

# THE REINFORCER

KORDSA | BULLETIN | N.08 | 2018 | TURKEY

*Determined to Create Value*

KORDSA



STRENGTH



LIGHTNESS

## THE BALANCE OF STRENGTH AND LIGHTNESS

As Kordsa, with our composite technologies we lightening the vehicles while decreasing the carbon emission to reinforce life.



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In line with our mission to reinforce the future, we continued our efforts to improve the health, education and life standards of the societies we work in.





## Foreword

### ALİ ÇALIŞKAN

#### CEO

Dear Esteemed Partner,

Kordsa has had yet another remarkable year of growth. Despite moderate global economic conditions, our company went above and beyond. Global awards, new acquisitions, partnerships, new innovative projects and so much more continue to bless our success.

In today's fast-paced and highly competitive marketplace, it is crucial for organizations to be flexible enough to change and agile enough to adapt. There has been a rapid change in mobility and digitalization, and that makes our lives easier and faster than ever. We can only guess what is to come. It is a new era for us, and also for the Reinforcers. I am proud to say that by embracing agility, predictability, rapid decision-making, and most importantly adaptation, Kordsa is transforming with ease and grace to take its place among the leading global players in the New Era of Reinforcers.

Over recent years, we have expanded our lines of business into construction reinforcement and composite technologies by transferring our know-how in tire reinforcement. Our business journey today has been brought to a new level by two major acquisitions which will lead us to become one of the leading suppliers of the aerospace and civil aviation industry with our composite technologies. We have acquired the companies Fabric Development Inc (FDI) and Textile Products Inc. (TPI), which are the most important players in aerospace and civil aviation industry in the U.S. These acquisitions are the next stepping stone in Kordsa's journey to fulfill its mission and vision. We envision the potential to unlock some enormous opportunities. We used to say "We reinforce every two out of three aircraft tires". But today, we can also say, "We reinforce the wings and hulls of those aircraft with our composite technologies", and with our construction reinforcement technologies we reinforce the runways those aircraft use. We create new technologies and make them meaningful through our experience in creating lasting value.

Our success is also reinforced with our co-operation with Continental, one of the key players in the tire industry. Together, we have developed a green and sustainable formula that is an

alternative to the 80-year-old resorcinol and formaldehyde-based formula used in the dipping of tire cord fabrics. Being a keen supporter of open innovation practices, we have leveraged our deep knowledge and diverse expertise together with Continental and become the pioneering model for showing the tire industry that "innovation is a long way to walk alone". Now, with our free licensing concept, we are working on making this revolutionary formula the new standard of the industry. This eco-friendly technology, in combination with the free licensing concept, will further improve safety, health and the environment.

On the other hand, the R&D Center at our Composite Technologies Center of Excellence has been officially approved as an R&D Center by the Ministry of Science, Industry and Technology in 2017, officially becoming Kordsa's second approved R&D center. We are very proud that we have already become involved in significant international projects at the Center. Within the scope of the Directional Composites Through Manufacturing Innovation (DiCoMi) project, we are working with Sabancı University on the development of systems, software and materials development to produce composite materials with 3D-printer technology. The DiCoMi project will last 2 years, with EUR 3 million funding from the European Union.

As Kordsa, we are in pursuit of a mission centered on reinforcing people, organizations, and societies. We were among the 100 fastest-growing companies in Indonesia last year. We were also granted the "Best Practices in Internship Program" award in Brazil, as well as the "Indonesia Most Powerful Companies (IMPCA) 2017" award. In addition, the "Best Employee" award in Indonesia went to one of our project leaders who carried out the "Safety Experience Center" project. This year, the Kordsa plant in Brazil has been listed as among the best employers for the second consecutive year, according to a survey conducted by the Great Place to Work Institute (GPTW). We are also among the 150 Best Employers announcement in the Você S.A. guide in Brazil and got a special recognition called 'revelation of the year'.

In line with our mission to reinforce the future, we continued our efforts to improve the health, education and life standards of the societies we work in. This year too, our corporate social responsibility projects included school renovation projects, internship and scholarship programs. We supported young and enthusiastic students through sponsorship programs in their efforts to invent new technologies and innovate in engineering. In 2017, we were the proud sponsor of Yıldız Technical University's Wind Energy Club for their eco-friendly vehicle, Kocaeli University's Turkish Mechatronics team for their electric vehicle and Trakya University's Design Project Team for their Pehlivan-02 and Pehlivan ElekTrak.

With our approximately 4,000 employees across four continents, we aim to operate with zero accidents, zero quality defects, and a zero machinery stop target, thanks to the training sessions that Kordsa employees at all levels attend. As an output of our Occupational Health and Safety practices, in 2017 our Thailand facility and Laurel Hill facility in the U.S. reached their zero-accident targets for the fourth time.

Thanks to our commitment to sustainability efforts, it has been confirmed that Kordsa will be listed in the BIST Sustainability Index for the upcoming period among the top 44 companies with superior corporate sustainability performances, as it performed above the threshold for the "Index Assessment Criteria".

A new year has already started. In 2018, Kordsa will continue to reinforce life and to transform the future. With our deep know-how in reinforcement technologies, advanced R&D efforts, and open innovation culture, we are more than ready to embrace new successes. Hand in hand, we take the journey to pioneer the way in the industry. The new issue of The Reinforcer is now in your hands.

I wish you an interesting read.



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Despite many new polymers invented and commercialized since 1939, the demand for nylon continues to grow.





## Nylon, Age-Old or Revolutionary?

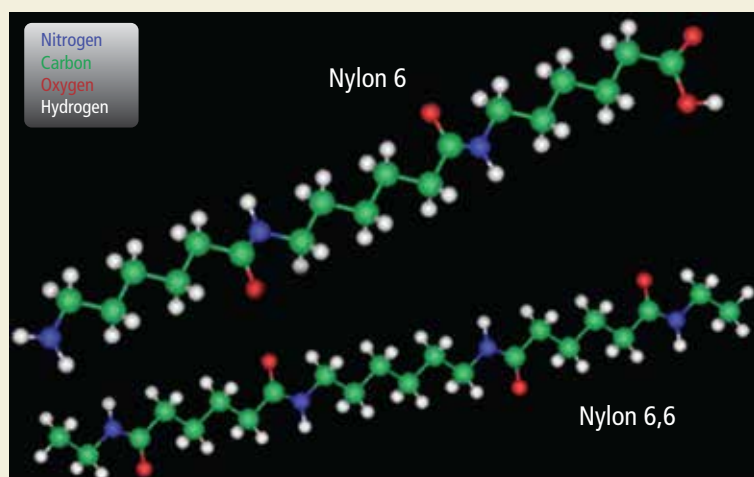
**BOB MERRILL**

**Director, IHS Markit, Americas Fibers and Feedstocks**

### What is Nylon?

Nylon is found everywhere around us. It is in the toothbrush we brush with, the carpets we walk on, the jackets we go skiing in, the baskets in our dishwashers, and the tires on our car. It is hard to believe that nylon has been around for more than 75 years, starting as a replacement for silk in women's stockings; then becoming strategic to World War II in flak jackets and parachute cord. It is even harder to believe, but nylon is even more relevant to us today and continues to grow in importance despite so many other polymers having been developed over the years.

Nylon constitutes a family of resins, the most important of which are nylon 6 and nylon 6,6. Nylon 6 and nylon 6,6 are the most successful and highest-volume members of the nylon family and are the focus of this report. The naming convention recognizes that nylon 6 is made from a single six-carbon monomer, caprolactam, and that nylon 6,6 is made from two six-carbon feedstocks, hexamethylenediamine and adipic acid. During polymerization, the carbon chains are linked together with an "amide" chemical bond with the resulting polymer generically referred to as a polyamide.



Nylon is a thermoplastic material that can be melt-processed into fibers, films, or shapes. Thermoplastic means that it can be remelted and reshaped, as opposed to thermoset plastics like rubber, which cannot easily be remelted and reshaped. End-use applications for nylon polymers fall into two broad categories: fibers and engineering resins. Nylon extruded into fibers of various forms is used in clothing, carpets, tire cords, and other textile applications. Nylon engineering resins are molded into various uses including auto and appliance components, electric insulators, and a wide variety of consumer goods and packaging.

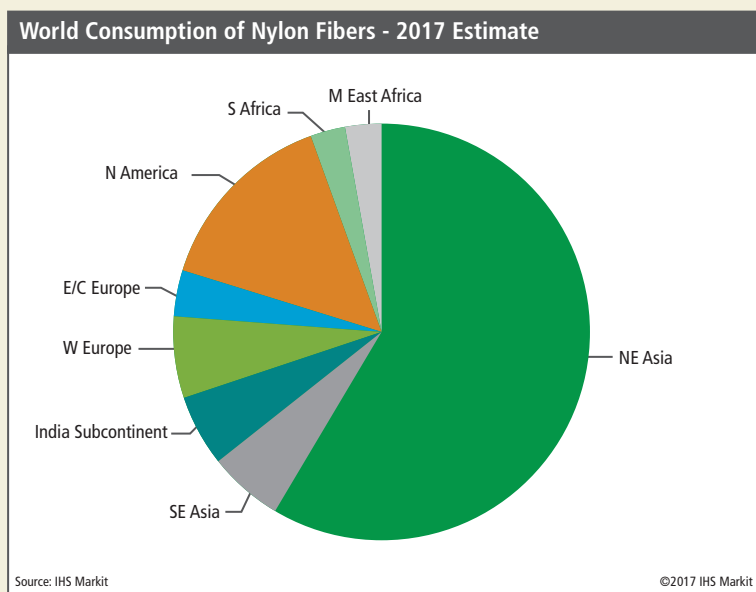
### Nylon as a Fiber

Fibers consume about 58 percent of the global demand for nylon. Textile filament for apparel and industrial filament for tires and auto airbags are the primary fiber forms produced today, accounting for nearly 80% of the total nylon fiber market and growing at an estimated 2.1 percent per year for the next five years. The textile apparel market continues to be the victim of changing consumer preferences as well as advances made in polyester filament. In fact, polyester has advanced against almost all apparel fibers, natural and synthetic, and is now the predominant fiber, having almost a 50 percent share of the global fiber market. Changing technology, such as passenger tires going from bias to radial, has also spawned further growth for polyester at the expense of nylon. However, nylon fiber continues to be used in a growing number of specialty applications requiring durability, light weight, and resistance to weathering and abrasion.





Northeast Asia consumes 78 percent of the world's nylon fiber for textile filaments and 48 percent of the world's nylon fiber for industrial filaments. In both cases, China is the largest consumer in the region. China's textile filament market is expected to be the fastest growing in the next five years, at about 3 percent per year.



Northeast Asia has also become the world center for manufacturing nylon fiber, account for nearly two-thirds of the world's nylon fiber output. China accounts for the majority of that expansion. In the past five years, the production of nylon fiber in China has increased at about 6.7% per year, but is envisaged to slow to 2.8 percent per year in five years' time. Most other Asian countries, such as Japan, South Korea, Taiwan, and India, experienced no growth or even declining production. North America and Western Europe are expected to remain, at best, stable as producers of nylon fiber. Both regions are important nylon fiber consumers, but both regions are growing at below-average rates.

Carpets and rugs account for the remaining 15 percent of global nylon fiber, with little or no growth envisioned. Once the premier fiber next to wool, nylon has seen demand soften. This market has continually been eroded by consumer preferences for hard surface flooring as well as polyester filament gaining acceptance in the residential market. North America and Western and Central Europe continue to be the major producers of carpets and rugs, accounting for about 78 percent of the nylon fiber consumed.

### Nylon as an Engineered Plastic

Nylon became the first engineered plastic in the 1950s, when fiberglass reinforcement was first compounded into polymers to impart added performance. The properties of nylon, which include mechanical strength and toughness, heat endurance, resistance to oils and greases and good electrical insulation characteristics, make nylon an effective substitute for metal and other traditional materials in many durable, load-bearing engineering applications. Nylon engineering resins consume 33 percent of the nylon 6 and 60 percent of the nylon 6,6 produced globally. Nylon engineering resins and nylon fiber resins are produced by the same polymerization technologies, and while some tailoring occurs to optimize the product for engineering or fiber uses, the two resin products are similar and are often made in the same facilities.

Nylon 6 has somewhat lower heat resistance than nylon 6,6 but has advantages in terms of aesthetics (especially in reinforced compounds), easier colorability and a historically lower cost. In practice, there is significant overlap in the performance of these two major nylon types. While the preference for 6 versus 6,6 varies by region, nylon 6 continues to hold the largest volume share of engineering plastic nylon resin globally by virtue of its broad use in the production of film used in packaging.

Nylon 6 and nylon 6,6 in engineering applications are most often made from a blend of the polymer with reinforcements, fillers, and additives. The blend, or compound, is produced during the compounding process, typically using a twin-screw plastic compounding extruder, although other types of compounding equipment can also be used. The ratio of polymer, reinforcements, fillers, and additives are formulated to optimize the properties of the compound to end-use requirements, to improve the processing characteristics of the compound during end-use article manufacturing, and to minimize cost. Improvements in compounding technology and improvements in reinforcements and additives, along with improvements in nylon polymer technology, continue to advance the performance profile of both nylon 6 and nylon 6,6. As a result, nylon 6 and nylon 6,6 continue to capture applications with ever more demanding end-use performance requirements.

Automotive uses are the largest application for nylon resins, accounting for 36 percent of the nylon resin consumed in recent years, and are forecast to grow at about 2.7 percent per year for the next five years. The forecast for automobile production shows growth of about 3 percent per year, with 2020 global production surpassing 100 million units. Regions with above-average annual growth rates for vehicle production include the Indian Subcontinent, Southeast Asia, and Central Europe. Northeast Asia, the largest vehicle-producing region, is expected to grow at an average rate of 3 percent per year. Nylon 6 and 6,6 resins are now typically compounded with a variety of materials to improve their material properties.

Applications include a wide variety of interior and exterior hardware



and under-the-hood parts that require heat resistance, strength, and good aesthetic appearance. Automotive applications generally require the properties of nylon compounds, which include fiberglass and/or mineral reinforcements, heat stabilizers, and impact modifiers. Further growth in automobile production is likely to support the continued geographical shift in OEM production, thermoplastic compounding, and molding operations, because the manufacture of bulky finished components tends to remain close to the assembly point.

Other rarer applications with above-average growth for nylon resins include electrical insulators, electronics, and appliances. The average annual growth rate for nylon resin consumption in electrical and electronic applications will be about 5 percent through 2020 and will account for about 20 percent of the nylon resin volume growth in the next five years.

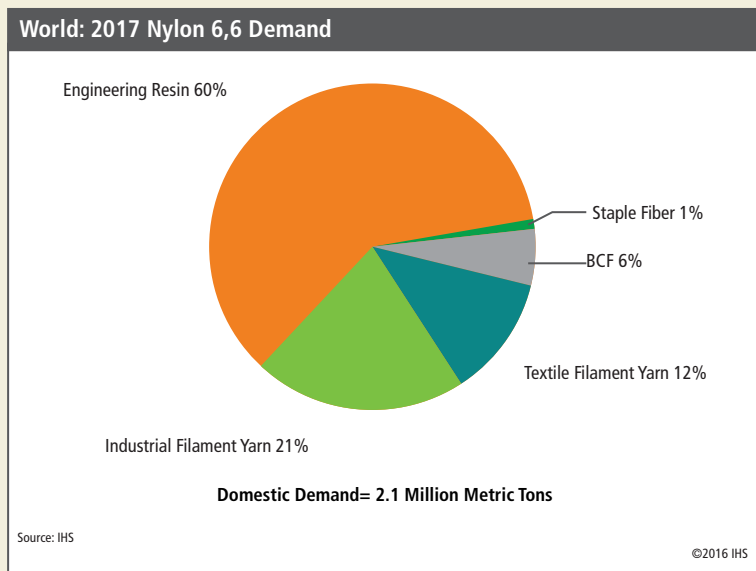
Film and coating consumed about 13 percent of the global demand for nylon resins of late. The average annual growth rate for nylon resins in film and coating applications is forecast to be about 0.6 percent over the period 2015–20. Its primary applications are in flexible packaging for meat and cheese. The film products for these foods require high barrier properties.



## Is Nylon 6,6 Higher in Value?

It all depends on the application. Although both nylon 6 and 6,6 are derivatives of oil, nylon 6,6 is generally more expensive to produce, given the complexity of the process, process yields, feedstock stream, and energy requirements. The value, however, is determined how well each performs in its intended end use, and whether the product properties such as melting point and durability differ because of the molecular bonding differences in the two.

In engineered plastics, the workhorse nylon 6,6 compound product is glass fiber reinforced, heat-stabilized, black nylon 6,6, which has a heat deflection temperature of around 250°C versus 220°C for a comparable nylon 6 compound. In some instances, engineers choose nylon 6,6 for the advantage obtained in heat resistance. Nylon 6,6 was the earliest engineering plastic and has been among the most successful. Today, engineering plastic applications account for 60 percent of the world's nylon 6,6 resin demand.



In fibers, the preference is clearly for nylon 6,6 for industrial applications. Its higher heat resistance allows it to be used in tires where heat or heat generation is a factor, either in manufacturing or in the running of the tire itself under high load or speed. Its combined properties of higher strength, shock absorption, and elastic recovery also make it ideal for high performance and aircraft tires. Auto airbags benefit from the strength, elasticity and chemical and aging resistance. The demand and value for nylon 6,6 has been less noticeable in recent years in textile, carpet (BCF), and staple applications, which have changed with style trends, or moves to alternate fibers altogether, such as polyester.

## What is the Future for Nylon?

Despite many new polymers invented and commercialized since 1939, the demand for nylon continues to grow. The nylon resin market is growing at about 3 percent per year and expected to continue at this rate to 2020. Most volume and volume growth will be in fiber applications; but at a slowing pace of just over 2 percent per year as trends in apparel move more to polyester. Nylon engineered resins will continue to prosper in the automotive industry, especially as manufacturers look to replace more heavyweight metal components. Product properties continue to be enhanced, increasing the conditions under which nylon can be used, somewhat making up for the fact that there are very few new markets opening up.

Looking longer term, the world will continue to shift. More cars will be electrically powered, regional energy and feedstock sourcing and economics will change, competing materials will emerge, sustainable bio-based and eco-friendly routes will be developed, government policies on trade will shift, and consumer preferences will change. Likewise, the demand for all polymers will continue to shift, but there is no end in sight to the demand for nylon. Nylon has truly been revolutionary. IHS Markit is at the forefront of understanding these chemical markets, as well as many others; providing insight and analytics that help drive better decisions for the future of our clients and industry in general.



(Automobile airbag being inflated.)

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The global composites industry is predicted to grow by 4 percent on average on a year-on-year basis between 2016 and 2021.







## A Review of the Global Composites Market and Turkish Composites Market

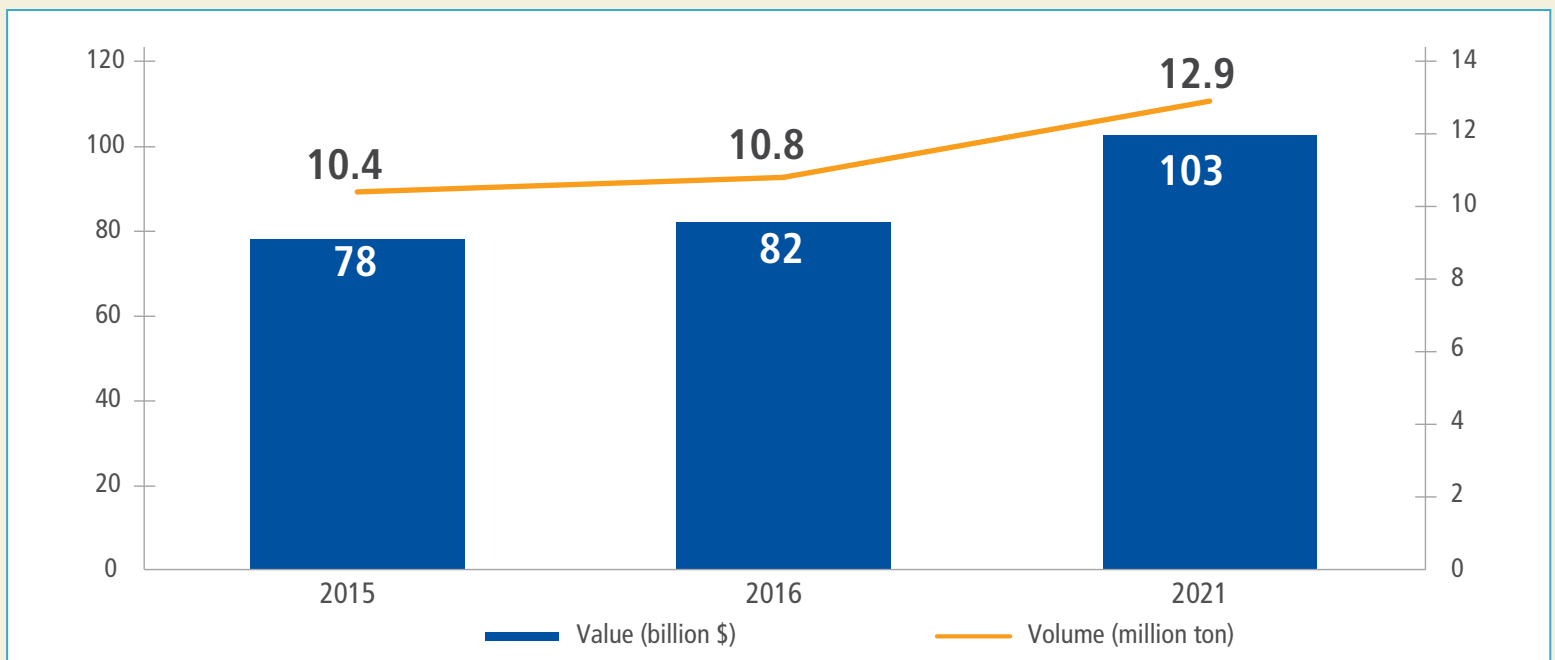
**İSMAİL HAKKI HACIOĞLU**

**General Secretary, Kompozit Sanayicileri Derneği**

### The Global Composites Market

In 2016, the volume of the global composites market reached 10.8 million tons. The market volume, which was 10.4 million tons in 2015, is expected to reach 12.9 million tons by 2021. The average year-on-year volume growth rate throughout the period between 2016 and 2021 is expected to be roughly 4 percent. In 2016, the value of the global composites market hit \$82 billion. The value of the market, which amounted to \$78 billion in 2015, is expected to reach \$103 billion by 2021. The average year-on-year value growth rate throughout the period between 2016 and 2021 is expected to be roughly 5 percent.

Figure 1. The global composites market in terms of value and volume



A review of the applications of the composites industry within the global composites market reveals that the top four industries in terms of volume are transportation, construction and building, electrical and electronic goods and the pipe and tank manufacturing industries. In terms of value, the top four industries which employ composite products are transportation, construction and building, electrical and electronic goods and the defense and aviation industries. The most remarkable industry among these is the defense and aviation industry. The defense and aviation industry, which ranks in final position in terms of volume, with only 0.4 percent by mass, is among the top three industries in terms of value, representing 13 percent of the market, indicating the high value-added nature of the composite products employed within the industry.

Figure 2. Distribution of the global composites market by application in terms of volume in 2016

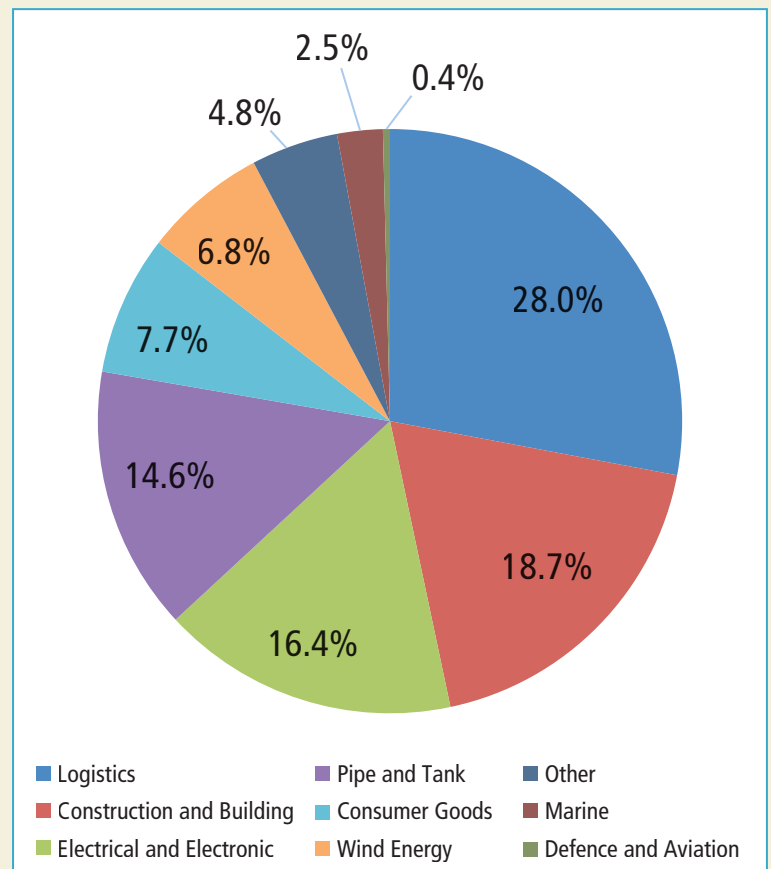
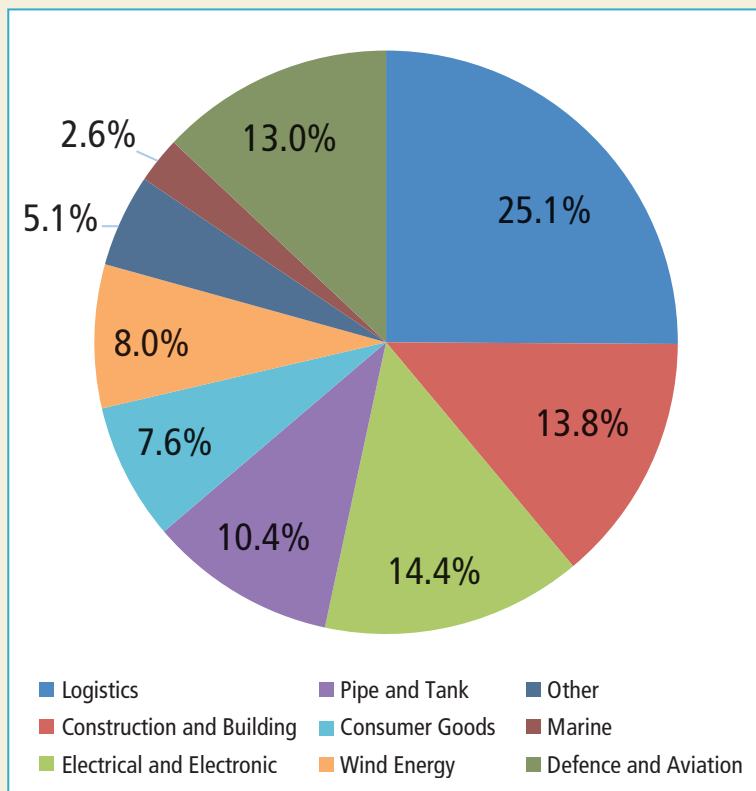


Figure 3. Distribution of the global composites market by application in terms of value in 2016



The development of the composites industry will vary depending on the relevant fields of application. While the growth rate in the maritime, construction and building and consumer goods industries is expected to see a growth rate of 0 to 2 percent; the growth rate in electrical and electronic goods, pipe and tank manufacturing, transportation and aerospace and aviation industries is estimated to be from 3 to 7 percent. The sale of composites to the wind power industry is expected to grow by 15 to 20 percent on a year-on-year basis with an optimistic perspective.

It is noted from a review of unit prices in 2016 that the composite materials used in the defense and aviation industries have a high added value.

Table 1. Unit value per kilogram of composite materials by the industry, where composite material is used (\$)

	Transportation		Defense and aviation	Electrical and electronic goods	Construction and building	Pipe and tank manufacturing	Wind power	Consumer goods	Maritime and other
	Automotive	Other							
Average price (\$/kg)	6.7	6.7	45	6.6	5.5	5.3	8.8	7.4	7.9
Industry penetration dynamic	↑	→	↑	→	↑	→	→	→	→

In 2016, the Asian market, with 5.2 million tons, held the largest market share, accounting for 47 percent of the global market in terms of volume and 43 percent in terms of value. The Chinese market alone accounts for 28 percent of the global market, or 3.1 million tons. The North American market, with 2.8 million tons, accounted for 26 percent of the global market in terms of volume and 30 percent in terms of

value. The European market accounts for 21 percent of the global market in terms of both volume and value. The African and Middle Eastern market, with 0.4 million tons, accounted for 4 percent of the global market in terms of both volume and value. Finally; the South American market accounted for 2 percent of the global market, at 0.2 million tons.

Table 2. Geographical distribution of the composites market in terms of volume and value in 2016

2016	North America	Europe	China	Outside China Asia	Africa and Middle East	South America	Total
Volume (Million tons)	2.8	2.3	3.1	2.1	0.4	0.2	10.9
Volume (%)	26%	21%	28%	19%	4%	2%	100%
Value (Billion \$)	24.6	17.2	20.5	14.8	3.3	1.6	82
Value (%)	30%	21%	25%	18%	4%	2%	100%

The global composites industry is predicted to grow by 4 percent on average on a year-on-year basis between 2016 and 2021. It is predicted that growth in China, which is expected to grow by 7 percent, will account for 60 percent of the said overall growth rate. Such a growth rate is larger than China's overall growth rate between 2010 and 2016, which was a combined total of 57 percent. The rest of the Asian market will grow by 3 percent on a year-over-year basis in the forthcoming

period, contributing to the overall growth by 17 percent. It is predicted that the North American market will grow by 2 percent on a year-on-year basis, accounting for 11 percent of overall growth in the forthcoming period. The forecast for the growth rate on a year-on-year basis of the European market is 1 percent for the period between 2016 and 2021. Thus, the European market will maintain its share of 6 percent within overall growth. The share of the Asian market constantly



grew between 2010 and 2016, as its market share, which was 45 percent in 2016, grew to 47 percent in 2015 and 2016. It is expected to attain 52 percent by 2021.

In Table 3, the distribution by industry of the composites market in terms of volume is examined. It is indicated that, in terms of volume, some 67 percent of the composite materials used in the transportation industry are used in North America and Europe, while 60 percent of the composite materials used in the construction and building industry were used in North America and China, and that North America holds a dominant share in terms of the use of composite materials in the maritime industry as well as the defense/aviation industry.

Table 3. Distribution of the composites market by application in terms of volume in 2016

	North America	Europe	China	Other Asian Countries	Other
Transportation	34%	33%	14%	14%	5%
Construction and building	31%	17%	31%	16%	5%
Electrical and electronic goods	18%	14%	39%	27%	2%
Pipe and tank manufacturing	20%	12%	42%	19%	7%
Consumer goods	22%	19%	25%	30%	5%
Wind power	11%	23%	38%	16%	13%
Other	23%	18%	30%	27%	3%
Maritime	52%	25%	6%	10%	7%
Defense and aviation	57%	22%	8%	10%	4%

In 2016, the most commonly used composite materials in terms of volume worldwide were thermoset resins as matrix and glass-fiber, a low added value product, as a reinforcing agent (Table 4). Furthermore, the distribution of the processes employed to derive composite materials is provided within Table 5.

Table 4. Value chain by basic materials in the composite industry in 2017 (volume %)

VALUE CHAIN IN 2016 (BY BASIC MATERIALS)						
RESINS (Matrix)		FIBERS (Reinforcing member)				
THERMOSET	THERMOPLASTIC	LOW ADDED VALUE	HIGH ADDED VALUE			
		GLASS-FIBER	CARBON-FIBER	ARAMID-FIBER	NATURAL FIBERS	OTHER
62%	38%	87%	11%	0.70%	0.50%	0.80%

Table 5. Value chain by process methods in the composite industry in 2017 (volume %)

VALUE CHAIN IN 2016 (BY PROCESS METHODS)											
FINAL TREATMENT METHOD	MANUAL PROCESSES		PRESSING PROCESSES			INJECTION PROCESSES		CONTINUOUS PROCESSES			
PROCESS DESCRIPTION	HAND LAY-UP	SPRAYING	PREPREG	TPC PRESS MOLDING	SMC-BMC	THERMOPLASTIC INJECTION	RESIN INFUSION	PULTRUSION	PLATE PRODUCTION	SPINDLING	OTHER
% (VOLUME)	12%	11%	9%	3%	12%	23%	10%	3%	3%	9%	5%

## Turkish Composites Market

The Turkish composites industry, which is comprised of some 700-800 companies at least partially engaged in the composites business, 180 of which are medium- and large-sized companies, employing roughly 8,200 people, produces products with a high added value.

Currently; the value of the Turkish composites market has reached €1.4 billion (\$1.65 billion) and the volume of the same has reached 265,000 tons. The composites industry in Turkey is growing by way of gaining market share from replacement materials as it does in the rest of the world.

The composites industry is growing in Turkey at a higher rate than it is in Europe and elsewhere in the world. The Turkish composites industry has developed rapidly, and in the long term, as the case is with the other industries, it has developed in line with global economic developments, leveraging the effects of the dynamics within the country. The industry grew by 8 to 12 percent on a year-on-year basis in Turkey over recent years in line with then-prevailing economic conditions. The growth rate in 2016 has been 6 percent.

A review of composites consumption per capita, which is globally recognized as a "Development Criterion", reveals that Turkey is looking at considerable opportunities in respect of the composites industry. The said amount, which ranges between 4kg and 10kg across the world, is 3.4kg for Turkey. The average unit price, which is around €6.9/kg (\$8.1/kg) globally, is roughly €5.3/kg (\$6.2/kg) in Turkey. Both the consumption amount per capita and the average price in Turkey are considered advantages for the country in the forthcoming period.

In terms of volume; composite products are most commonly used in pipe and tank infrastructure (36%), the transportation and automotive (24%) and construction and building (21%) industries in Turkey (Table 7). The acceleration of the production in Turkey of high-tech products is expected to increase the amount and the percentage of composite materials used, particularly wind power, aerospace and aviation as well as the electrical and electronic goods industries.

**Table 7. Comparison of distribution by industry of composite materials in the world (%)**

	World (%)	Europe (%)	Turkey (%)
Transportation and Automotive	28	30	24
Construction and Building	19	20	21
Electrical and Electronic Goods	16	14	5
Pipe and Tank Infrastructure	15	13.5	36
Consumer Goods	8	3	3
Wind Power	7	12	7
Maritime	3	5	2
Defense and Aviation	0.5	0.5	-
Other	3.5	2	2

**Table 6. Composites consumption amounts per capita in the world and in Turkey (gr)**

COUNTRY	GR PER CAPITA
USA	7,100
Japan	5,850
Germany	9,100
Austria	4,000
France	3,900
UK/ Ireland	2,300
Spain / Portugal	3,100
Benelux	10,600
Scandinavian countries	4,400
Italy	4,700
Greece	3,250

Also, the other composite applications with high growth potential include carbon fiber applications, pipe applications, automotive and transportation, greenhouse applications, solar panels, construction reinforcements, window and door applications, Polypropylene Random Co-polymer (PPRC) heating pipes (for boilers), engineering plastics and maritime applications.

There is a considerable distance Turkey must cover with respect to the production of machine-driven and high-tech products.

Glass-reinforced plastic (GRP) pipe production, the growth rate of which has reached 36 percent, leveraging demand in Turkey and in surrounding countries, will continue being the driving force of the Turkish composites industry. Pultrusion, hot press molding (HPM) roll-up - hot press molding compound (BMC) and thermoplastic injection processes are expected to increase their market shares in the forthcoming period. Resin transfer molding (RTM) will continue its growth especially in wind power, maritime, automotive and transportation as well as the water slide industry.

Composite materials enjoy an advantageous position relative to the conventional materials of steel, aluminum and metal alloys for their high level of strength, light weight, design flexibility, capability of maintaining their form and functionality, electrical insulation, long service lives due to their being stainless and corrosion-resistant, the ability they offer to mold numerous parts which are monitored in conventional materials into a single piece instead of being designed in multiple pieces and subsequently assembled, as well as the ability to apply the desired color to the product during molding and to use the same for a long period of time without the need for maintenance, and the fact that the equipment chosen for production is cheaper irrespective of the selected molding method. Hence, over 50,000 successful applications that have so far emerged. The growth of the composites industry and the increase in the export levels of the same will enable Turkey, which produces a considerable portion of the relevant raw materials, to gain an advantage in global competition.

State-sanctioned market creation efforts such as the most recent wind power plant tender will accelerate the growth path of the industry, and will offer significant advantages to the companies that operate in the industry.

The composites industry falls into the scope of the chemistry industry on account of polyester, vinyl esters, epoxy and similar other resins being the main raw materials of thermoset products; into the scope of the plastics industry on account of polyamide (PA), polypropylene (PP), polycarbonate (PC) and other similar thermoplastics being the main raw materials of thermoplastic products; into the scope of the textiles industry on account of the technical textiles that are manufactured by way of the weaving and knitting of glass fibers, carbon fibers and aramid fibers; into the scope of the glass industry due to glass fiber production and certain other industries on account of the finished composite products that are employed in automotive, defense, aviation, construction, sports, entertainment, consumer goods and other similar industries.

The growth course of the composites industry is generally above that of global economic growth. This course will also remain unchanged in the forthcoming period.

The composites industry is a crucial industry for Turkey, since it produces high added-value products and composites are the materials of the future. It would be useful for governments, local governments, investors and industrialists to demand and prefer lighter composite material alternatives with longer service lives and higher strength, which offer more contemporary solutions, both for the benefit of such governments, local governments, investors and industrialists and for the benefit of the national economy. Currently, a decrease in the amount of energy and fossil fuel consumption in both the aviation and aerospace industries and the automotive industry is entirely and directly connected to the penetration into those industries of composite materials. It is estimated that this process will develop further, serving the interests of the composites industry, being an





industry that offers inputs to and generates solutions for almost all other industries.

In that regard; it is considered that, as composite materials are used more effectively and prevalently in Turkey, composites production in Turkey will also be able to grow in high added-value industries; that, as the production of advanced composites becomes prevalent in Turkey, Turkey's export potential to not only Europe but also the entire world will increase, and the industry will contribute to covering Turkey's trade deficit.

Glass fiber (87%) and carbon fiber (11%), currently the most commonly-used reinforcement materials in the world, are both produced in Turkey. In respect of resins; while unsaturated polyester resin and vinyl ester resin are produced in Turkey, epoxy resins and thermoplastic resins are imported. Styrenes, phtalics, maleics and glycols, which are used for unsaturated polyester production, are not produced in adequate volumes in Turkey, so the need for the said items is covered entirely by way of imports. As the production of technical textiles, which are used for composite production, has grown in Turkey, the industry is now able to cover all its needs from the domestic market. The figures indicate that the composites industry currently exports some €250 million (\$294 million) worth while it imports some €250 million worth.

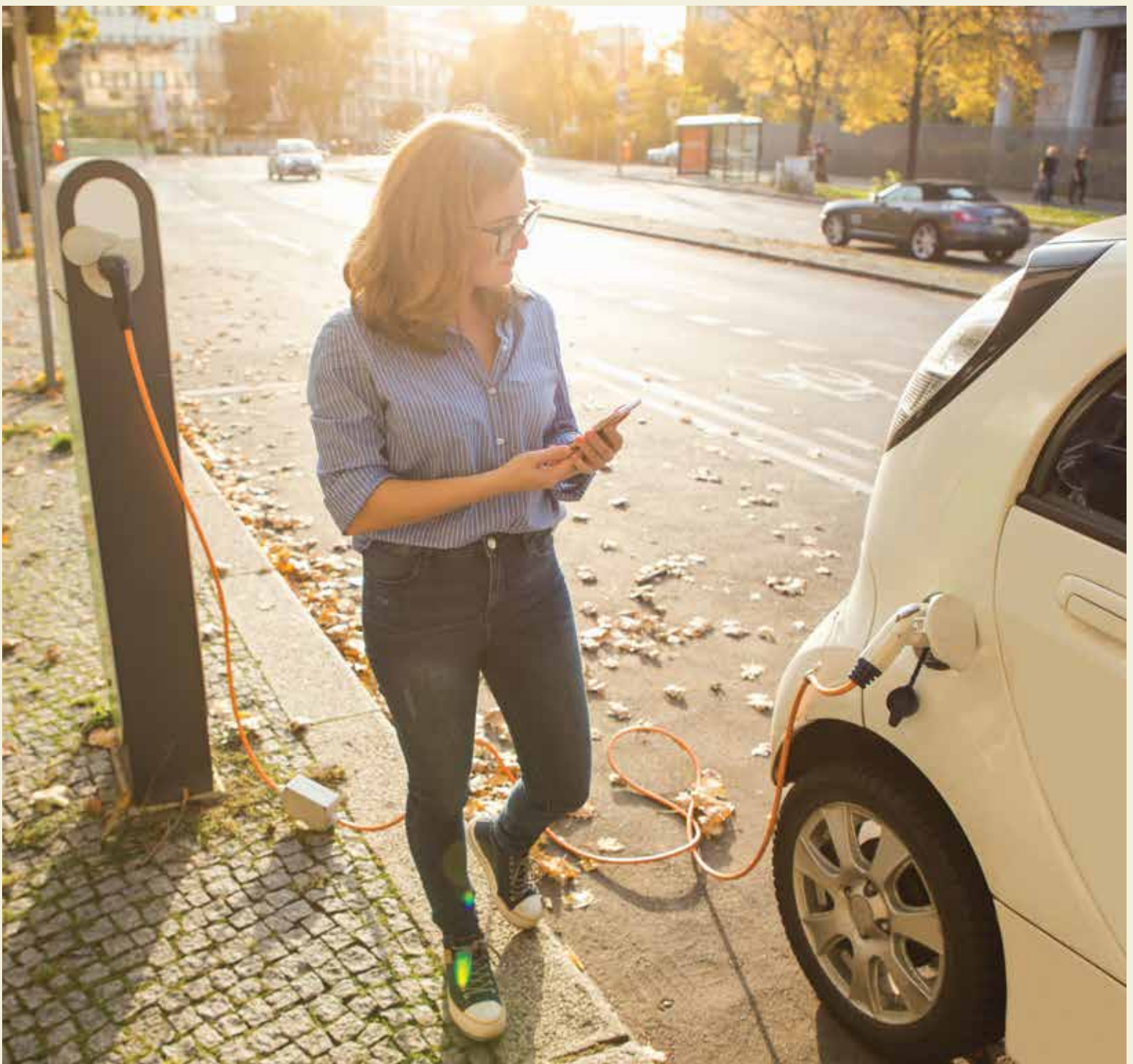
The Turkish composites industry, which imports the chemical raw materials needed and exports the reinforcing materials and resins as well as technical textiles and finished products produced in Turkey, and which, therefore has helped balance foreign trade, and has gained a reputation in the international arena for the Turkish companies that undertake and carry out major contracts worldwide. The most substantial indicator of the industry's position is the fact that Turkey has been announced as the Country of Honor at JEC 2013 Paris, the most prominent international event in the industry, which was held in Paris between March 12 and 14, 2013.

The composites industry exports goods both directly and indirectly. While directly exporting the raw materials, industrial intermediate goods and finished products produced thereby through contracts awarded and projects undertaken, the industry also indirectly exports its production outputs as parts of each automobile, bus, boat, bathtub etc. exported. The industry exports its production outputs essentially to European countries, Russia, the Turkic Republics, the Middle East and North Africa. Endeavors to increase the number of export destination countries and to cover new markets are increasingly being carried out. Certain companies in the industry export their products all over the world, including the United States and even to Far Eastern countries.



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Electrification, shared services and autonomous driving are key trends shaping the future of mobility.





## Towards Sustainable Mobility – Trends in Tire Reinforcement

**BAHADIR OLKUN**

**Technology Director, Brisa**

The 21st century has been transformational from several perspectives. From our types of accommodation to the way we commute to work, and from shopping to communication we have witnessed breathtaking change in our daily lives by nature and by definition. This is also valid for the world of transportation. Connectedness, digitalization and sustainability have turned the transportation of individuals into a comprehensive concept of “mobility”.

Electrification, shared services and autonomous driving are key trends shaping the future of mobility. En route charging stations, extending the usage of ride sharing apps across the nation, and hard talks about how to regulate autonomous vehicles are becoming issues of daily life. Consumers are changing their spending patterns from “ownership” towards “service uses”. As mobility evolves, the whole transportation infrastructure as well as vehicle components are following.

### Car Sharing:

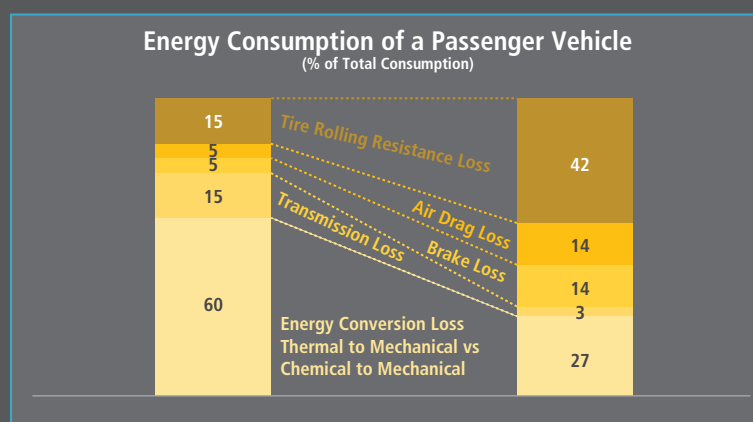
To keep the pace, tire technology is experiencing a rapid change as the sole element of vehicle-road interaction. As passengers turn into service users from being the owner of the vehicle, vehicle utilization rates will increase dramatically from today’s mere 5 percent level. This puts emphasis on total drivetrain reliability. Tires will play an important role.

As shared car service providers will manage a remote pool of assets, total trouble-free operation will be expected from tires. A punctured tire will upset users the most while keeping the vehicle idle until proper maintenance. This will create additional demand for run-flat tires. To withstand heat generated during run-flat driving, these tires feature body ply material with superior adhesion properties at higher temperatures. Until recently, and still extensively, rayon yarn has been used in run flat tires thanks to its excellent thermal properties. Rayon is being replaced by polyester with improved heat resistance to sustain certain adhesion at higher temperatures. This brings considerable cost improvement and promotes run-flat technology expansion on standard cars, which we call the “vehicle-free run-flat” concept.

### Electric Vehicles (eV):

Rising environmental concerns, leaps in battery performance, and significantly lower operational costs have put eVs in strong competition with petrol cars. Miles-per-charge is still a major challenge, putting overall vehicle energy efficiency into focus. As the inefficiency of combustion is eliminated, every element, from drivetrain to air-conditioning, will be expected to function ever more efficiently. This is so valid for tires. A typical passenger car consumes 15 percent of fuel due to tire rolling resistance loss. As seen in chart 1, this portion will almost triple for an eV, increasing the demand for ultra-low rolling resistance tires.

Chart 1 -Passenger Car Energy Consumption (% of total consumption)



It is all about reducing inertia (tire weight) and the hysteresis loss of the tire structure. Apart from progress in compound technology, tire reinforcement will play an important role in both aspects. Body ply and cap ply materials with higher tenacity and smaller geometry will reduce total reinforcement weight. Hybrid cords have significant potential to secure optimized performance over a diversified range of mechanical properties. As cord geometry shrinks, less coating rubber is required, resulting in a further reduction in hysteresis loss.

Vehicle weight is another critical issue for eVs. While the specific energy (kWh/kg) of electric batteries are improving, the total weight of an eV is still 10–30 percent heavier than a petrol car depending on the required power and mileage range. Increased vehicle weight shifts demand to extra load (XL) tires. Keeping the same tire dimensions, XL tires bear higher loads at higher inflation pressures. Considering sports eVs, with UHP (Ultra High Performance) tire fitment, compelling load and speed, tire reinforcement will be forced to its limits to balance the lightweight requirements and durability. Hybrid cords of Aramid with Nylon or Polyester will have increasing potential in terms of UHP tires for eVs.

### Autonomous vehicles – connected tires:

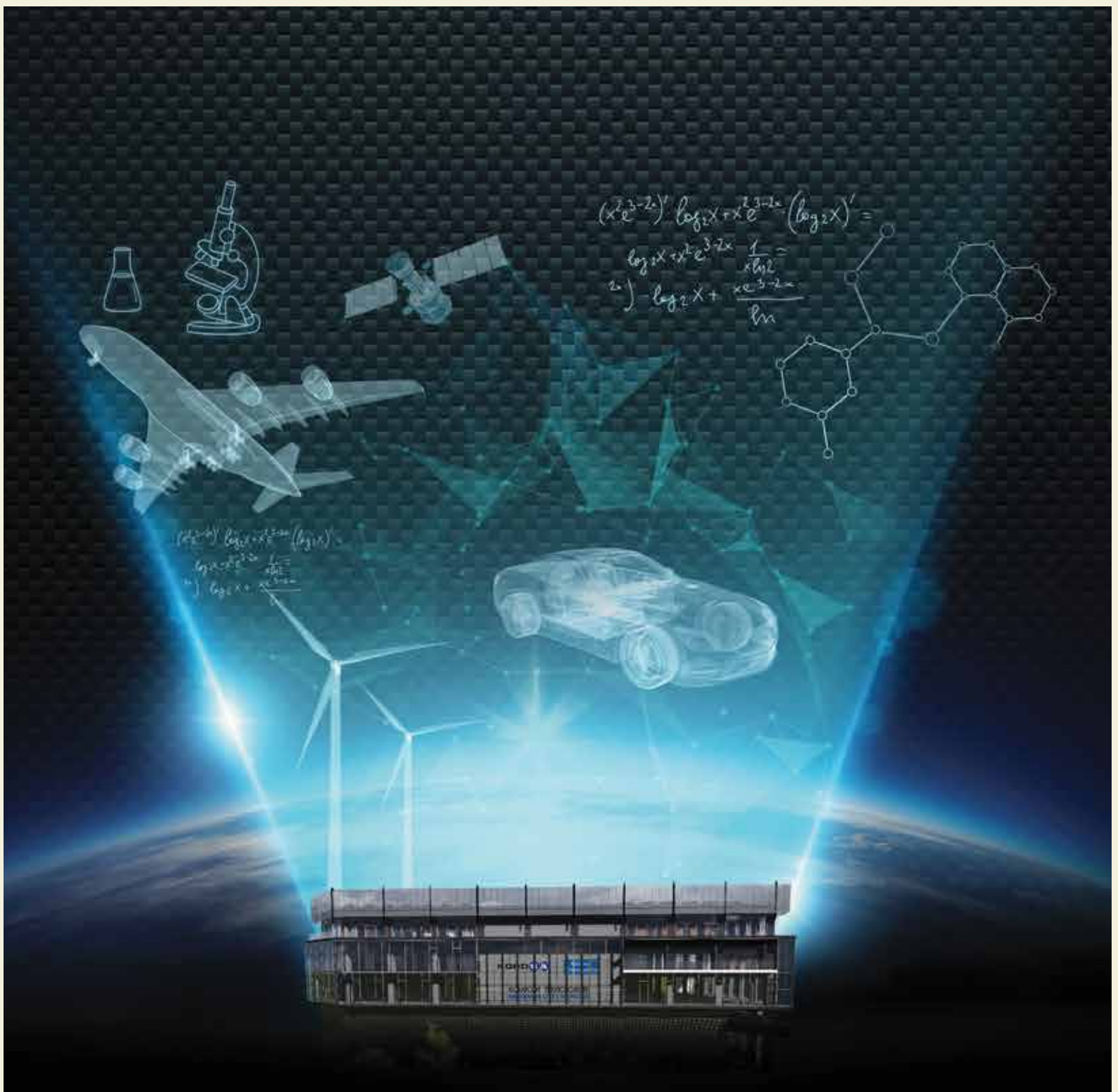
Human beings as drivers are the adaptive component of the whole vehicle system where the interpretation of road and traffic condition into driving regime is performed by the driver. Autonomous vehicles will take over the same operations with the help of peripheral sensors or trackers. Inflation pressure, tire wear level, tire temperature and even abnormal vibrations indicating a possible tire failure will be key information channeled from the connected tire.

Another aspect of autonomous vehicles is demand for continuous mobility. The occupants of a complete autonomous car will eventually become non-drivers, lacking the critical capability to replace flat tires en route. Similar to shared car operations, run-flat tires will be indispensable parts of the autonomous world.

In terms of safety, energy consumption and continuous service, tires will play a major role in the future of mobility. Environmental concerns, both public and regulative, will push users and vehicle manufacturers towards energy-efficient solutions. Reinforcement technology is expected to provide tire manufacturers with high performance and lightweight materials, not only improving vehicle energy efficiency but reducing the tire manufacturing carbon footprint as well.



The increased usage of improved raw materials in order to decrease ballistic protection equipment weight is expected to create new opportunities in the market.





## The Increasing Need for Life Protection Products

**ELİF ERDOĞAN**

### R&D Project Leader, Composite Technologies

The global market for ballistic protection is estimated to grow at above-average rates at a CAGR of around 5.5 percent from 2017 to 2020 and is forecast to be worth \$11.2 billion by 2022.

The ballistic protection market can be segmented by geography (Americas, APAC, EMEA), by type (body armor, vehicular armor), sub-type (soft armor, hard armor, personal protective headgear), and by application (defense, homeland security, commercial) and there are good opportunities in the market thanks to the high protection budgets in many developing countries. The defense segment dominates the industry with a 75 percent share of the market and it is expected to maintain its position over the coming years.

America dominated the defense market with a share of around 44 percent of it. Its military expenditure was \$1.8 trillion in 2014, accounting for 34 percent of the total<sup>(1)</sup>. In 2015, the US House of Representatives allocated a defense budget of \$585 billion which accounts for 54 percent of the total federal discretionary spending. This resulted in a high market share, and it is expected to maintain its position due to the huge investments in this region. North America is followed by Asia-Pacific and Europe. Increasing military spending by China and India as part of their geo-political strategies is expected to further complement Asia-Pacific market growth<sup>(2)</sup>. However, due to the global economic slowdown, leading spenders in the world, including the US, France, Germany, and the UK have cut spending in various defense sectors such as space, aircraft, and vehicles.

There is an increased demand of ballistic protection products like helmets, armored vehicles, and bulletproof vests: the three main categories in the ballistic segment. The soft armor segment is expected to account for 30.5 percent of the market, followed by the hard armor segment, with a share of 29.7 percent. While protective headgear and clothing account for 21.6 percent and 14.1 percent of the market respectively, the remaining 4.1 percent is accounted for by boots<sup>(3)</sup>.

The increased use of soft body armor (bulletproof vests) is an accelerator for the market which is designed to improve soldier's

survivability and protect army personnel and special police task forces. It is expected to reach a value of \$3.7 billion by 2023. Vehicle armor is another significant contributor within the ballistic protection market and expected to undergo a considerable growth rate over the years thanks to its excellent capability to withstand high-piercing ballistic impact. Not only these concerns, but also increasing competition between countries to demonstrate their capabilities is also expected to fuel market growth.

Investments in R&D focusing on the soldier's comfort, the load he carries and enhanced personal protection will result in the augmented use of soft body armor.

### There are two constraints hindering market growth;

- 1- The high cost of ballistic protection equipment
- 2- High equipment/protective helmet and vest weight causing immobility of the vehicle/soldier

The increased usage of improved raw materials in order to decrease ballistic protection equipment weight is expected to create new opportunities in the market. Therefore, companies are demanding lighter protective solutions, thus driving raw material companies' product development and creating competitiveness in life protection.

Equipment weight reduction is the recent trend among market players. At the beginning, a lot of effort was put into conventional materials like steel, fiberglass (E- & S2-), and NY6.6 in manufacturing them. However, due to growing concerns and increased demands in terms of mobility and flexibility, many manufacturers have been forced to use high performance materials like ceramic, titanium, aluminum, and aramid fibers, which demonstrate outstanding strength-to-weight properties, and a high tenacity and ballistic performance.

Our aramid prepreg EF14 is an intermediate raw material used in helmets, body armor and vehicle panels production with the simultaneous application of appropriate heat and pressure so as to increase the protection level against heavier and more lethal threats like high-speed fragments as well as high-caliber rifle bullets. Aramid is fiber in which the fiber-forming substance is a long-chain synthetic polyamide in which at least 85 percent of the amide linkages are attached directly to two aromatic rings. Aramid has a more polar chemical structure when compared to UHMWPE. Therefore, it allows other substances to attach themselves to the aramid. This allows the aramid fiber to be more chemically active than UHMWPE. In addition to the polarity, its high young modulus (stiffness) & low elongation at break compared to carbon or glass, resistance to strong organic solvents, good resistance to abrasion and cutting, resistance to thermal degradation, and low flammability increase the use of Kevlar fibers in life protection every passing day.

As previously mentioned, the ongoing race is to develop life protection products that stand up to complex threats and ultimately save the lives of humans while providing flexibility and comfort. It is obvious that the industry dynamics are changing. Increased protection ballistic level demand will increase the usage of lightweight materials compared to normal.

### Ballistic, Stab and Spike Levels

A bulletproof vest is not designed to protect against any bullet, and body armor is available at different levels of protection. These standardizations have been carried out by many agencies. However, the US National Institute of Justice (NIJ) and the UK Centre for Applied Science and Technology (CAST, formerly HOSDB) are the two most important in the industry. NIJ and CAST are the world leaders in bullet and stab testing, respectively. In addition to this, any armor that meets the standard of one institution will meet the requirements of its equivalent.

## Ballistic Levels

What strength of attack each level of body armor will protect against is determined by ballistic levels. The higher levels can protect against the attacks outlined for lower levels, but will still only protect up to and

including the threats outlined below. Body armor incorporates bulletproof, stab-proof, and spike-proof vests, each with their own levels of protection and testing methods. The levels of protection for body armor are as follows:

Table 1 Body Armor Protection Levels<sup>(4)</sup>

Threat	NIJ Level IIa	NIJ Level II	NIJ Level IIIa	NIJ Level III	NIJ Level IV
	Areal Density				
	3.5 kg/m	4.2 kg/m	5.9 kg/m	25.9 kg/m	32.5 kg/m
	Thickness				
	4mm	5mm	6mm	15mm	20mm
.22mm short	x	x	x	x	x
.9mm	x	x	x	x	x
.45mm	x	x	x	x	x
.380mm	x	x	x	x	x
.38mm	x	x	x	x	x
.22mm long		x	x	x	x
.44 Magnum			x	x	x
.30 Carbine				x	x
5.56mm				x	x
7.62mm NATO				x	x
.30-06				x	x
.30 Armour Piercing (M2 AP)					x

The threat levels for stab proof vests are standardised as follows:

Table 2 Stab Proof Vest Protection Level<sup>(4)</sup>

	KR1		KR2	
	Knife Resistant Level 1		Knife Resistant Level 2	
	E1	E2	E1	E2
Energy Level	E1	E2	E1	E2
Energy (joules)	24	36	33	50
Velocity	5 m/sec	6.2 m/sec	5.9 m/sec	7.3 m/sec
Total Missile Mass	1.9 kg	1.9 kg	1.9 kg	1.9 kg
Maximum Penetration	7mm	20mm	7mm	20mm



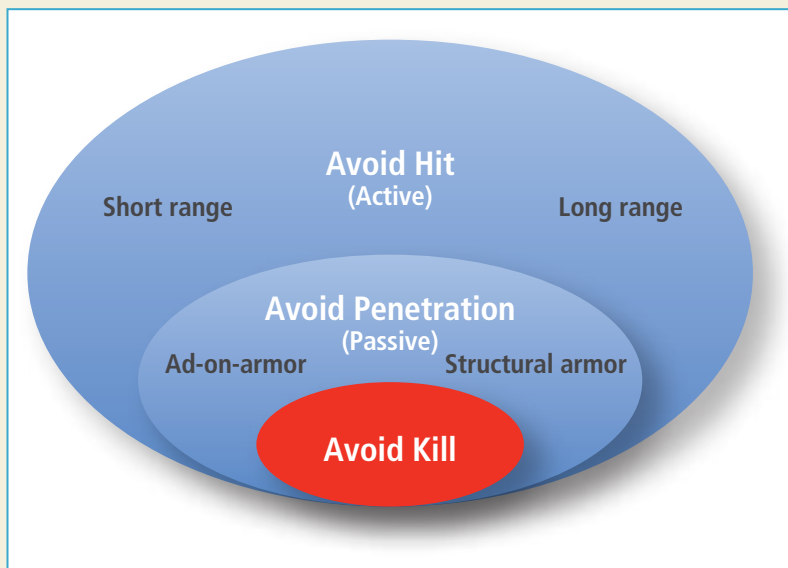
**CAST will only certify spike protection in addition to stab protection.**  
**The threat levels for spike proof vests are standardised as follows:**

Table 3 The threat levels for spike proof vests<sup>(4)</sup>

	KR1 & SP1		KR2 & SP2	
	Knife Resistant Level 1 & Spike Protection Level 1		Knife Resistant Level 2 & Spike Protection Level 2	
Energy Level	E1	E2	E1	E2
Energy (joules)	24	N/A	33	N/A
Velocity	5.0 m/sec	N/A	5.9 m/sec	N/A
Total Missile Mass	1.9 kg	N/A	1.9 kg	N/A
Maximum Penetration	KR1=7mm, SP1=0mm	N/A	KR2=7mm, SP2=0mm	N/A

When we talk about vehicle protection, spall liners are used as add-on armor on vehicles. Here, the first aim is to avoid being hit, second aim is to avoid penetration. Spall liners made of light and advanced protection layers to help to protect a vehicle from the exposed threat.

Table 4 Steps of Protection Vehicle from Threat



**Armoring levels differentiate a lot:**

European Committee For Standardization Ballistic Levels	Bullet Type	Mass	Velocity	Other Standards
B4	• 9mm	• 124gr	• 427 mps	• NIJ IIIA
	• .38 Special	• 158gr	• 259 mps	
	• .357 Magnum	• 158gr	• 425 mps	
	• .44 Magnum	• 240gr	• 427 mps	
B5	• 7.62X33/.30 CAL Carbine	• 110gr	• 600mps	
	• 7.62X39/AK-47	• 123gr	• 715 mps	
B6	• 7.62X51 mm/M-80	• 149gr	• 838 mps	• NIJ III
	• .308 Winchester FMJ	• 150gr	• 838 mps	
	• 5.56X45mm/M-16/193	• 45gr	• 919 mps	
B7	• 30.06 AP (Armor Piercing)	• 166gr	• 869 mps	• NIJ IV

(1) <https://www.technavio.com/report/global-defense-ballistic-protection-market>  
(2) <http://www.grandviewresearch.com/industry-analysis/ballistic-protection-market>  
(3) The Global Body Armor and Personal Protection Market 2013–2023.  
(4) <https://www.safeguardclothing.com/support/nij-levels/>

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We sales people have outstanding stamina.  
But sometimes we feel tired...





## VAHE HANAMIRIAN

### Global Accounts and Marketing Director

#### The Story is Finished

We sales people have outstanding stamina. We run from one meeting to the other, go on long trips, wait hours at airports, have a long dinner in the evening and breakfast with another customer the next day. But sometimes we feel tired...

In one occasion we were travelling from one city to another and there were four of us in the car. We had a driver and I was sitting in the front. I was quite tired and nearly fell asleep. I could hardly keep up with the conversation at the back between Bulent and Peter. Peter was telling a joke to Bulent. The conversation went as follows:

PETER: One day two gentlemen visit London

BULENT: Yes

PETER: They decide to go to a pub

BULENT: Yes

PETER: They ask for two drinks

BULENT: Yes

PETER: Then the waiter [inaudible]

BULENT: Yes

PETER: Then they [inaudible]

BULENT: Yes

PETER: Finally they [inaudible]

BULENT: Yes

PETER: Bulent, the story is finished. Wasn't it funny?

BULENT: Sorry, Peter I am a bit tired and could not concentrate

PETER: No problem Bulent I will tell it again, we still have a long distance to our destination

BULENT: Ok, Peter thanks.

PETER: One day two gentlemen visit London

BULENT: Yes

PETER: They decide to go to a pub

BULENT: Yes

PETER: They ask for two drinks

BULENT: Yes

PETER: Then the waiter [inaudible]

BULENT: Yes

PETER: Then they [inaudible]

BULENT: Yes

PETER: Finally they [inaudible]

BULENT: Yes

PETER: Bulent, the story is finished again. Do you want me to tell it again.

BULENT: No, Peter, please tell it tomorrow in the morning at breakfast when I am fresh.

VAHE: Peter, please tell it when I am absent, I cannot listen to it a third time.

#### Duty Free Shop in the Middle of Nowhere

In Eastern Europe, they had highway hotels built for travelers. These were huge facilities quite far away from cities, with a limited number of rooms but with big restaurants to serve travelers who wanted to rest a few hours. The rooms were quite humble, with just a bed and shower, and the only TV was in the restaurant. As mentioned the restaurant was very big and if you wanted to watch the TV you had to sit very close to it - but TV programs were also in the local language. I rarely saw people staying in the hotel part and usually we were alone in the big facility.

Most of those facilities had a Duty Free Shop. There was a system that you could purchase various items when you showed a foreign passport. Those shops were also quite big, but there were a limited number of items to purchase.

Bulent, Peter and I liked playing chess. There was nothing to do in the room anyway. Nothing outside and the TV was in the local language. As there were three of us, we took turns as the time passed by.

But, on one trip, we had Nuri with us. He had joined the group as Technical Manager. He had not spent as much time as in the country and he also hated playing chess. While we were playing, he would walk around in the restaurant, trying to watch the few local TV channels, and go to the Duty Free Shop and come back to us:

NURI: Look I bought a bottle of whiskey - very cheap.

VAHE: (Trying to concentrate on the game) Good.

Later

NURI: Look I went to the shop again and bought this cheap watch for my daughter.

BULENT: Good.

Later

NURI: Look I bought some cheap perfume.

PETER: Good.

Later

.....

When we were leaving the next day, Nuri had difficulty trying to pack everything he had bought due to boredom in the bag he had also bought quite cheap from the shop!

The shopkeeper, on the other hand, had sold all his inventory and was very pleased.



An aerial photograph of a blue sports car driving on a paved road. The road is flanked by green grass and trees. A white coordinate system is overlaid on the image, with a vertical arrow pointing upwards labeled 'STRENGTH' and a horizontal arrow pointing to the right labeled 'LIGHTNESS'.

STRENGTH

LIGHTNESS

## THE BALANCE OF STRENGTH AND LIGHTNESS

As Kordsa, with our composite technologies we lightening the vehicles while decreasing the carbon emission to reinforce life.



# WE REINFORCE LIFE

## News

### Kordsa to Make Two Major U.S. Acquisitions



Kordsa has announced that in furtherance of its efforts to strengthen its already strong global leadership in reinforcement technologies, it has entered into a definitive purchase agreement to acquire two advanced composite technology companies in the United States. Following its Composite Technologies Center of Excellence investment, Turkey's first industry-university collaboration investment, Kordsa plans to acquire Fabric Development Inc. (FDI) and Textile Products Inc. (TPI), which provide advanced composite materials to the commercial aviation industry, through an investment of approximately USD100 million. With the acquisition, Kordsa will strengthen its position in the United States, as well as becoming a strong player in the commercial aviation industry supply chain, which is expected to grow by at least 10 percent annually over the next 5 years. The consummation of the acquisition is subject to customary closing conditions, including certain forms of U.S. government approval. Kordsa

expects to complete the acquisition in the first quarter of 2018.

Sabancı Holding CEO Mehmet Göçmen made a statement regarding the acquisition: "In line with our 'Sabancı of New Generation' approach, this acquisition will enable Kordsa to take an important step forward in advanced composite technologies, which is within our scope of future targeted industries. Kordsa will be among the major suppliers of the commercial aviation industry with this acquisition. This new step will ensure that Kordsa is a strategic supplier to key players in aerospace and civil aviation, particularly Boeing and Toray Composites Materials America Inc. This investment will contribute greatly to our innovation-oriented growth strategy at Sabancı Group while enabling our industrial companies to export technology as a part of our open innovation mindset. We will continue to work in an effort to strengthen the position of both our group and our country in global competition with our commitment to be 'Sabancı of Turkey', as much in the future as we are today."

Sabancı Holding Industry Group President Cenk Alper said in relation to the acquisition: "In an era of transformation in mobility services, the position and technology acquired through this purchasing decision will make an important contribution to the differentiation of our group companies. Following the announcement of our market entry strategy for composite technologies in 2013, we took the first step with the Composite Technologies Center of Excellence investment in 2016. In the wake of the approximately USD 100 Million investment we are about to undertake, we will have an important presence in the commercial aviation value chain and strengthen our position in the U.S. We plan to pursue additional acquisition opportunities while developing new technologies in Turkey and exporting to the world, with the aim of being a global player in composite technologies."

Kordsa CEO Ali Çalışkan expressed the following regarding the acquisition of FDI and TPI: "This investment will allow Kordsa, within our composite technologies strategy, to now reinforce the wings and fuselage of an aircraft, in addition to our legacy aircraft tire reinforcement capabilities. Following the consummation of the acquisition of FDI and TPI in Philadelphia and Los Angeles, Kordsa will operate on 4 continents with 10 plants. As Kordsa, we will continue to reinforce life and take firm steps forward."

### Kordsa Sponsored the 26<sup>th</sup> Quality Congress for "Leadership in Transformation"

Kordsa, which has pioneered change and transformation through its open innovation approach, sponsored the 26<sup>th</sup> Quality Congress of the Turkish Quality Association (KalDer). The main theme of the congress, held in Istanbul on Nov. 21-22, was "Leadership in Transformation", enabling companies to survive in the marketplace, protect and improve their market position in an age of transformation.

During the two-day congress, opening speeches were made by the Chairman of KalDer's Board of Directors Buket Eminoğlu Pilavcı and the Chairman of TÜSİAD Erol Bilecik, and many inspiring panels were organized in an effort to guide and motivate the companies participating in the congress.

KalDer, which has Kordsa CEO Ali Çalışkan as one of its board members, organizes the Quality Congress every year in order to shed light on the future of industry through speeches made by experts. Throughout the congress, this year's "Corporate Excellence and Management Systems Exhibition" was also opened to attendees.

At the congress, which lasted two days with the participation of over 2,000 attendees, estimable speakers and panelists took part in panels and special sessions with the topics "From Futurism to Reality: Transformed and Transformational Technology", "Valued Humanitarian Attitudes", "United Nations Sustainable Development Goals and Risks", "Worker Safety as the Main Factor in Sustainability", "Wellness in Business Life: Spiritual Ergonomics and Happiness", "The Future of Business", "The Transforming Face of Europe - Transformations and Effects" and "Quality as a Lifestyle".



## Kordsa's Investments Continue at a Great Pace Through Increases in Capacity

Kordsa held a groundbreaking ceremony for an additional factory line in İzmit, Turkey to increase polyester yarn capacity by 7,000 tons. In addition to this new polyester yarn line investment, Kordsa also held a groundbreaking ceremony for the "polypropylene monofilament" line in the field of construction reinforcement.

Kordsa, a Sabancı Holding subsidiary, the world's leading nylon and polyester yarn and cord fabric producer, carried out a groundbreaking ceremony to expand its polyester capacity at its İzmit plant in order to meet the growing demand. Following the completion of the building construction and upon the arrival of new equipment, Kordsa aims to have an additional polyester yarn capacity of 7,000 tons with an additional 3,500 m<sup>2</sup> area in the current facility by 2018.

Cenk Alper, Sabancı Holding Industry group president, emphasized Kordsa's success as the only global brand in the group and its leadership in innovation in his speech at the groundbreaking ceremony. Alper said: "We proudly witness the global success of Kordsa, one of the major ambassadors of

the Sabancı's vision. Kordsa's success story started 44 years ago in İzmit and today, Kordsa has turned into a world leader. Kordsa reinforces one out of every three automobile tires and two out of every three aircraft tires manufactured globally. To maintain our technology leadership and move it even further, our smart investments continue without slowing down. In the fast-paced digital world, Kordsa will strengthen its presence day by day with its innovative technologies and continue to reinforce life. I wholeheartedly believe in it."

Kordsa CEO Ali Çalışkan expressed his gratitude for the capacity increase and also shared the good news that the firm would also continue to expand its product line. Çalışkan said: "Kordsa's strong growth momentum continues. In 2017, we have globally adopted important investment decisions and strong business partnerships while reinforcing our success through domestic and international awards. We are proud to globally represent both our company and Sabancı Group as well as our country."

"This investment in İzmit, where we started our journey 44 years ago, is a major step for our global leadership. Kordsa's first R&D Center was also established in İzmit. The role of our İzmit factory in Kordsa's long-term expertise in reinforcement technologies and its market leadership is enormous. In 2016, we announced our \$30 million investment in additional capacity in our facilities in Turkey and Indonesia. With the new line at our İzmit plant, we will be able to meet the growing demand faster and more efficiently. I am glad to share with you that our new polyester yarn line in Indonesia is operational now. We have increased the polyester yarn capacity at this facility by 7,000 tons. This investment will strengthen our position in the Asia-Pacific market, in which we have been operating since 2007. With our intensive R&D efforts and open innovation mindset, we will continue to invest in developing innovative, value-added products that globally shape the industry."

Kadir Toplu, Kordsa's COO for the Europe, Middle East and Africa region, gave detailed information about the capacity increase as well as expansion in product range: "As Kordsa, we distinguish ourselves in the construction reinforcement market with easy-to-use products that provide durability and high performance. Now, we are expanding our product range with this investment in 'polypropylene monofilament', which is a new form of our synthetic fiber reinforcement product, Kratos. Following its launch in 2018, this product will offer both sustainable high performance for our customers with its durable characteristics as well as a cost advantage compared to its benchmarks in the market. We will provide this efficient and durable fiber reinforcement material both to Turkey and the European market. Kratos adds value to tunnel and infrastructure projects as well as providing a cost advantage which differentiates Kratos from its competitors. This is a new product that excites us thanks to all these features. We will continue to reinforce the world with our technology and products that change the rules of the game."



## Kordsa Talks About Digital Transformation at Textile 4.0 Conference

Kordsa participated in the Textile 4.0 Conference, which took place in Amsterdam on October 25-26, to share its practices in tire, construction reinforcement and composite technologies.

150 delegates from 31 countries attended the conference, organized by the World Textile Information Network (WTIN), to discuss new applications in the textile industry and discuss the impacts of Industry 4.0.

Over the course of two days, industry experts gave information about inspiring practices, opportunities and smart technologies in the industry. In a panel on digitalization in textiles on the first day, Kordsa talked about its mission to "reinforce life" with its 44 years of experience, and gave information about the technologies and digital transformation practices developed as a result of Kordsa's open innovation and sustainability approaches.





## Continental and Kordsa Join Forces to Create a New Adhesion System for Textile Reinforcement Materials



The tire divisions of Kordsa, a leading international supplier of textile reinforcing materials for the tire industry, and technology company Continental are working together on a new, sustainable adhesion system standard for bonding textile reinforcement materials to rubber based compounds. In the context of their collaboration in the development sector, the two companies have agreed to develop a technology in which the substances resorcinol and formaldehyde are replaced by more eco-friendly chemicals.

"Taking responsible action in the interests of our employees and of society as a whole forms a key component of our corporate strategy," said Dr. Boris Mergell, who heads up worldwide research and development of passenger car tires at Continental. "So we are constantly seeking new ideas to make our tire manufacturing processes as environmental friendly as possible. In Kordsa, we have found a competent development partner for adhesion systems who can contribute their extensive knowledge in the field of resorcinol- and formaldehyde-free bonding technologies. The high quality of the collaboration between Continental and Kordsa is also reflected in the test results obtained to date, which are very promising both in the laboratory and in test tires."

"We are therefore planning the progressive introduction of this technology in the production of our tires across all segments in what is a further substantial step toward greater sustainability. Numerous suppliers are currently working on solutions of their own and the complexity of the approvals process alone for all of the unique solutions could soon become excessive. That's why our approach in this collaboration is to make the technology accessible to other suppliers and competitors, thereby laying the foundations for a new adhesion system standard," Mergell added.

"In view of the critical fields of application, the use of resorcinol and formaldehyde represents a major challenge to the tire industry," said İbrahim Özgür Yıldırım, chief technology officer at Kordsa. "As 'The Reinforcer', we have been working to eliminate the use of resorcinol and formaldehyde since 2008, which is a reflection of our mission to develop better, more sustainable products for future generations. Being a keen supporter of open innovation practices, we have leveraged our deep knowledge and diverse expertise together with Continental and accomplished to make a change in the formula used in the dipping of tire cord fabrics.

"The final formulation is an eco-friendly alternative to the resorcinol-and formaldehyde-based adhesives which have been widely applied for more than 80 years. Reviewing our massive investments into research in this field and the results obtained, we are absolutely convinced that, in collaboration with Continental, we can make the new technology ready to become the new industrial adhesion standard for textile reinforcement materials."

## Kordsa Shares Insights at KalDer's 3<sup>rd</sup> Excellence Summit

Ali Çalışkan, Kordsa's CEO, participated in the "Agility and Innovation" panel at the Third Excellence Summit organized by KalDer Kayseri, on October 18 at Kayseri Chamber of Commerce.

The Excellence Summit, organized by KalDer's Kayseri Representative Office and attended by many business people as well as academics and students, took place on October 18, 2017.

Tire and construction reinforcement and composite technologies leader Kordsa's CEO Ali Çalışkan - who is also a member of KalDer - emphasized the importance of a flexible and simple management structure in developing innovative technologies, products and processes at the "Agility and Innovation" panel. In addition, Çalışkan explained in detail that Kordsa, with its open innovation mindset, has been working together with experts, companies, institutions and universities when necessary to attain successful, efficient and effective results.



## Kordsa Releases Third Sustainability Report

Kordsa, has released its annual sustainability report, which highlights the company's social, economic and environmental performance in 2016. Striving to "Reinforce Life", Kordsa's third sustainability report has been prepared in accordance with new standards released by the Global Reporting Initiative (GRI) in 2016. Kordsa is one of the first 100 companies worldwide to comply with these standards.

This year's sustainability report is the third by Kordsa and reflects its "Reinforcing the Future" mission and highlights its R&D activities in every market it operates, as well as its innovative products, technologies and processes, its relationship with its suppliers and customers, its energy emissions, waste and water management and biodiversity within the scope of environmental management.

Kordsa operates in accordance with international standards within the scope of the United Nations Global Compact, which the company signed in 2014. The sustainability report clearly reflects its global business model while also demonstrating its transparent and accountable management approach. The report, including the company's best practices, sets a priority for sustainability as the basis of the company's future-oriented strategies. The report also notes that Kordsa has been included in the BIST Sustainability Index together with 43 other companies listed on the Istanbul Stock Exchange for their superior corporate sustainability performances, and underlines the accident-free hour targets reached in the field under the guidance of its "Safety Experience Center", as well as highlighting its innovative technologies developed within the "Green Products" program and practices carried out within the scope of environmental management. The report also highlights how Kordsa's second R&D center at Composite Technologies Center of Excellence – a pioneering example of academy-industry collaboration in Turkey for the development of future reinforcement technologies – gained official ministerial approval as an R&D center.

Today Kordsa, which reinforces one out of every three automobile tires and two out of every three aircraft tires worldwide, is developing innovative technologies for more sustainable mobility. Reducing rolling resistance with its tire reinforcement technologies, Kordsa is producing composite technologies that will allow lighter automobiles. Thanks to its reinforcement technologies, Kordsa decreases fuel consumption, which is of great importance for the environment. Kordsa took part in one of the industry's foremost collaborations with Continental to produce safer and more environmentally friendly products.



## Kordsa at Composites Europe 2017



Kordsa, participated in the Composites Europe 2017 fair held in Stuttgart, Germany between September 19-21 this year. Kordsa presented its efficiency solutions for the automotive and aviation industries, which are two of the most common areas of usage for composite materials.

Kordsa participated for the second time in Composites Europe, one of the most important gatherings in Europe, which hosts thousands of visitors every year in the field of composite materials and equipment. Kordsa introduced its new technologies developed by combining its past experience of reinforcement with its R&D and open innovation vision. Kordsa's drone, bicycle and motorcycle chassis made of composite materials attracted a great amount of attention from visitors.

Kordsa, which presented its new revolutionary resin technology – shortening the curing process and reducing the curing time from 9 minutes to 3 minutes in the field of automotive composites – at the JEC Fair in March, introduced its new solutions especially for the aviation industry in Composites Europe.

Kordsa, with its solution-partner vision, also shared with fair participants how in addition to innovative and authentic prepreg, fabric and resin development works, it could provide customized services in subjects such as design, analysis, material libraries, and prototype manufacturing support in line with customer needs. The reinforcement giant also provided information about the Composite Technologies Center of Excellence, Kordsa's innovation and production center for the development of the composite technologies.

Kordsa continues to strengthen its commitment to composites technologies and take the lead in innovation by attending the most prestigious fairs of the industry.

## Kordsa Attended ITEC, the Niche Conference Focusing This Year on Reinforcements for Tire Performance



“The Reinforcer” Kordsa attended ITEC in Focus, which was held on September 13–14 in Akron, Ohio. This year, ITEC focused on reinforcements for tire performance. Kordsa was one of the sponsors of the conference, showcasing their brand and solutions to attendees.

The focus of ITEC 2017 conference between September 13–14 in Ohio was tire reinforcement this year, as it is critical to every aspect of tire manufacturing. Among the attendees there were decision-making chemists, designers, engineers, compounders, mixers, R&D teams, testing specialists, production managers and other professionals. ITEC attendees had the opportunities to listen to the speeches of conference speakers and interact with attendees and speakers during refreshment breaks and at the networking reception. Conference speakers shared the latest technologies, developments and trends in reinforcing materials, the interaction of materials with

rubber, compounding, machinery, chemicals, design and more.

Known as The Reinforcer, Kordsa attracted interest due to its unique and innovative solutions. Kordsa Reinforcers shared Kordsa’s ongoing collaborative hard work in harmony with its current customers and its best practices in finding innovative and sustainable solutions to its business partners’ issues both today and in the future. Attendees had the opportunity to take a first-hand look at Kordsa’s tire reinforcement solutions and to see how Kordsa is always a competent development partner who can contribute to their extensive knowledge.

## EU Funding of 3 Million Euro to Support Kordsa and Sabancı University Joint Project

The Composite Technologies Center of Excellence, jointly established by Kordsa and Sabancı University, is positioned as a technology hub that brings together R&D, innovation and production under one roof in composite technologies. The Directional Composites Through Manufacturing Innovation (DiCoMi) project, in which the Composite Technologies Center of Excellence is involved, has obtained 3 million Euro in funding from the European Union.

As a reflection of its vision to reinforce life, Kordsa has embarked on a joint venture with Sabancı University. Kordsa and Sabancı University will carry out the project within the Composite Technologies Center of Excellence, which has been officially registered as an R&D Center by the Turkish Ministry of Science, Industry and Technology and is both a pioneer in Turkey and an important example in the world with its academy-industry collaborative business model.

The Directional Composites Through Manufacturing Innovation (DiCoMi) project will be run by a joint consortium that includes Kordsa and Sabancı University and is supported by the European Union. Within the scope of this project, which will strengthen Kordsa’s global reinforcer position, systems, software and material development will be carried out in order to produce composite materials with 3D printer technology. The DiCoMi project, which will last 2 years, will enable both domestic and foreign qualified personnel to be exchanged between EU member countries and associated non-EU countries. The DiCoMi project will be carried out with the participation of 16 project partners from 11 countries under the Horizon 2020 program.



## Kordsa at Turk Kompozit 2017



Kordsa participated in Turk Kompozit 2017, organized by the Turkish Composite Manufacturers Association between 5-7 October in Istanbul. Kordsa participated in the event with a booth and two presentations, and shared its latest innovations and solutions in composites technologies with participants.

Organized by the Turkish Composites Manufacturers Association this year for the 3rd time, Turk Kompozit 2017 focused on production, processing and application methods in composite industry. Almost 200 brands had the chance to share with participants their technological developments as well as their products, solutions and applications during the 3-day event at İstanbul Lütfü Kırdar International Congress and Exhibition Center in Istanbul.

Kordsa’s latest innovations and solutions attracted great interest from attendees. The reinforcement giant exhibited the visual and structural composite parts it produces for various sectors at its booth together with a bicycle manufactured using Kordsa’s composite technology. Two of the many technical and commercial presentations at the event were made by Kordsa. These were entitled "Life Protection Products" and "Quick Cure Compression Moldable Prepreg for the Production of Visually Appealing Automotive Parts".



# WE REINFORCE LIFE

## CSR Projects

### University Team Wins Design Competition with Kordsa Materials



Kordsa provided composite material support for the production of an award-winning vehicle designed by Kocaeli University vehicle team Türk Mekatronik. The team won first place in the TUBITAK Efficiency Challenge Electric Vehicle Race's Design Category with its vehicle. The design of the vehicle's outer shell and inner console as well as building a realistic vehicle through integrating domestic electronic and mechanical components were major factors in winning the award.

The carbon fiber fabric produced by Kordsa was used throughout the whole interior, inner and outer door, chassis, suspension and instrument panel of the 2nd vehicle developed and produced completely by the Türk Mekatronik Team. The electrical vehicle was 3.5 meters long, 1.7 meters wide and 1 meter high. The team, which had previously produced a 430kg single-motor electric vehicle, succeeded in reducing the weight of the new dual motor vehicle produced with Kordsa's carbon fiber fabrics by 45 percent to 240 kg.

### Kordsa Continues to Reinforce a Sustainable Future

Kordsa is reinforcing the students of The YTU Wind Energy Club as part of its "reinforcing the future" mission. The YTU Wind Energy Club has completed the production of a vehicle "Bulut 17" that operates completely on wind energy. Its speed is variable according to the wind and it can run at a speed of 40-50 kilometers with over 80 percent efficiency. "

"Bulut 17" draws its energy from the wind with a 2 meter diameter diffuser and wings and transfers the energy generated by the wind to its wheels using a mechanical system. The YTU Wind Energy Club participated with "Bulut 17" in the Racing Aeolus races to highlight the importance of energy efficiency and renewable energy. Composite materials were preferred in order to lighten the vehicle and provide an advantage in the race. Kordsa once again sponsored with prepregs and composite fabrics produced by Kordsa used in the body, chassis, wing and diffuser sections of the vehicle.



### Kordsa Runs for Good at Istanbul Marathon



Kordsa participated in the 39th Istanbul Marathon for the fifth time. Kordsa, continuing its corporate social responsibility initiatives in an effort to reinforce the future, running for TOÇEV, a foundation that changes the lives of children and has been saying that "education is every child's right" for 23 years. 42 Kordsa reinforcers joined the marathon.

Kordsa also ran for the "İçerde Çocuk Var" (Children Behind Bars) project, to raise awareness for children who are in prison with their parents, at the Runatolia marathon,

### Kordsa Continues to Reinforce the Future of Children

Operating in tire and construction reinforcement and composite technologies from America to the Asia Pacific, Kordsa has once again renovated a school in Kocaeli, which is a reflection of its mission to reinforce life. Kordsa aims to contribute to the society in every country in which it operates and continues to reinforce the future of children through this renovation.

Eight classrooms, a staffroom, a sports hall, a library, an arts and technology room, a laboratory, and a cafeteria as well as a classroom for students with special educational needs were completely renovated with the participation of reinforcers from Kordsa's production facilities around the world. Both the reinforcers and the children enjoyed their time together during the renovation.



Continuing its corporate social responsibility efforts with the mission of reinforcing the future, Kordsa also renovated a school in Bogor region, where Kordsa facility in Indonesia is located.

Kordsa aims to reinforce the society of every country it operates. Kordsa reinforcers once again proves that they are committed to reinforce children and the future by renovating a school in Bogor, Indonesia. Students at the renovated school enjoyed various games and activities together with Kordsa employees. Kordsa will continue to reinforce the future through its social responsibility projects in the regions in which it operates.

# WE REINFORCE LIFE

## Awards

### Grand Award Presented to Two Kordsa Teams at the 20<sup>th</sup> Quality Circles Sharing Conference

Kordsa has been awarded the Grand Award in the category of quality circles at the 20th Quality Circles Sharing Conference organized by KalDer (the Turkish Quality Association). Group Flex, established for flex automation in Kordsa's finishing machinery and Group "Ip Koptu", established in an effort to reduce waste on aramid bending machines, were honored with awards at the ceremony held on October 11. The Quality Circle and Kaizen Awards were awarded this year for the tenth time. Kordsa received the Quality Circle Award for the seventh time since 2008.

### Kordsa Continues to Win Awards Worldwide

The leading firm in tire and construction reinforcement and composite technologies was among the 100 fastest-growing companies in Indonesia this year. It has been selected as "Best Employer" for two years in a row in Brazil. Kordsa was recently awarded the "Best Practices in Internship Programs" in Brazil, as well as the "Indonesia Most Powerful Companies (IMPCA) 2017" award. The selection was conducted by identifying the financial performance of companies listed on the Indonesian Stock Exchange grouped by industrial subcategory by the Economic Research Team. Using financial indicators, the research team then produced a list of candidate companies that added value to the economy.

Kordsa is also among the 150 Best Employers announced in the Você S.A. guide in Brazil. Kordsa got a special type of recognition known as "newcomer of the year" because among those companies which had applied for first time, it had the highest score of 80.5 in the IFT, an index measuring happiness at work.

Kordsa Brazil was recognized by Instituto Euvaldo Lodi as the best mid-size company in its internship practices in the industrial sector. Kordsa was honored with this award due to its internship initiatives, the opportunities provided to interns and its egalitarian approach towards its employees and interns. The award evaluates the intern development process, looking at criteria such as training, mentoring, initiatives and contributions to suggestions and continuous improvement, taking advantage of school and industry contributions, management practices and, in particular, the development and commitment of the company to the internship program and interns.

### Kordsa Wins the Third Prize in The Innovation Strategy Category at Turkey Innovation and Entrepreneurship Week

Kordsa received the third prize in the Innovation Strategy category at the Inovalig Awards held within the scope of Turkey Innovation and Entrepreneurship Week. Kordsa CEO Ali Çalışkan received the award from Turkish Economy Minister Nihat Zeybekçi and the president of the Turkish Exporters Assembly, Mehmet Büyükeksi. Kordsa also made a presentation on its successes and future goals in R&D and innovation at the event.

Kordsa Business and Market Development Director and Construction Reinforcement Business Unit Leader Murat Oğuz Arcan made a presentation about Kordsa's R&D and innovation success within the scope of Turkey Innovation and Entrepreneurship Week. Arcan emphasized that their journey, which started in İzmit 44 years ago, continued to this day across a wide geographical area from America to the Asia Pacific. He pointed out that Kordsa was the pioneering innovator of many products, processes, equipment types and business models.

### Kordsa Takes the First Prize in the Textiles Category at the 6<sup>th</sup> Private Sector R&d and Design Centers Summit

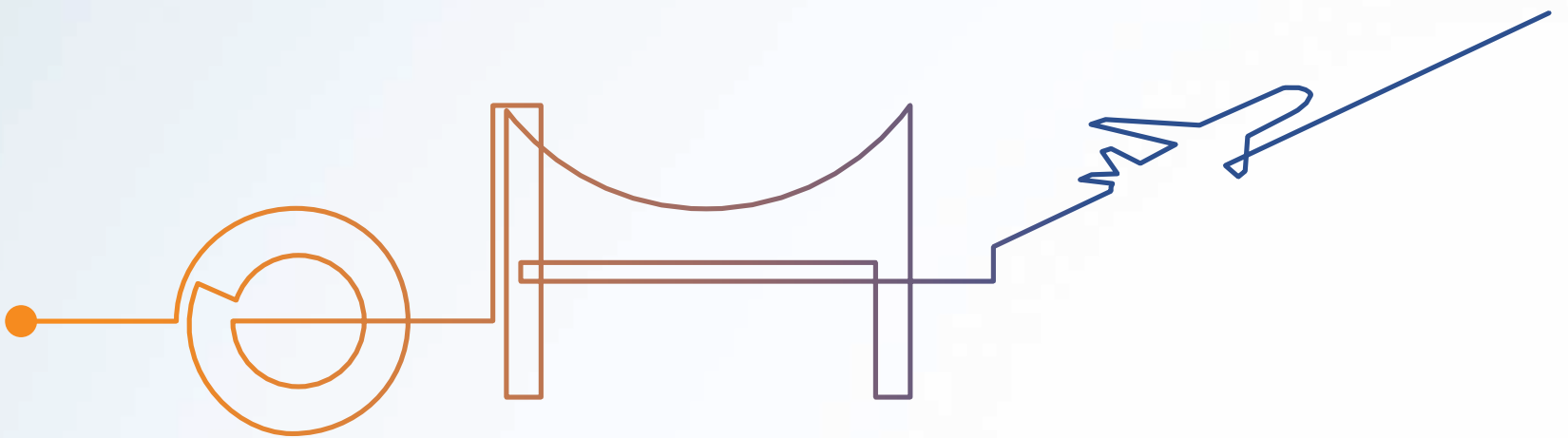
Kordsa was awarded first prize in the textiles category at a prizegiving ceremony carried out at the 6th Private Sector R&D and Design Centers Summit. Kordsa CEO Ali Çalışkan was given the prize by Turkish Science, Industry and Technology Minister Faruk Özlü.

Ali Çalışkan said of the award, "R&D and innovation form the fundamentals of our perspective. Our global collaborations and projects we carry out with our open innovation approach strengthen our title as 'Leader of Innovation'. Today, we are in a position to export technology to the world, and in the upcoming years, we will continue to proudly represent both our company and our country in the global arena. We thank the Science, Industry and Technology Ministry very much for this prize they have seen fit to give us. As the Kordsa family, we will continue unabated to strengthen life and to contribute to our country."

Following the prizegiving, the Science, Industry and Technology Ministry presented Çalışkan with a certificate certifying the Composite Technology Center of Excellence as an official R&D center. This center serves as Kordsa's second R&D Center.



# TRANSFORM THE FUTURE



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