phenolic Coated Honeycomb

- Aerospace Grade Nomex® Honeycomb*
- Meets most commercial and military specifications, including the strength requirements of BMS 8-124, DMS 1974, AMS 3711, and MIL-C-81986

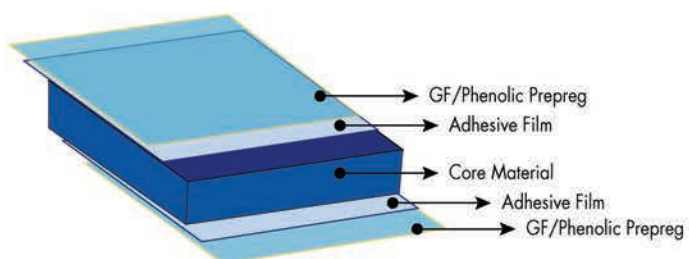
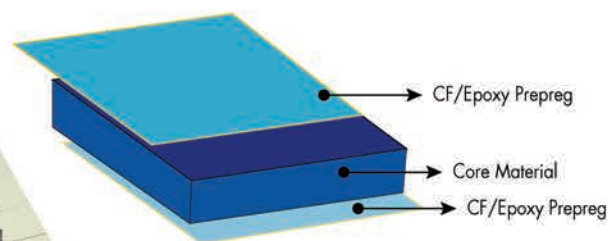
*Honeycomb is supplied by Advanced Honeycomb Technologies (AHT) that is the only honeycomb manufacturer using "green" resin (water soluble) meeting Mil R 9299

FACESHEETS

Phenolic* / Epoxy-glass fabric or Phenolic* / Epoxy-carbon fabric prepreg for aircraft interior applications

*Prepregs with low FST characteristics are supplied by Axiom





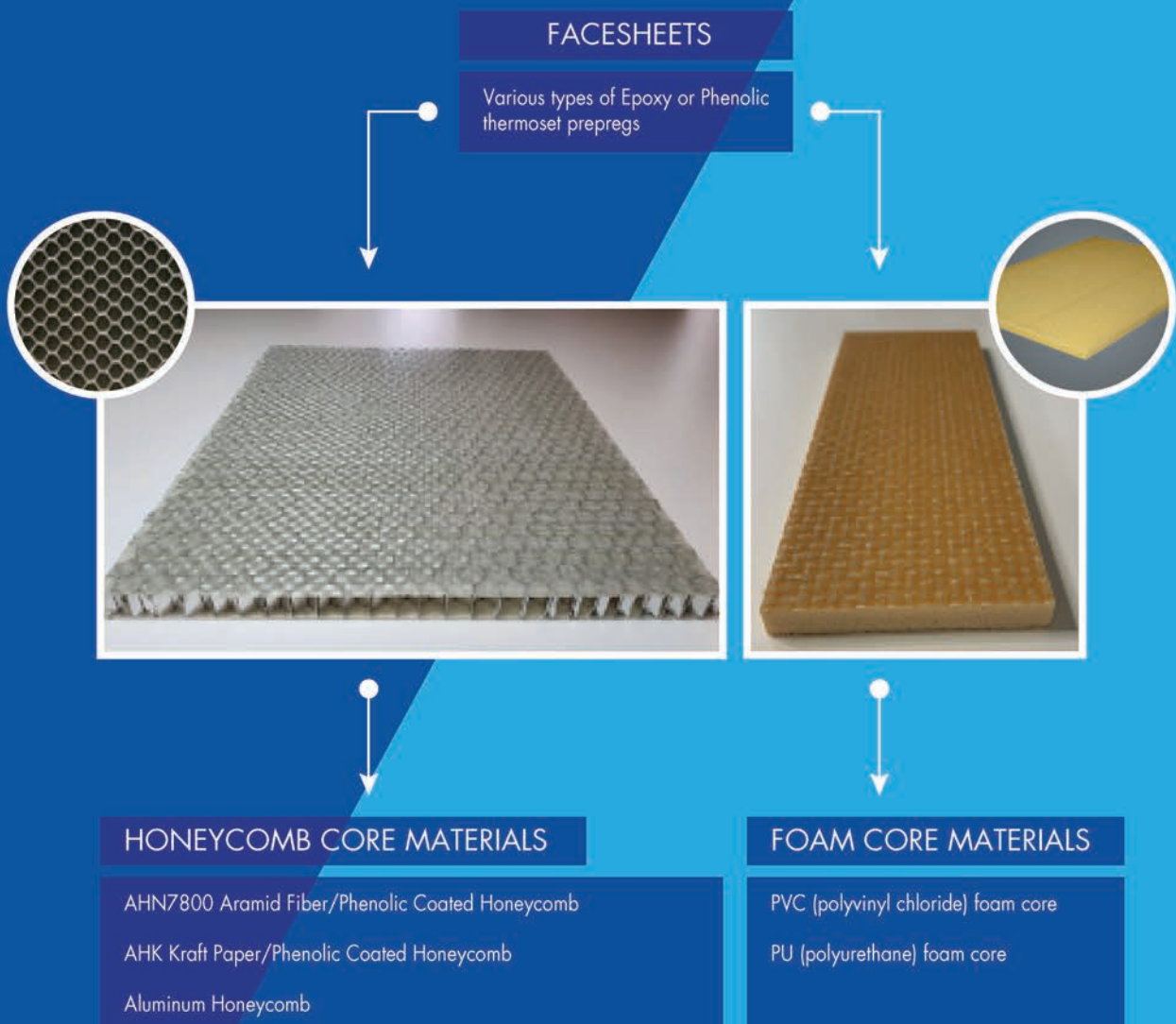
Sandwich Panels For Industrial Applications

The cell size and thickness of honeycomb core materials can be tailored, and various types of thermoset preregs reinforced with glass, carbon or aramid fibers may be used as facesheets for composite sandwich panels. For industrial applications, Kordsa deploys woven glass fabric-based phenolic or epoxy preregs, together with the core materials listed below.

Typical **core materials** and their attributes are:

- **Commercial Grade Nomex® honeycomb** is manufactured from a commercial grade paper. This material possesses high strength, high flame-retardancy, excellent thermal insulation and dielectric properties, as well as high moisture resistance.
- **Phenolic-coated kraft paper honeycomb** boasts high strength, water resistance, high flame-retardancy and superior thermal insulation properties.
- **Aluminum honeycomb** has high strength and enables weight reduction.
- **Foam cores** are generally made from PVC and PU polymers. They are cost-effective, can be used in lightweight structures and possess advanced mechanical properties.

The industrial uses for composite sandwich panels include floors, doors, flat bulkhead, roofs, containers, shelters, crash absorbers, furniture, and facing panels for high-rise construction.



Thermoplastic Prepregs

Kordsa produces woven based PP and PA thermoplastic prepregs. Matrices of the fiber based thermoplastic composite such as PP and PA have already been used notably in automotive, industrial, sports and leisure industries thanks to their cost saving and light weighting properties as well as being easy to process with the low processing temperature and pressure.

Kordsa's product range for polymer matrices is PP and PA6.6. The resin systems are specially formulated by Kordsa, which has excellent compatibility with reinforcing fibers such as E-glass or carbon. Prepreg is available as sheets with maximum dimensions of 1.2 m x 1.2 m. Laminates are usually produced from one to four layers depending on customer requirements.

Kordsa's woven glass fabric based PP thermoplastic prepreg exhibit 25% better flexural properties compared to its counterparts.

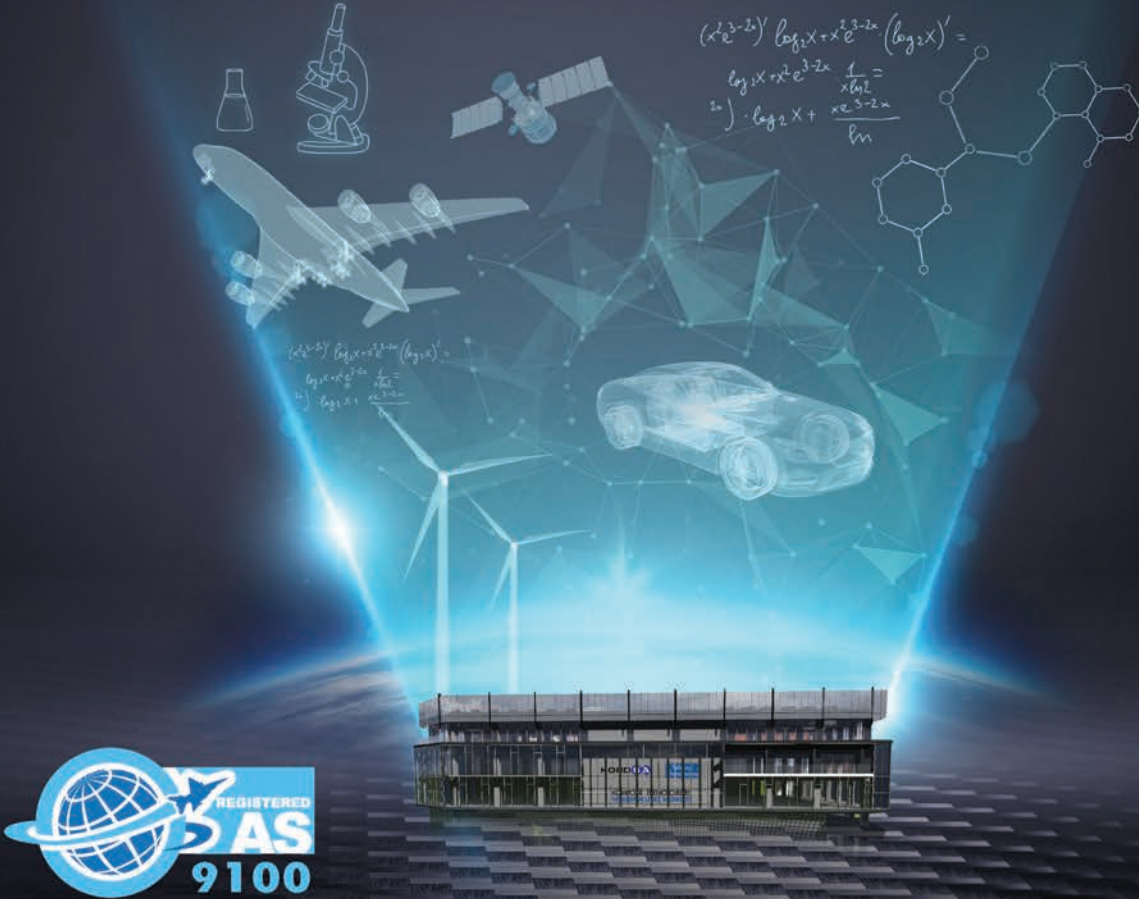
Typical features which we supply in the standard products:

- High stiffness
- High toughness
- Shorter manufacturing cycles
- No need for cold storage
- Recycling potential

Polymer Type	Fiber	Fabric Type	Fiber Volume Content (%)	Processing Temperature (°C)	Number of Layers	Usage Area
High crystalline polypropylene (PP)	E-glass, carbon	Woven	45-55	195-215	1 to 4*	Industrial, Sports & Leisure, Automotive
Polyamide 6.6 (PA6.6)	E-glass, carbon	Woven	45-55	275-300	1 to 4*	Industrial, Sports & Leisure, Automotive

*Number of layers can be changed depending on customer requirements.



**[COMPOSITE TECHNOLOGIES
CENTER OF EXCELLENCE]**

Composite Technologies Center of Excellence is the key development facility in composite industry in collaboration with Sabancı University to bring together engineers, researchers, faculty members, students, entrepreneurs and designers under one roof including:

- Kordsa Prepreg Production Line
- Kordsa Composite Reinforcement R&D Center
- Sabancı University PhD Programs
- Incubation Centers
- Kordsa - Sabancı University Joint Composite R&D Labs

Sabancı Group established a “world university” under Sabancı Foundation’s stewardship in 1994. Instead of choosing a university as a template or replicating existing examples and institutions, a novel and unique university was designed during its founding. Sabancı University opened its doors to students in 1999 and has since set an example for many other universities. The main differentiator of Sabancı University is its unique educational system. Academic programs at Sabancı University are innovative and interdisciplinary.

Sabancı University was named “The Most Innovative and Entrepreneurial University” in 2012, 2015, 2016 and 2017 in the Ministry of Science, Industry and Technology’s Entrepreneurial and Innovative Universities Index. In 2016, Sabancı University maintained its position in the global top 500 rankings compiled by prestigious organizations such as Times Higher Education and QS. In 2016, the Sabancı University ranked 44th globally in the Times Higher Education (THE) “Best 150 Universities under 50 Years Old” list, which evaluates the performance of young, rising universities. Meanwhile, the University rose four spots to place 18th in the 2017 Times Higher Education (THE) “BRICS and the Best Universities in Emerging Economies” ranking. Recently, the University ranked 34th in the Times Higher Education (THE) “Asian Universities” rankings.



OTHER FACILITIES

Fabric Development, Inc.



Fabric Development Inc. was established in 1972 to manufacture specialty woven fabrics to meet specialty end use requirements. In time, FDI has greatly expanded its capabilities to work with all high performance fibers, including Carbon (standard to ultra-high modulus), Aramid (Kevlar® & Twaron®), Spectra, Ceramics, Quartz, Teflon, Nomex and Vectran. FDI has manufactured these fibers in a variety of fabric geometries, hybrid structures, polar weaves and multilayer fabric structures. This capability allows FDI to serve the expanding needs of specialty fabric applications.

www.fabricdevelopment.com

Textile Products, Inc.



Textile Products Inc. operating as a Kordsa company, is a specialty textile manufacturer, experienced in the development and production of custom fabrics. TPI offers a wide range of standard fabrics as well as custom design textiles engineered to meet specific requirements including: Uni-directional, Bi-directional, Multi-directional and Hybrid fabrics and tapes. TPI also has considerable experience with all available yarns, including Carbon-Standard, Intermediate and High Modulus, Aramid-Kevlar™ & Twaron™, Ceramic-Nextel™ & Nicalon™, Quartz, Metallic Wires, Nickel Coated Carbon and Commingled Thermoplastics.

www.textileproducts.com

Advanced Honeycomb Technologies



Advanced Honeycomb Technologies manufactures a wide range of honeycomb core used in products as diverse as commercial and military aircraft, communications and transportation equipment, space vehicles, construction materials and recreational and sporting goods. AHN4120 is an Aerospace Grade Nomex® Honeycomb which exhibits high strength and toughness in a small cell, low density, non-metallic honeycomb. AHN7800 is a Commercial Grade Nomex® honeycomb particularly suited for use where resistance to corrosive attack and moisture are important.

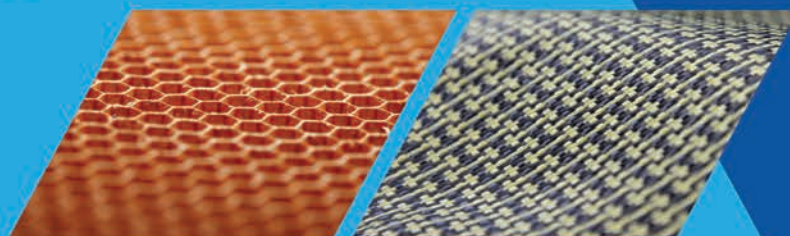
www.ahtinc.com

Axiom Materials, Inc.



Axiom Materials, Inc., is a progressive composite materials manufacturer founded with the intention of combining a quality prepreg, adhesive, and ancillary composite products platform with customer-focused service and forward-thinking design. Axiom Materials manufactures an unrivaled range of composite materials and engineered products, including ceramic prepreps, epoxy unidirectional carbon prepreps, tooling prepreps and film adhesives.

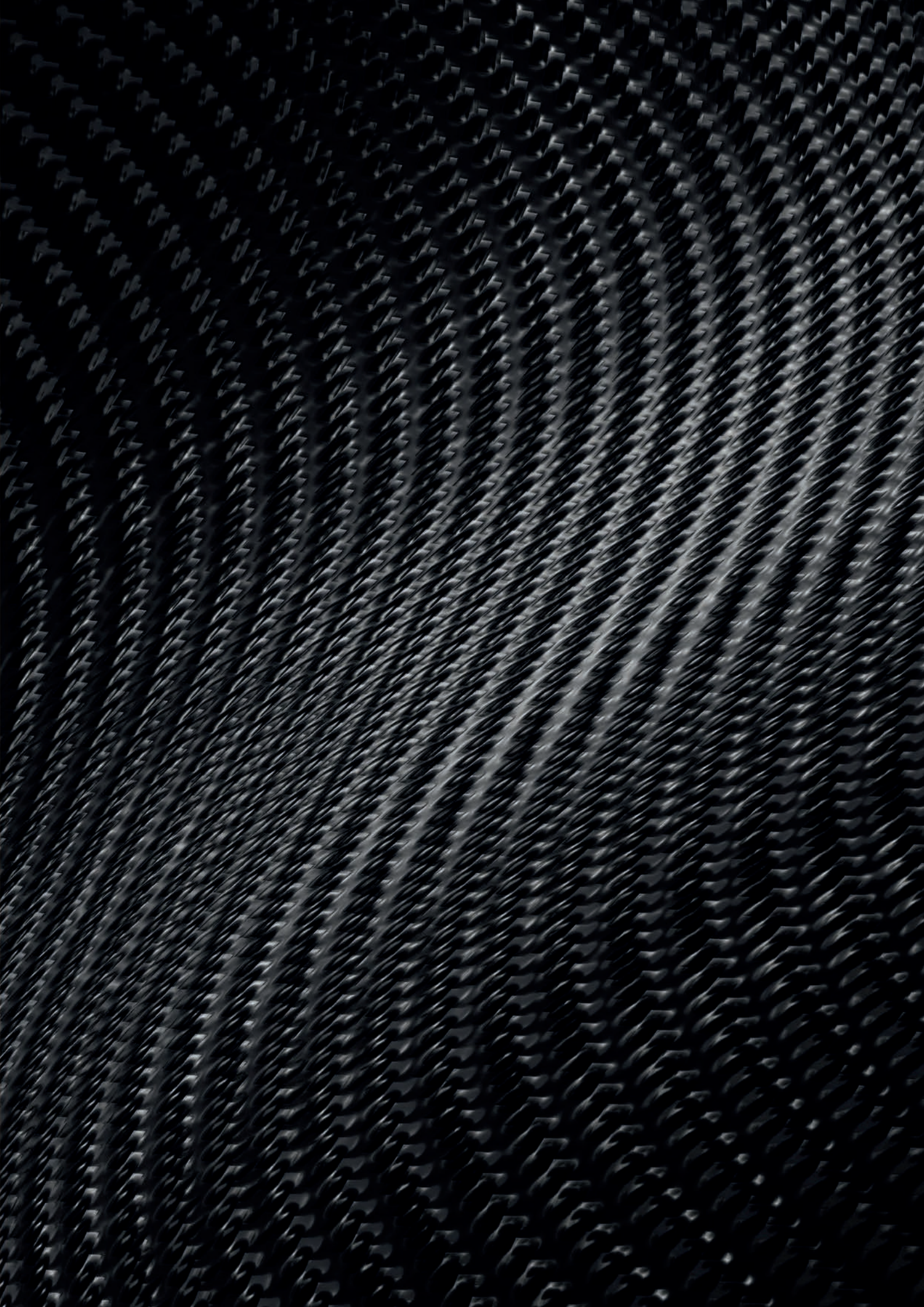
www.axiommaterials.com



GLOBAL PLAYER OF **COMPOSITE TECHNOLOGIES**

We reinforce our future by developing advance composite technologies for space, aviation, automotive industry as well as industrial and transportation applications.







THE REINFORCER

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