



ADVANCED COMPOSITE TECHNOLOGIES

KORDSA
THE REINFORCER

About Sabancı Holding & Kordsa “The Reinforcer”

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

Kordsa, established in 1973 operates in tire reinforcement, construction reinforcement and composite technologies fields. 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. Thanks to its durable and practical reinforcement solutions in the construction industry, Kordsa continues to touch every aspect of life. Kordsa develops composite technologies for aerospace and automotive industries to reduce fuel consumption and carbon emission.

Pursuing its growth strategy, Kordsa has stepped in Advanced Composites with the Composites Technology Center of Excellence, one of the few integrated production centers in the world. Composite Technologies Center of Excellence is a technology hub driven by collaborative research and production, and it was conjointly established by Kordsa and Sabancı University in 2016. Thanks to this collaborative ecosystem, Kordsa offers tailor-made services to its customer by involving the stakeholder in all stages of research and development, from basic research to the production of a prototype and finally, to mass production.

Kordsa is continuing its growth by having integrated its new affiliates; Fabric Development Inc., Textile Products Inc., Advanced Honeycomb Technologies, and Axiom Materials.

GLOBAL PLAYER OF COMPOSITE TECHNOLOGIES

Anaheim, CA
Santa Ana, CA
San Marcos, CA
Quakertown, PA
Laurel Hill, NC
Chattanooga, TN

Brazil

İstanbul
İzmit

Thailand

Indonesia



Composite Technologies
Production



Tire Reinforcement
Production



R&D Center



Construction
Reinforcement
Production

Thermoset Prepregs

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

The primary resin matrix used is epoxy for thermoset prepregs.

Kordsa formulates, develops and qualifies its resin systems in the Composites Technologies Center of Excellence.

Kordsa prepregs are used in a wide range of industrial markets and tailored to meet specific performance requirements such as: low-temperature cure; fatigue; cosmetic; fire, smoke and toxicity.



THERMOSET PREPREGS

Resin Code	Resin Type	Tg *			Value Proposition	Recommended Curing Method			Market / Applications	Additional Properties
		Dry Tg *	Post Cure Tg **	Wet Tg ***		Oven	Auto clamp	Press		
OM10	Epoxy Hotmelt	116	-	-	Toughened Structural, 120 °C 1 hour Autoclave Cure		x	x	Industrial, Marine, Automotive	Opaque, High Tack
OM11	Epoxy Hotmelt	117	-	-	Fatigue Resistant, Low Exotherm, Hot-Demoldable		x	x	Leaf Spring, Thick Parts	Translucent, Medium Tack
OM12	Epoxy Hotmelt	110	-	-	Toughened Structural, 120 °C 2 hour Oven Cure	x			Industrial, Marine, Automotive	Opaque, High Tack
CM11	Epoxy Hotmelt	141	151	104	Snap Cure, Hot-Demoldable			x	Automotive, Visual	Transparent, Low Tack
EF12	Epoxy Hotmelt	220	-	154	220 °C Tg, Toughened Structural		x		Aviation, Industrial	Medium Tack
AX-201XL	Epoxy Hotmelt	111	-	-	Cosmetic Carbon Look, Variable Temperature Cure	x	x		Automotive, Marine, Industrial, Visual	3 Tack Level: Low, Medium, High
AX-180	Epoxy Hotmelt	125	-	-	Low FST/HR, 120 °C 1 hour Autoclave Cure, Excellent Surface Quality		x		Aircraft Cabin Interior & Seat, Automotive, Industrial	2 Tack Level: Low and Medium
AX-180SC	Epoxy Hotmelt	133	-	-	Low FST/HR, Snap Cure, Hot-Demoldable, Excellent Surface Quality			x	Aircraft Cabin Interior & Seat, Automotive, Industrial	Low Tack
AX-170	Cyanate Ester Hotmelt	NA	371	-	High temp. prepreg for structural composites offering good mechanical performance at operating temp. up to 315 °C	x	x	x	Structures for motorsport and defense applications requiring service temp. up to 315 °C	Inherently flame retardant

ADHESIVE / SURFACE FILMS

AX2116	Epoxy Hotmelt	-	-	-	High peel and high lap shear strength	x	x	x	Metal to metal bonding	Excellent resistance to high moisture
KY01	Epoxy Hotmelt	168***	-	-	Surface film for A class surface applications for automotive industry		x		Automotive painted body panels	Perfect surface finish for painting process

BALLISTIC PREPREGS

EF14	Phenolic Modified PVB	-	-	-	Flame Retardant, High Toughness, High Energy Transfer			x	Ballistic Protection (Helmet, Vehicle Armor, Ceramic Backing Applications)	Very low tack
EF30	Undisclosed	-	-	-	Enhanced performance-to-weight ratio, Better kinetic energy absorption than woven products, High temperature stability and high rigidity			x	Hard Ballistic Protection (Helmet, Spall Liner, Platform Armor, Rigid Ballistic Plates)	No Tack
EF35	Undisclosed	-	-	-				x	Hard Ballistic Protection (Body Armor)	No Tack

*DMA Storage Modulus Onset

**Values from Recommended curing profile from TDS

***DSC Storage Modulus Onset

Other Prepreg Technologies

Thermoplastic Prepregs

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 E-glass fabrics. Kordsa's woven glass fabric based PP thermoplastic prepreg exhibit 25% better flexural properties compared to its counterparts. Thermoplastic prepregs are available as rolls or organo sheet (OS) form.

Polymer Type	Fiber	Fabric Type	Fiber Volume Content (%)	Processing Temperature (°C)	Format	Usage Area
High crystalline polypropylene (PP)	E-glass	Woven	45-55	195-215	Roll / OS	Industrial, Sports & Leisure, Automotive
Polyamide 6.6 (PA6.6)	E-glass	Woven	45-55	275-300	OS	Industrial, Sports & Leisure, Automotive

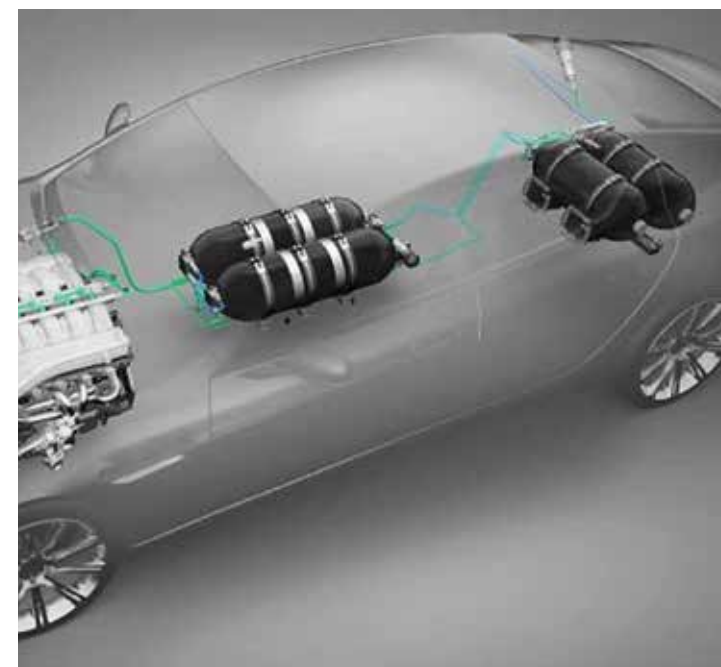
*Number of layers can be changed depending on customer requirements.



Slittape & Towpreg

Kordsa offers slittape and towpreg products. These products are designed for automated fiber placement (AFP) or for machine-supported winding techniques used in the preparation of round, cylindrical and rectangular 3D vessels and structures. These narrow products are mainly used to improve passenger safety, enhance fuel efficiency, reduce waste, all the while enabling lower cost, higher performance and more environmentally-benign transportation. By offering these products Kordsa is placing sustainability at the core of its activities. Compared to traditional composite counterparts, these products are designed to withstand high temperatures, enabling their use in transportation applications including electric, compressed natural gas (CNG) and hydrogen-powered aircraft and vehicles.

Style	Fabric Weight [gsm] (min. - max.)	Fiber Types	Width [inches]	Value Proposition	Market / Applications
UD Slit Tape	132-200	3K / 12K / 24K	1/2" - 1/4" - 1/8"	Optimal impregnation, highly precise areal weight and width	High Pressure Vessels, Driveshafts, Mandrels, Masts, Golfshafts, Pole & Barrels
Towpreg	N/A	12K / 24K	N/A	Optimal impregnation, stable tow width, wrinkle-free	



Fabrics

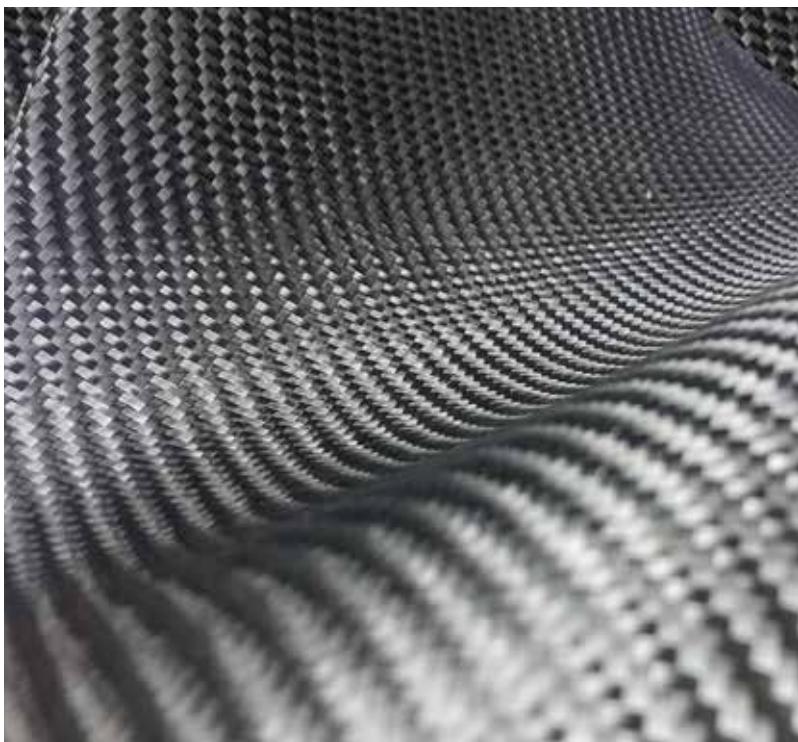
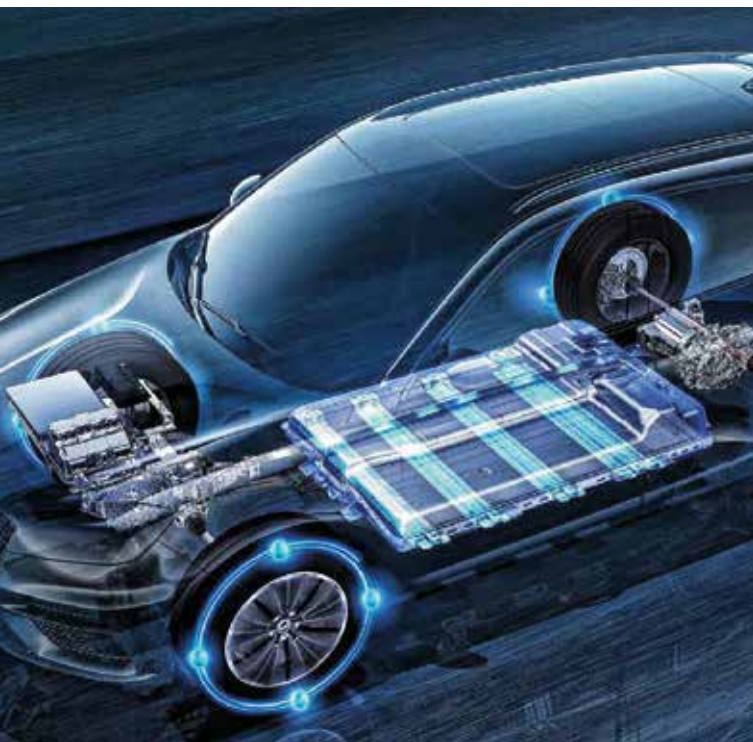
Kordsa has a wide range of unidirectional and bidirectional fabrics (plain, twill, harness satin and basket) carbon, glass, UHMWPE or aramid fibers can be used as reinforcement materials in traditional and hybrid fabrics. Woven fabrics can be suitable for prepreg production, vacuum infusion, RTM and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

WOVEN FABRIC CAPABILITIES

Weaving Styles	Fabric Weight [gsm] (min. - max.)	Fiber Types	Width [mm] (min. - max.)
Plain, Twill, Satin	160 - 1200	3K to 24K	1000 - 1600

UNI-DIRECTIONAL FABRIC CAPABILITIES

Weaving Styles	Fabric Weight [gsm] (min. - max.)	Fiber Types	Width [mm]
UD	200 - 1000	3K to 48K	100 - 300 - 500 - 1000



CARBON FABRIC PORTFOLIO

	Weaving Type	Fabric Weight [gsm]	Filament Count	Width [mm]	Warp Density [picks/cm]	Weft Density [picks/cm]
	Plain/Twill	160	3K	1250	4	4
*	Plain	193	3K	1255	4,8	4,8
*	Plain/Twill	200	3K	1250	5	5
*	Plain	224	3K	1255	5,6	5,6
*	Twill	240	3K	1000	6	6
*	Twill	245	3K	1250	6,1	6,1
	Plain/Twill	280	3K	1250	7	7
*	Plain	288	3K	1250	7,2	7,2
	Plain	288	6K	1250	3,6	3,6
	Plain/Twill	380	6K	1250	4,7	4,7
*	Plain/Twill	400	12K	1250	2,5	2,5
*	Plain	445	12K	1255	2,7	2,7
*	Plain/Twill	600	12K	1250	3,7	3,7
*	Twill	630	12K	1000	3,9	3,9
*	Plain/Twill	650	12K	1250	4	4
	Plain/Twill	800	24K	1600	2,5	2,5
*	Plain/Twill	1000	24K	1000	3,1	3,1
	Plain/Twill	1200	24K	1600	3,7	3,7
	UD	200	12K	500/1000	2,5	-
	UD	230	12K	500/1000	2,8	-
*	UD	300	12K	500/1000	3,6	-
*	UD	300	24K	500/1000	1,8	-
	UD	400	12K	500/1000	5	-
	UD	400	24K	500/1000	2,5	-
*	UD	500	24K	500/1000	3,1	-
	UD	600	24K	500/1000	3,7	-

* Standard fabrics can be supplied with shorter lead times.

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.

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

- **Aerospace or Commercial Grade Nomex®** This material possesses high strength, high flame-retardancy, excellent thermal insulation and dielectric properties, as well as high moisture resistance.
- **Aluminum honeycomb** has high strength and enables weight reduction.
- **Foam cores** are generally made from PVC and PU polymers. They are cost-effective, they 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.



Sandwich Panel Portfolio

Skins

- Low FST/HR Epoxy AX-180 SC (Snap Cure) – Glass or Carbon pre-preg
- Phenolic pre-preg
- CM11 Snap Cure Carbon Pre-preg

Cores



Nomex Cores ANH4120 (Aerospace grade) and AHN7800 (Commercial grade)

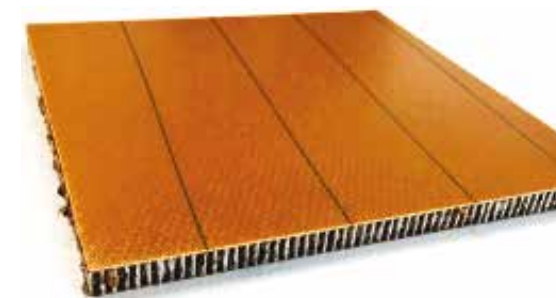


Aluminum Core



Foam Core – PVC or PU

Sandwich Panels



Up to 1.5m x 3m dimensions



High flexural & shear & peel strength



Excellent fire-smoke-toxicity and heat release characteristics (AX-180 – Phenolic prepreg)



Eco-friendly production allowed by water based phenolic AHN4120 & AHN7800 Nomex Cores

Characterization



ASTM C393 (Short Beam):
4-Point-Bending



ASTM D1781:
Drum-Peel

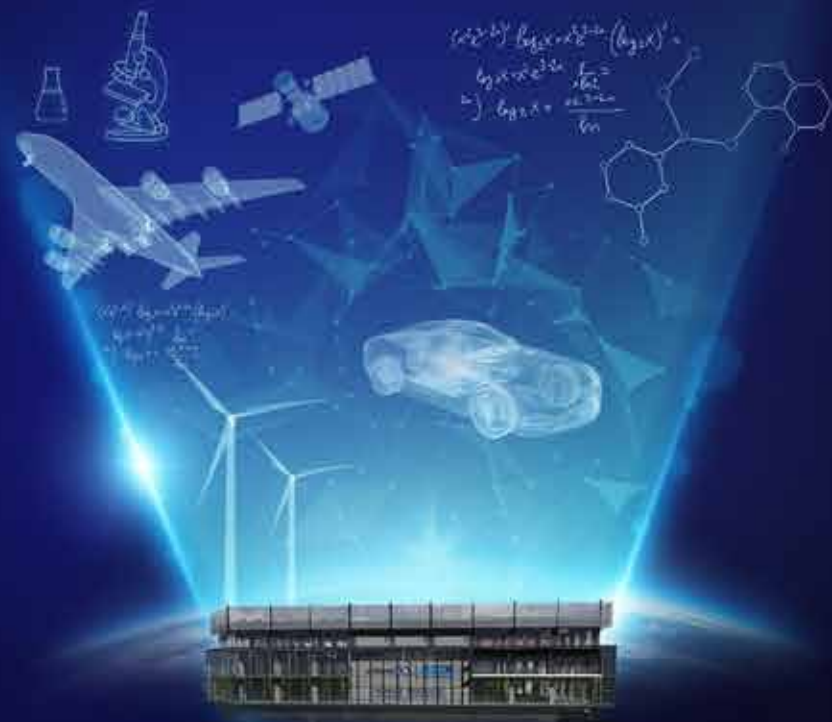


FAR25.853
Flammability Test

KORDSA

Sabancı
Universitesi

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.

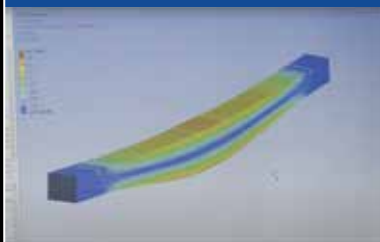
End to end approach

Material Development



- Global product development teams for innovations
- New Resin Development
- Benchmarking
- Material Characterization for CAE modelling
- Material Cards

Modelling & Simulation



- Thermal Modelling
- Failure Analysis
- DoE Statistical Analysis
- FE Calculation on material and components

Mechanical Validation



- Durability Testing
- Static & Dynamic Tests
- Thermal
- Structural
- Climate Chamber
- Investigation on Customized Components

Application & Processing



- Prepreg Cutter
- Clean Room
- Automatic Fiber Placement
- Additive Manufacturing
- Application engineering with core and strategic partners

Prototype Production



- Compression molding with press
- Autoclave curing
- Oven



About Kordsa Affiliates



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



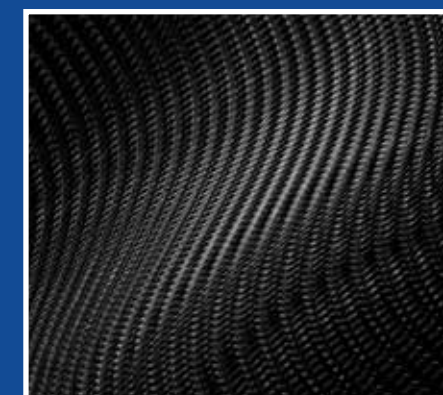
Axiom Materials, Inc.

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 advanced composite technologies for space, aviation, automotive industry as well as industrial and sports & leisure applications.





THE REINFORCER



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