THE REINFORCER

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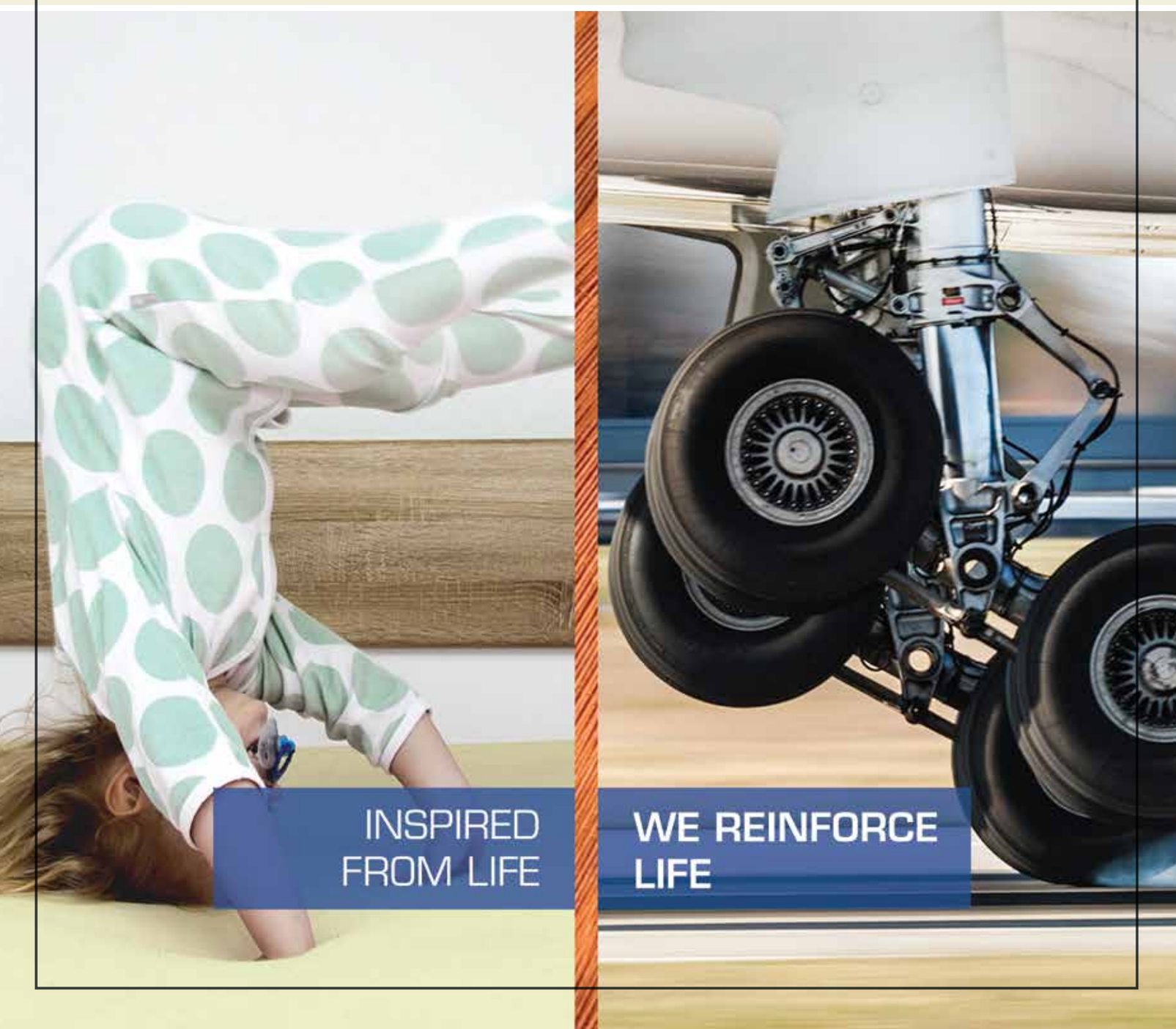
Determined to Create Value

KORDSA



INSPIRED FROM LIFE
WE REINFORCE LIFE

People are as strong as
they can hold happy moments together.

Inspired by those unique moments in life,
we are trying to make them permanent.

Because we believe that a sustainable future is possible
only by reinforcing the vehicles and structures
that carry us to those unique moments.

And we believe that we add value to life
as we increase and share our competency.

That is why we are reinforcing life all over the world.

KORDSA

THE REINFORCER

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As Kordsa, we know by heart that the real richness is the unique moments spent with family, friends and colleagues. We get inspired from these joyful, peaceful and secure moments in life and use this inspiration to protect, sustain and enrich those moments.

Foreword

ALİ ÇALIŞKAN

CEO

Dear Esteemed Partner,

Second half of 2018 have provided a significant milestone towards our goal to build a second Kordsa. With our strategic investments and game-changer technologies, past 6 months had been a period that we broadened our reinforcement abilities and the geography we operate in. With the acquisitions of Fabric Development, Textile Products and Advanced Honeycomb Technologies, we have taken firm steps to become a strong player in the supply chain of the growing aviation industry. We are capable of reinforcing the interiors, fuselages, wings and engines of the aircrafts; and yet we have set our eyes on the space!

We are now a bigger family operating in 11 production facilities with our almost 4.500 Reinforcers throughout 4 continents.

When your absence is felt, your presence is the essence and it makes a difference. That's true for Kordsa. We are the "invisible" Reinforcer. Although you do not see it, as Kordsa we are in every corner of life. Our signature is on the road you walk, on the tires of your car that you drive, on the plane you fly with... We strive to make the life safer, easier and more peaceful for the loved ones. As Kordsa, we know by heart that the real richness is the unique moments spent with family, friends and colleagues. We get inspired from these joyful, peaceful and secure moments in life and use this inspiration to protect, sustain and enrich those moments.

As you all know, our inspirations are translated into technologies at our two R&D centers. Both R&D Centers work to develop value-added and sustainable technologies that make a difference in all its business lines. As an output of these efforts, in our R&D Center in Composite Technologies Center of Excellence, we have developed and introduced a new fast cure press curable prepreg system, which is dicy free formulated against waterspot and whitespot problems. This is really a significant step for us, for this new generation press curable fast resin is a promising product, which enables the use of prepregs in volume car production. I am also proud to say that we have already started to produce sandwich panel press for aerospace interiors installation at the Center.

We are currently capable of weaving unidirectional and bidirectional fabrics in 4 different weaving types either plain, twill, harness satin or basket. Now, I am proud to share with you that our new composite weaving field of 1300 m2 plant in Izmit will come on-line at the end of this month. With the increased weaving capacity, we will meet the increasing market demand.

With the efforts of our R&D Center at Izmit plant, we become among the partners of yet another Horizon 2020 project which aims to demonstrate a set of innovative, cost-effective and sustainable solutions for efficient plastic recycling with 22 project partners from 11 countries. On the other hand, while we ascribe great importance to developing eco-friendly and more sustainable products, our open innovation mindset is taken one step forward with the RF-free dip technology, developed co-jointly with Continental. We are open for cooperation with other companies and we want to emphasize that the final goal of the collaboration is to make the this dip technology accessible for the tire and supplier industries via a free licensing concept, so that at a certain development stage everyone can become part of the cooperation and support the new eco-friendly technology to eliminate the use of resorcinol and formaldehyde in dipping systems.

In June 2018, we commenced the production of polypropylene monofilament fiber for the construction industry, in the new polypropylene monofilament fiber reinforcement line at Izmit plant. This is a new type of KraTos which is an innovative concrete reinforcement synthetic fiber that will shape the industry. With this new polypropylene monofilament fiber line, we aim to grow by differentiating from our competitors in the market. We aim to offer this new version of KraTos, both in Turkey and in the European market.

We will continue our organic growth with our investments into R&D and technology, we are also looking into opportunities for inorganic growth in the global arena with our composite business line. With the acquisitions of Textile Products, Fabric Development and Advanced Honeycomb Technologies, we have already started to contribute Kordsa's target to become a leading player in aerospace industry. In this regard, Fabric Development and Textile Products, both companies provide advanced composite materials to the commercial aviation industry. These companies are one of the leading suppliers of commercial aviation brands in the world, Boeing and Toray Composites Materials America Inc.

In line with mission to reinforce life, we aim not only to develop breakthrough technologies but also to create sustainable value for our employees and society. I am proud that we have received many other global awards in 2018. We are among the top "Great Places to Work" in Brazil for 3 consecutive years, and received the "Best Employee" award in Indonesia two years consecutively. Besides, our sustainability reports which has been honored by the League of American Communications Professionals (LACP) awards for being comprehensive, having clearly articulated our long-term approach to sustainability.

Looking ahead, we are focused on building more success stories, and improving our competencies in every business we are in. We will always share our knowledge and knowhow to create innovation in bringing positive change to the societies and industries in which we operate and live. Inspired from life, we will keep reinforcing more areas in life. I am incredibly excited about our journey and truly believe that we will grow together as the culmination of our commitment to deliver enduring results for our clients.

I wish you an interesting and fun read.

Ali Çalışkan

CEO

The Determination of Convective Heat Transfer Coefficents on Quenching Monofilament

MERT PATKAVAK

Phd Candidate, Project Engineer, Kordsa

Kordsa is a leader in the global tire cord industry. Kordsa's R&D center reseach focuses on the improvement of existing products and new product development as well as research on new materials. Before the R&D center was established, new product developments were carried out by trial and error and process experience. It is almost impossible to find optimum solution for a product through trial and error. So these trials took too much time and too much expense. Moreover, the response time in developing new products for customers will be shorter and accordingly Kordsa will be able to better serve its customers.

The purpose of this study is to determine a convective heat transfer coefficient in order to understand the temperature profile of a filament in the cooling process. A functional model will have many benefits to the textile industry over the long term. Some of these benefits include new product development in a shorter time and at less cost, the optimization of equipment and processes and better service to customers.

Fiber Production

Synthetic fibers can be produced through the following steps: polymer synthesis, spinning (the extrusion, solidification, and deformation of the spinning line or filament), drawing (used to increase the degree of orientation and improve the tensile strength, modulus of elasticity, and elongation of fibers), heat treatment (crystallization), and textile processing (twisting, dyeing, etc.)

Spinning means a different thing for synthetic fibers. Spinning for natural fibers means that twisting of short fibers so that they gain continuous filaments. However, the spinning of synthetic fibers means the production of continuous filaments by any means. The yarn is made by twisting many filaments together. Spinning can also be called continuous drawing. The word "spinning" is commonly used in textile industry. A fiber is the fundamental unit of textiles, and it is defined as a material which has a length to diameter (or width) ratio of about 100. There are two types of fibers, natural and synthetic, and the aim of fiber spinning is to produce continuous filaments of a uniform diameter with the physical properties desired by the end user.

Spinning can be performed with three different techniques: melt spinning, dry spinning, solution wet-spinning, phase separation spinning, emulsion spinning, gel spinning, and reaction spinning. Melt spinning is the easiest and most economical technique of the three. It involves only heat transfer and extensional deformation.. Polyamides (nylons), polyesters, polystyrene, polyolefins and inorganic glasses are typical examples of melt spun polymers.

A typical example of the melt spinning process is shown in Figure 1. The extrusion through a spinneret (or die), the die swell (relaxation of the elastic stress of the polymer), the quenching of the filaments, the solidification of the polymer, and the cold drawing from the solidification point are all shown below.

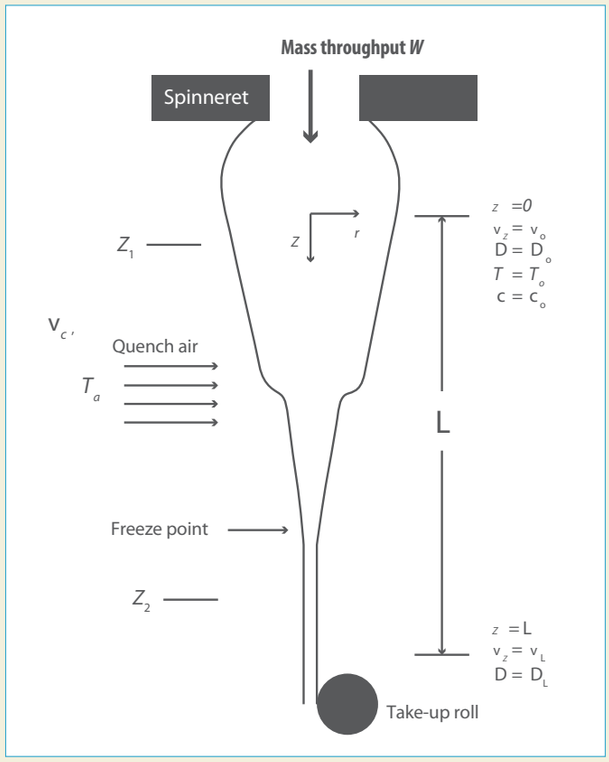

Figure 1: Melt Spinning

The Quenching Process

Heat transfer (or heat) is thermal energy in transit due to a spatial temperature difference. The transfer of energy as heat is always from a higher-temperature medium to a lower-temperature one, and heat transfer stops when the two mediums reach the same temperature. Heat can be transferred in three different modes: conduction, convection, and radiation. The heat transfer mechanisms used in this study are convection and radiation. These mechanisms are formed on the wires in the wind tunnel environment.

The regional convective heat flux of a fluid over a surface and total heat transfer are expressed as:

$Q_{Conv.} = h.\pi.D.L.(T_S - T_\infty)$

Radiation is the emission or transmission of energy in the form of waves or particles through space or through a material medium such as alpha radiation (α), beta radiation (β), and neutron radiation, electromagnetic radiation. Its equation is expressed as:

$Q_{Rad.} = \varepsilon.\sigma.\pi.D.L\,(T_{S^4} - T_{SURR^4})$

Heat transfer is a function of Reynolds Number,

$Re=\rho.V.L / \mu$

and the Prandtl Number,

$Pr=\mu.cp / k$

where ρ is the fluid density, V is a bulk velocity, μ is dynamic viscosity, k is the fluid conductivity, and cp is the specific heat. L is a characteristic length, such as a diameter. Reynolds number is the ratio of the forces of inertia to the forces of viscosity. The Prandtl Number is a dimensionless number approximating to the ratio of momentum diffusivity to thermal diffusivity. In heat transfer at a boundary (surface) within a fluid, the Nusselt number (Nu) is the ratio of convective to conductive heat transfer across (normal to) the boundary.

$Nu=h.L / k$

This equation gives us the Nusselt numbers for various flow conditions. The Nusselt number is added into the equation and the heat transfer coefficient h is found. There are many correlations that predict the heat transfer coefficient in the literature.

Equation for Nu-number (Only parallel flow)	References and conditions
$3.0Re^{-0.22}$	Golzar
$0.25 + 0.15Re^{0.36}$	Zieminski
$0.325Re^{0.3}$	Glicksman
$0.53Re^{0.33}$	Copley
$0.42Re^{0.334}$	Kase, Matsuo
$0.28(Re^{2})^{0.17}$	Brünig
$0.16(Re)^{0.50}$	Ohkoshi

Table 1: Relationships of Reynolds and Nusselt Numbers in melt spinning

Experimental Study

Figure 2: Wind Tunnel Test Apparatus

A Wind Tunnel Test Apparatus is shown in Figure 1. The experimental test apparatus comprises a tunnel, fan, power supply, digital multimeter, flow meter, frequency converter and wires which are of diameters between 0.2 mm to 1.0 mm. These are used to represent monofilament yarn.
An AATech-ADM 3303 DD model power supply is used for heating the wire and to convert electric current from source to the correct voltage, current, and frequency to power the load. An AATech-ADM 3055 model digital multimeter is used for the measurement of voltage and to obtain the temperature of the wires. The fan sucks air from the medium to the tunnel. Air passes over the wires and cools them. The air flow rate is adjusted with a frequency converter and is measured with Testo 435 model flow-meter.

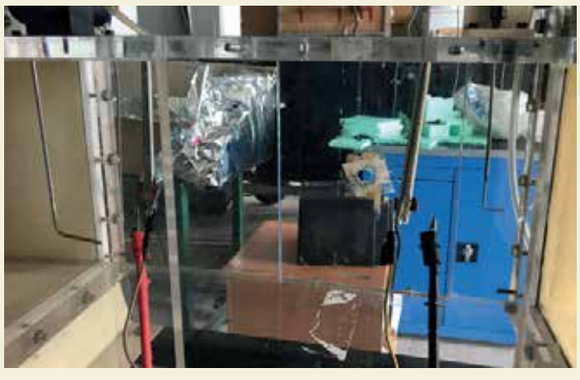

Figure 3: Wire and wire holder for parallel flow

A wire holder is used to keep the wires stable within the air flow and an insulation material is used to prevent current flow. The position of the cylinder inside the wind tunnel is very important. The cylinder is positioned longitudinally at a 0 degree angle within the parallel flow. Tests are carried out according to experimental parameters that are given in Table 2.

	Min Value	Max Value
Air velocity (m/s)	0,5	5
Diameters of wires (mm)	0,2	1,0

Table 2

Results and Discussions

The results showed that a higher diameter value of wire provides a lower forced convection heat transfer for the same air velocity. Under the same experimental conditions and with the same wires, the convective heat transfer coefficient increases with air velocity, which is seen in Figure 4.

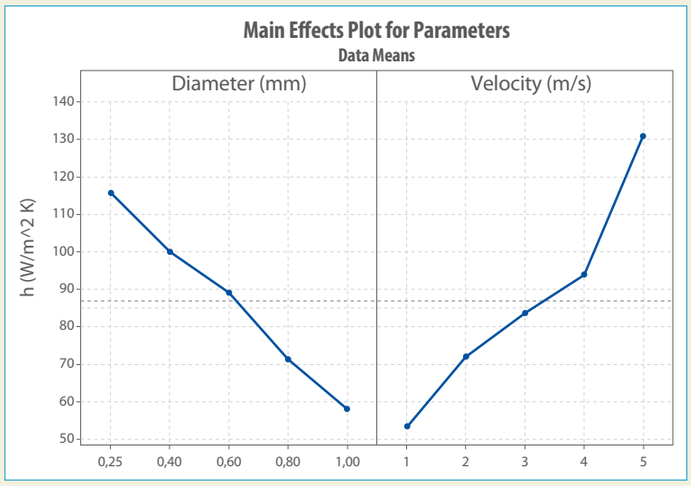

Figure 4: Main Effects Plots for Parallel Flow

Figure 5 shows that the Nusselt and Reynolds numbers change when they are calculated from experimental results for parallel flow. The experiments were carried out in the range of Reynolds numbers from 9 to 275, with an r2 value of 0.93. The convective heat transfer coefficients were found from 24 to 160 W/m2.K. The results were compared with Golzar, Ohkoshi, Zieminski, Glicksman, Copley, Brünig and, Kase and Matsuo's correlations.

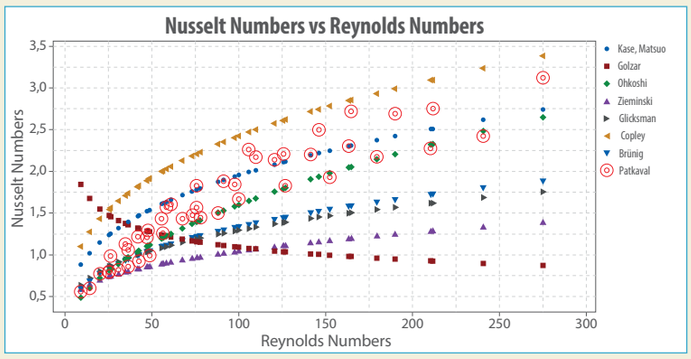

Figure 5: Reynolds and Nusselt Numbers for Parallel Flow

The Patkavak correlations of the Nusselt numbers for the present data can be expressed as follows;
$Nu = 0,1516Re^{0.5368}$ for parallel flow, 9<Re<275
The present results are in good agreement with literature and they are in same range as these Reynolds numbers. These studies will be continued at Yildiz Technical University's laboratory to obtain convective heat transfer coefficients underwater in liquid isothermal bath cooling. Afther these studies, Kordsa will use their own formulas to further analyze the cooling process of yarn.

The most significant property of fibre-reinforced polymer composite materials is their "high-strength to low-density" nature. It is these characteristics that have made polymer composites an essential component for the aviation and aerospace industry over the last 40 years.

The Importance of Sandwich Structures and the Development of Kordsa's First Composite Sandwich Panel

DR. FATİH ERTUĞRUL ÖZ

Project Leader in Composite Reinforcement Process Technologies, Kordsa

INTRODUCTION

Saving energy or reducing its consumption is among the primary aims of engineering today. Innovations in the field of materials science offer opportunities for producing lighter and stronger structures with reduced energy consumption. Among the most popular materials for this purpose are "Composite Materials". Instead of having single constituents, these have at least two different constituents, which when combined preserve the benefits of the separate constituents. While one constituent (reinforcement) provides strength and stiffness for the overall material system, the other constituent (matrix) is used to hold the reinforcement together. Fibre-reinforced polymer composite materials are the most important types of all.

The most significant property of fibre-reinforced polymer composite materials is their "high-strength to low-density" nature. A comparison of tensile strengths and densities of composites with different materials can be seen in Figure 1 (Ashby's material chart). It is these characteristics that have made polymer composites an essential component for the aviation and aerospace industry over the last 40 years. Nowadays, at least 50% of any aeroplane consists of polymer composites. An example of the exterior of a Boeing B787 is shown in Figure 2.

The usage of composites is not limited to the outer regions of an aeroplane. 70% of the interior parts consist of polymer composites as well. By founding the Composites Center of Excellence (CTCE) in 2016, KordSA made an important contribution to increasing the use of composites and thus generating the kind of statistics we see in Figure 2. Now, however, we seem to be moving on to a new phase, with the development and widespread use of "Composite flat sandwich panels".

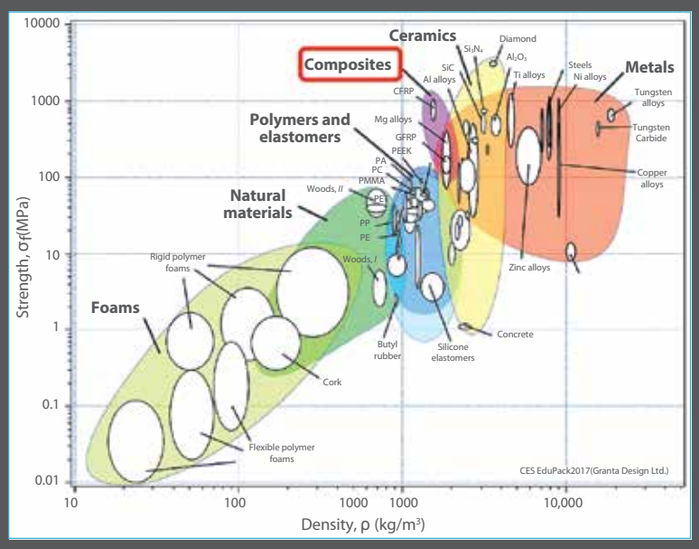

Figure 1: Comparison of materials with respect to strength vs. density.[2]

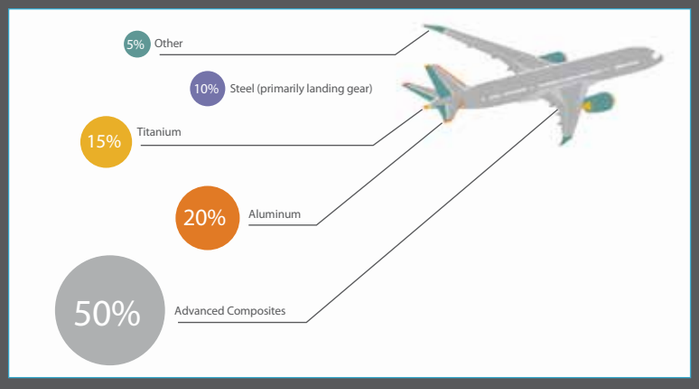

Figure 2: Percentage of materials used in outer regions of Boeing B787 aeroplane.[1]

COMPOSITE SANDWICH PANELS

Through CTCE, Kordsa is engaged in producing large composite flat sandwich panels for the cabin interior of a commercial aeroplane, including elements such as galleys, lavatories, crew rest-spaces, floors and sidewalls. But what is a composite sandwich panel? As mentioned before, a fibre-reinforced polymer composite material can provide considerable strength owing to its low density. Despite its high tensile strength properties, though, a composite cannot sustain such strong loads when being bent. A simple "solid mechanics" rule, shown in Figure 3, states that the sustained bending stress is related to its moment of inertia (I) which is also related to its thickness (h). If the thickness of a structure is increased, the magnitude of bending stress under a load decreases, as the equations in Figure 3 illustrate. However, it is not easy to produce thick composite materials, since this involves high cost and considerable time. In addition to this, exothermic reactions are more likely to happen in thick composites and this can have detrimental effects on the physical and chemical properties of the material. For this reason, a different type of reinforcement is required to increase the bending load bearing capacity of these fibre-reinforced polymer composite materials.

Composite sandwich structures are special types of composite materials that are produced by inserting a thick, lightweight core between two thin, stiff and strong polymer composite facesheets. Also, an adhesive material is used to join the facesheet to the core. Since the thickness of the structure increases, its bending load bearing capacity is also enhanced, as is evident from the formulations shown in Figure 3.

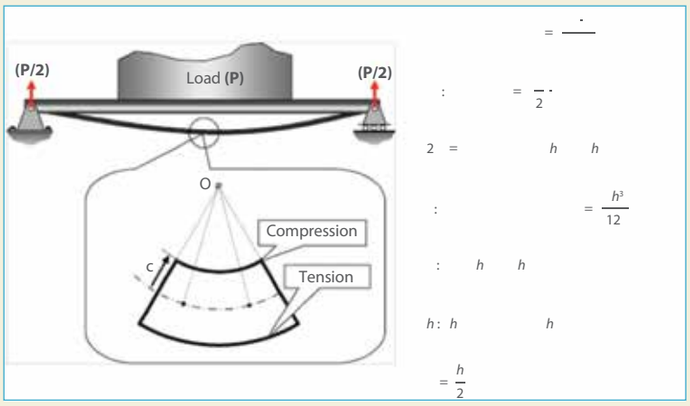

Figure 3: Formulation for bending stress under a load.

There are various options for designing a sandwich structure. Any variation in facesheet, core type and overall geometry will have a great impact on the general structural properties. Examples of different composite sandwich panels are shown in Figure 4. While the first two types are used for outer regions of an aeroplane, the third type is highly appropriate, indeed invaluable, for the interior of an aeroplane. This is KordSA's new "honeycomb" composite sandwich panel.

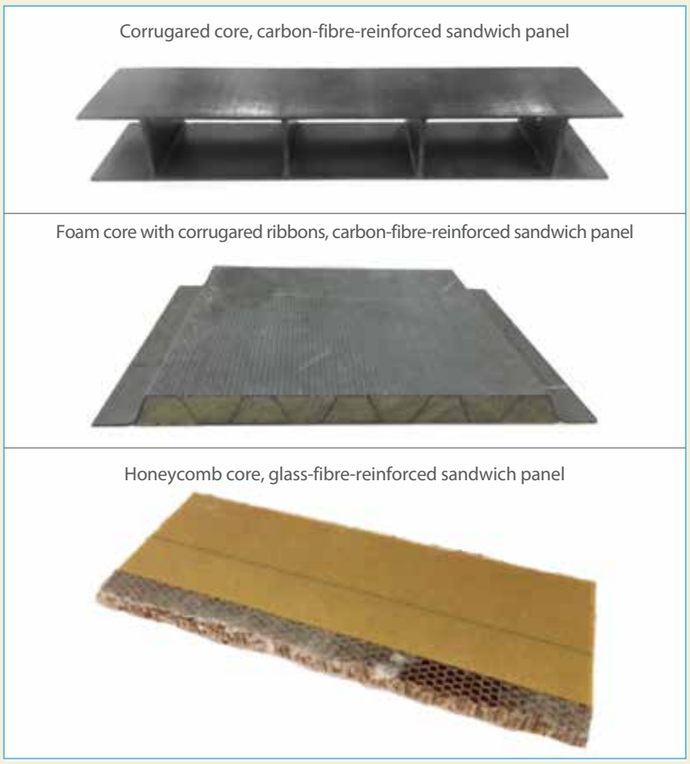

Figure 4: Different types of composite sandwich panels

KORDSA'S NEW HONEYCOMB SANDWICH PANEL TECHNOLOGY

Manufacture of Sandwich Panels

The Composites Reinforcement Business Unit has been producing composite sandwich panels since 12th June 2018. The primary use of these panels is in the construction of galleys of commercial aeroplanes. Since the panels will be used for interior structures, their fire progression and smoke/toxic gas emission properties need to be very low. Because of this, the product is made of glass fibre-reinforced phenolic facesheets and nomex honeycomb core. Phenolic is a flame retardant resin type and the honeycomb is an aerospace-grade aramid fiber made from Nomex® paper, which is also phenolic-coated. The honeycomb cells are hexagonal shaped and 3.2 mm in size. The schematic view of the fabrication process is shown in Figure 5.

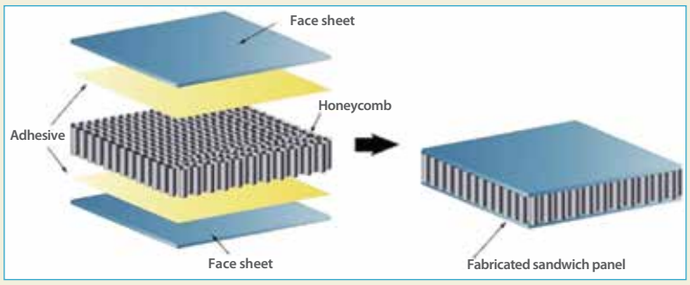

Figure 5: Schematic view of a composite sandwich panel.

Test Results

The extensive product development period for the composite sandwich panels lasted from 12 June 2018 to the beginning of December 2018. Two different panel types were produced. While one is 10mm thick, the second has a thickness of 22mm. A total of 30 panels were produced and tested with 8 different tests (2 fire tests and 6 mechanical tests). The test list is presented in Figure 6. These tests were applied in two perpendicular directions, namely longitudinally (L) and transversally (W), in accordance with the geometry of the honeycomb cells, as illustrated in Figure 6. Different production process parameters were tested and an optimization study was carried out to determine the most effective process cycle in terms of cost, time and mechanical strength properties.

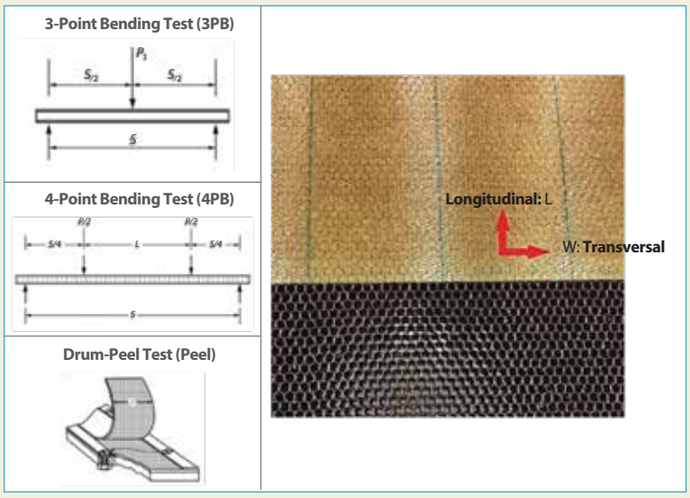

Figure 6: Test and direction configurations

The production process parameters were fixed at the beginning of December 2018. Since then, KordSA has been able to manufacture flame-retardant composite sandwich panels that have greater mechanical properties than those of the similar, commercially available composite sandwich panels produced by a leading brand. To highlight the reliability of the product development process, it should suffice to mention that, while 6 specimens are usually regarded as sufficient for determining the mechanical properties of a product in terms of required testing standards, KordSA has tested no less than 18 specimens from different regions of a sandwich panel. This is necessary to spot the "worst scenarios" and to trace the consistency and homogeneity of mechanical properties through the entire product. A comparison of the mechanical properties of KordSA's panels with the leading brand's commercially available product is shown in Figure 7. Figure 8 presents the distribution of test results from various regions of a panel, with different colors representing the specimens of each test.

The test results in Figure 7 attest to the success of the product. KordSA's composite sandwich panels can bear greater bending than can the sandwich panels of the leading brand and can withstand peel loads in either direction. In addition, Figure 8 presents the traceability of the maximum loads of the test specimens in different regions of the panel. All these results provide insight into the mechanical behavior of Kordsa's new composite sandwich panel product.

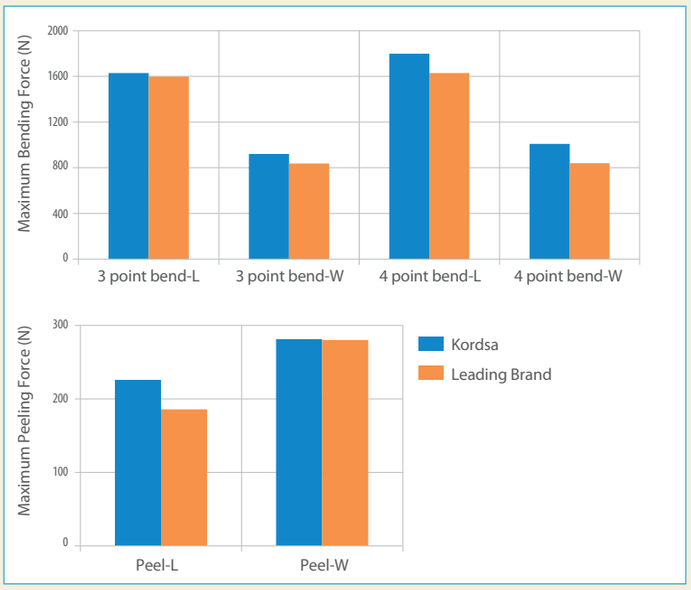

Figure 7: Comparison of test results with leading brand's commercially available product

Figure 8: Maximum loads of each tests from different regions of the sandwich panel.

CONCLUSION

This article has briefly described composite materials and the requirements of composite sandwich panels, as well as giving some simple theoretical background. It has also introduced the development period for KordSA's composite sandwich panel product. Clearly, the current mechanical test results prove that, in a period of just 6 months, KordSA has developed a successful product with efficient production process parameters. The next step is the rapid commercialization of the product, so that it can become one of the first products to make its mark in the statistical reports about the use of composite materials in aeroplanes.

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The Future of Manufacturing

MERT TÜKEL

TCF Production and Lean Group Manager, Kordsa

Starting Lean

In business, everything starts with the customer. When the customer's needs change, not only the product itself but also the way the product is produced becomes critical.

For decades, the dream of business leaders has been to establish operational systems without any kind of waste, in other words, to reach the "Operational Excellence Level". Here, the key word is "Excellence", a target that in reality cannot be achieved but which evolves along with improvements, and people come ever closer to it with every step they take. This makes people even more eager for new ideas that will shape the future. In our age, this means running more complex operations—operations that, on the one hand, are leaner and more efficient, on the other hand that are suitable for "Digitalization". The reason is that if we do not make the process lean, we end up digitizing a "not lean" process, which in the future will create more problems than solutions.

Inputs and Outputs

We hear so much about digitalization. But what is it? First of all, with respect to the leanness of production processes, we need to be clear about the inputs and outputs of processes. Outputs are usually defined as being zero-incident, zero-defect and zero-waste, and as having high volume and minimum inventory and lead times, all of which in theory make for the most productive operation. Thus, we know where we want to go. On the other hand, inputs are defined with reference to the machines, employees, materials, specifications and other factors specific to the industry. Frankly speaking, for a given function we mostly forget how to process the inputs when we want to yield a standard output. In the real world, logic would suggest that there are in fact two ways to achieve this:

1. We should have high problem-solving capability and display continuous effort

2. We should stick exactly to the standards given.

Doing both will enable a company to stand out in any industry. And this is why today there is so much talk about the 4th Industrial Revolution, a concept that reflects the dramatic changes in the way we do things in every part of our private and business lives, using multiple high-technology tools.

Data is the New Oil

We may have immaculate systems, process control systems, digital screens, machines that give us basic alerts, well-designed and actualised ERP, and even robots to do the heavy work. However good the machinery that we use is, machinery that we believe is running perfectly, what maintains standards are our daily routine in operations and the effort that we invest.

In order to maintain standards, we need to pinpoint the relevant data and collect it on a periodic basis, preferably online. Gathering data allows us to compare the deviations for simple alerts, to scrutinise inputs, outputs and specifications; indeed, to look at all the circumstances of the process. Unfortunately, collecting all of this information is not easy since most of the companies built their systems successively to deal with different needs on different platforms. This is why a company that wishes to control the entire process needs to bring all of the data sources onto a single platform reachable from anywhere, preferably a Cloud, from which they can extract information easily depending on their requirements.

Continuous Improvement

Operation staff occasionally find themselves having to deal with unexpected problems. Standard procedure for well-organized companies with well-trained staff is to frequently use root cause analysis techniques to prevent the same problem from reoccurring. The question that presents itself then is whether companies should spend most of their valuable resources on developing solutions for problems or on moving forward. Of course, it is an improvement when a company is not confronted with a problem that it faced before. However, we can never be sure whether or not this will be the case until the problem reoccurs.

In the digital world, all the reasons for something happening will leave behind a digital trace. In statistical terms, if this collection of data can be transformed into information using analytics, it can be made to give an alert before a failure takes place, which we call "Prediction". As Sigmund Freud once said, "Analysis itself is the cure".

Action by Prediction

Advanced analytics can support our systems in almost all the operations and processes we can think of, from a sales forecast to planning, to quality, breakdowns and even shipment delays. When we have a well-configured database containing generic data about predicted problems or results, merely knowing this data gives us information. However, when we are able to use this data to activate people, equipment or any other components in a system, we can say we have knowledge. In other words, the concept of the so-called "Internet of Things" can guide our generation to find methods that result from action. For example, when a high-potential problem is observed by the system, this can trigger an alarm or most likely change the settings of a machine so that the same product emerges at the end. Alternatively, the system may reroute an AGV (Automated Guided Vehicle) or even reinitiate material planning. Maybe there will no longer be an operator running the machine; instead, the machine will run the operator!

From Data to Wisdom

We have observed how data has been transformed into information and then into knowledge. Today, companies' systems or minds are learning from the deviations or mistakes made by themselves or others. Each and every item of data added to the process, whether as input or at output, reconfigures the analysis that prevents the same mistake from being made again. Once a data system has been constructed effectively—that is, so it is "lean"— it will not deviate from the standard and it will improve itself constantly, eventually being able to serve the whole company. Herein lies the wisdom of continually striving to fulfil the requirements for operational excellence.

Life is the assessment of probabilities. By following the path outlined above, we can let Artificial Intelligence assess the probabilities of our business life so that we can invest our own knowledge and time in building strategies.

Nothing Comes From Nothing

For centuries, people have been building machines, methods, and robots and once again it is people who are at the forefront of the fourth industrial revolution. We need to map the logic behind the digital organism, in the same way that we may sketch the organizational structure of a company. Similar organizations can benefit from such maps, so that similar decisions can be made digitally for better, faster and more accurate results. However, the vision needs to be determined by humans. And to make humans capable of understanding the potential of such systems, they are dependent on the chief prerequisite for development: training.

If we care about the future of manufacturing, we have to consider reinforcing the future skills of constructors and operators. All team-members need to be equipped with multiple new skills that we had never heard of ten years ago. In The Future of Management, Gary Hammel says, "Not operational excellence or new business models fuel the long term business success but management innovation, new ways of mobilizing talent, allocating resources and building strategies."

Walls or Windmills?

The winds of change are blowing faster than ever. Speed is everything. It is time for us to separate what is valuable in our processes from what is not. We can continue with what we were doing before, based on the premise that this was successful in the past, and we can block any changes that we fear may affect our "existing" success. Or we can dare to develop our team and systems with the aim of energizing the whole company with the vision of a future that may not be so clear but is certainly powerful.

Every brand has a story.
Kordsa's story started in Izmit and spread to the whole world, touching people from all cultures.

Yes!
We Know Each Other,
Even If We Haven't Met Yet!

NEVRA AYDOĞAN GÜRSOY

Brand and Corporate Communication Manager, Kordsa

I'm part of your life.
Even if we haven't met, we spend long hours together.
I accompany you as you try to make it in time to the ballet performance your daughter was so looking forward to.
I am with you as you board the plane on the way home from a meeting.
I am right there as you enjoy the view of the magnificent sea while crossing that colossal bridge.
I am with you
As you get into a car,
On a plane trip...

You wonder who I am?

I am a tire reinforcement technology.

I am a cord fabric. I am the skeleton of the tire of a vehicle which holds it together.
I develop technology drawing on the know-how and experience I have gathered in various geographies.

You wonder who I am?

I am a composite technology.

I put my heart and soul into looking for ways to make an aircraft or car lighter and consume less fuel.
I make inventions and work on innovations in composite technologies that will influence global composites market at my R&D center so that the wings of the aircraft bend during turbulence and it gets you home safely.
Sometimes, my engineers who greet the first lights of the day in their laboratory, are seeking to develop the best resin technologies. As I work on improving surface quality and safety for automotive industry, my main focus in aviation is lightness and travel safety.

You wonder who I am?

I am a construction reinforcement technology.

The non-conductivity property of the material I use in my construction reinforcement technologies ensures that electronic passes are read without loss and accurately at toll booths, and railroad switches function 100% efficient and safely.
Unawares to you, I am by your side in your happiest, most exciting and sometimes hardest moments.
Every brand has a story. Kordsa's story started in Izmit and spread to the whole world, touching people from all cultures. One of our employee has been selected as the best employee in Indonesia for two consecutive years by its Safety Experience Center project, and we are among the best employer brands in Brazil for three years.
Every brand grows around its story. The lives it touches, its area of influence help it survive and thrive. As reinforcers, we hand over this enthusiasm from one generation to the next as we move on. Sometimes we are loud and excited, sometimes slightly timid and quiet... However, we continue on our journey with the same enthusiasm and relentless love for development.
Kordsa, the brand that never sleeps, boasts a long line of reinforcement that stretches from America to Asia-Pacific. As night falls on one of our geographies, in another we greet the first lights of the day. While the geographical conditions specific to each region enrich our experience in reinforcement, we continue on our way cherishing the fact that we are learning from one another.
At the beginning of our story we were "reinforcement material providers". In time, as we evolved into The Reinforcer, the areas we reinforce started to grow. Our reinforcement areas are growing from vehicles circulating on ground to the one which give us the mobility possibilities on air.
Today the fields where we provide reinforcement solutions have grown horizontally and vertically, ranging from vehicles moving on the ground to shuttles going to space.
An enthusiastic team that is looking for ways to reinforce life is here for value-added innovation. Every one of them has a fantastic story.
Should you want to find out more:

We reinforce life...
In line with our mission of reinforcing life, we set out this year to visualize our journey and translate our reinforcement love into images and words.
We wanted to show you around the myriad layers of reinforcing life and to share with you the fascination and joy that we experience during our work.

We wanted to contribute to the happiness. It gives us peace of mind to know that we are part of that little rascal's laughter when you get back home in the evening.

Now, do you have 60 seconds for us?

Kordsa is Participating in the EU-funded Horizon 2020 Project "Polynspire"

NAZİF UĞUR KAYA

Global Technology Project Leader, Kordsa

Kordsa is a participant in the European Union-funded Horizon 2020 Project "polynSPIRE" (Demonstration of Innovative Technologies towards a more Efficient and Sustainable Plastic Recycling, Grant agreement ID no. 820665), which started in September 2018.

Coordinated by CIRCE, the Research Centre for Energy Resources and Consumption (Zaragoza, Spain), polynSPIRE has a duration of 48 months (1st September 2018–30th August 2022) and a total budget of 9.95 million Euros. The EU contribution of the project is around 7.95 million Euros. The kick-off meeting of the project was held in Brussels, Belgium on 25th-26th September 2018.

Thermoplastic materials (PP, PE, PET, PA, etc.), which are based on fossil fuels, are used in a vast range of products and applications in everyday life but also generate an ever-increasing amount of plastic waste. Even though, throughout Europe, significant attempts are made to recycle, landfilling, incineration and reusing are the preferred methods for handling plastic waste. In 2016, over 27 MT of plastic waste were collected for further treatment.

There are several technological and non-technological barriers to plastic waste recycling. One of the biggest technological barriers is the insufficiency of the current waste management system in terms of the separation of plastic blends and composites. The heterogeneity and variant structure of plastic wastes is another challenge for mechanical recycling. This makes it all the more difficult to process large quantities of different types of plastic waste so that they can be introduced into the value chain. Moreover, plastic waste is generated at different points along the value chain. Due to the diversity in consumption patterns and in standards across Europe (cf. waste directives and the "End of Waste Criteria"), it becomes harder still to map, classify and deliver plastic waste types.

The aim of the project is to develop novel strategies for sustainable and cost-effective recycling processes for post-consumer and post-industrial waste streams in which at least 80% of the contents are plastic materials. The consortium also aims to develop a comprehensive business plan, offering 7 business models and establishing a cross-linked relationship between the plastic, chemical and steel manufacturing industries (Figure 1)

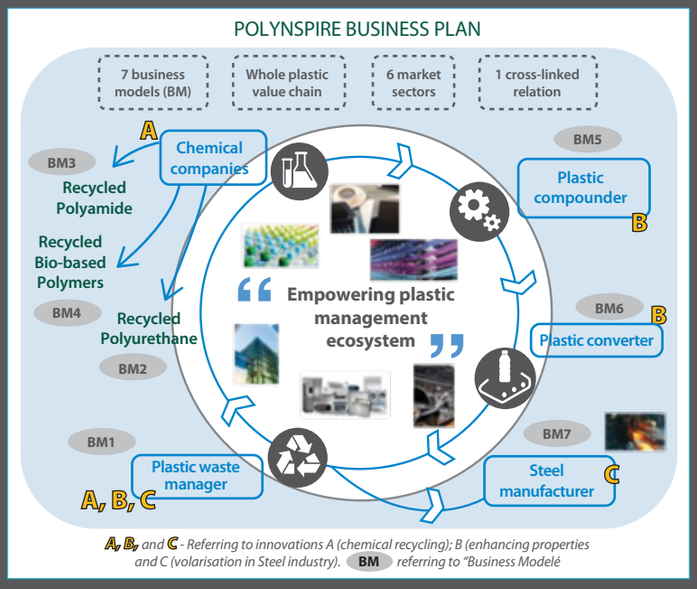

Figure 1: polynSPIRE Business Plan

The project brings together 21 leading entities: 4 research & technology organizations, 1 university, 9 large companies, 5 medium-sized enterprises and 2 multiplier associations. The chemical companies are Kordsa (Turkey), Repsol Quimica (Spain), Nurel (Spain), Arkema (France) and Novamont (Italy). The plastic compounder is Bada (Spain), the converter Maier UK (United Kingdom) and the waste manager IdealService (Italy). The technology developers are CIRCE (Spain), Kemijski Inštitut (Slovenia), Ioniqa (Netherlands), AITIIP (Spain), Eindhoven Technical University (TU/e, Netherlands) and RINA Consulting (Italy). The equipment and steel manufacturers are Fricke und Mallah (FM, Germany), Chemical and Pharmaceutical Process Engineering (CPPE, Slovenia), HTT Engineering (Czech Republic) and Ferriere Nord SPA (Italy). The Danish Standards Foundation (Denmark) is implementing standardisation while European Plastic Converters (EuPC, Belgium) and the Istanbul Chemicals & Chemical Products Exporters' Association (İKMİB, Turkey) are responsible for dissemination.

The overall objective of polynSPIRE is to propose a comprehensive set of innovative, cost-effective and sustainable solutions aimed at improving the energy and resource efficiency of the recycling processes for materials containing plastics. These solutions pertain to both post-consumer waste, i.e. the waste generated when products have come to the end of their lives, and post-industrial waste, i.e. waste generated during the transformation of raw materials into final products. Achieving this objective depends on three innovation pillars, which are implemented in operational environments reaching TRL 7 (Figure 2):

Innovation A (Chemical Recycling): The aim of this pillar is to recover monomers (adipic acid and hexamethylene diamine in Kordsa's case) and fillers (carbon fiber, glass fiber, minerals, etc.) from engineering plastics and thermoplastic composites. Essentially this means that plastic parts will be extracted from household, automotive, electrical & electronic (E&E) products. Afterwards, these plastic parts will be treated with microwave-assisted equipment, enabling an up to tenfold increase in the reaction rate while reducing energy consumption by 65%. More importantly, the reaction yield is estimated to increase from 70% to 82%.

The use of smart magnetic materials is another strategy for chemical recycling, yielding an increase in the conversion rate for the target polymers from 18% to 80%. This is also estimated to lower energy consumption, thus enabling an increase in energy efficiency of around

60%. One of the biggest advantages of this technique is that it makes it possible to work under milder reaction and process conditions. Removal of magnetic catalysts from the process and their recovery are also possible, thereby further reducing the environmental impact and the operational cost of the process.

Innovation B (Mechanical Recycling): The mechanical recycling pillar is comprised of different methods for enhancing the quality of recycled plastics, using vitrimers, high-energy radiation, and compatibilizing additives. These two innovative recycling approaches can lead to a 34% direct saving in fossil resources in the case of Polyamide (PA) and a 32% saving for Polyurethane (PU).

Innovation C (Valorisation): Finally, the valorisation of plastic waste as a source of carbon could enable the steel industry to reduce its use of fossil carbon sources in electric arc furnaces (EAF) by around 80%.

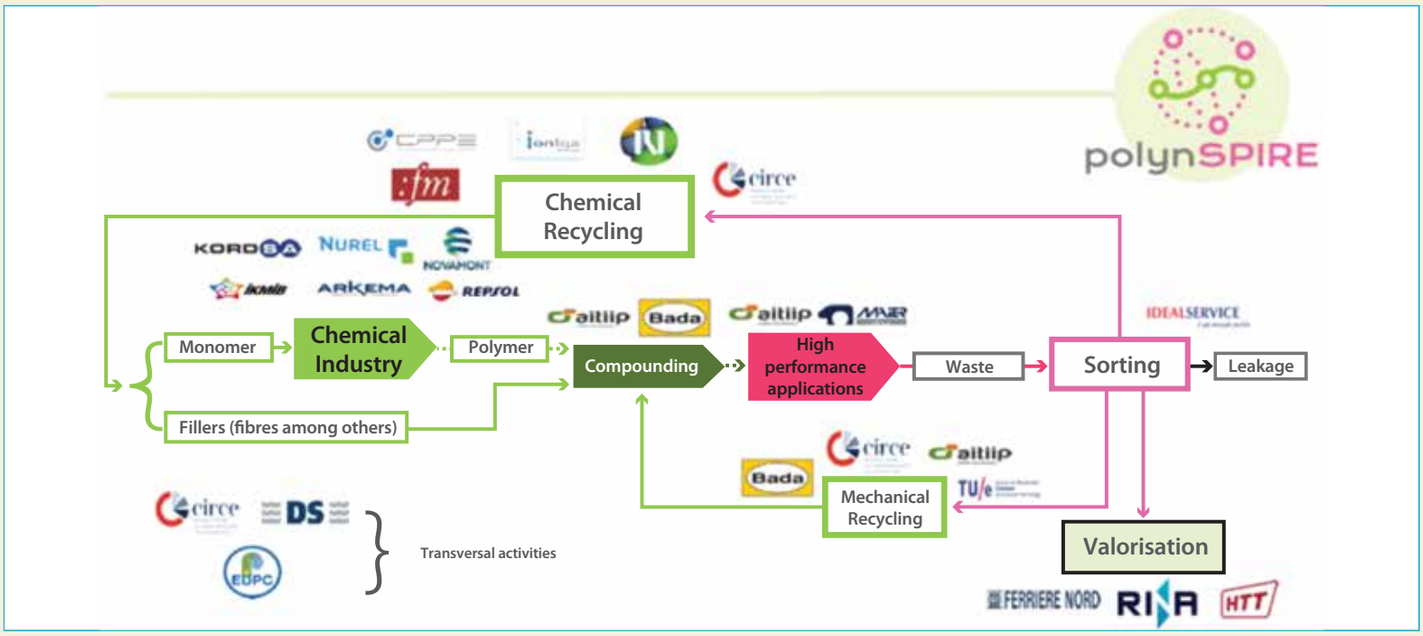

Figure 2: General view of plastic recycling/valorisation strategies along the plastic value chain.

The project will reveal the optimal technical, environmental and economic fit for different materials, taking into account parameters such as waste source (post-industrial or post-consumer), composition, and contaminants. A Life Cycle Assessment (LCA) and Life Cycle Cost (LCC) of the different strategies will be executed in order to investigate the economic and environmental advantages for each recycled material.

The project will deal with streams containing 100% waste and ensure that at least 50% of the total plastics containing PA and PU is recycled, leading to a reduction in CO2 equivalent emissions of between 30 and 40%. The project also addresses non-technological barriers at EU level, such as issues of legislation and standardization, and proposes business models for integrating the aforementioned solutions into the overall plastic waste management system (Figure 3).

polynSPIRE will create a database by mapping the distribution of plastic wastes across Europe, with a focus on Polyamide (PA) and Polyurethane (PU) wastes, as well as these wastes combined with other plastics such as Polyolefins (e.g. PE or PP). Additionally, the consortium will develop a guideline for overcoming potential legislative barriers. Six market sectors will benefit from the project, namely the automotive, appliances, electronics, construction, packaging and textile sectors.

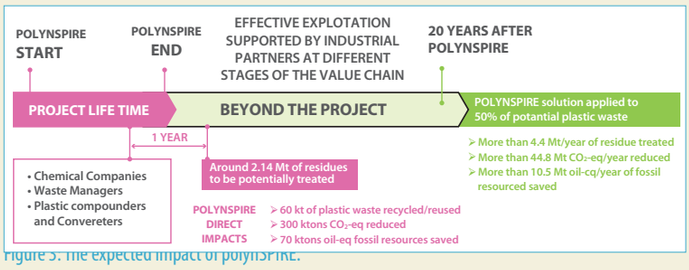

Figure 3: The expected impact of polynSPIRE.

Kordsa's Contribution

As the Polyamide Validation Task Leader, Kordsa will be responsible for the validation of the recycled monomers for Polyamide-66 (PA66) and for fostering collaboration between Arkema (responsible for long-chain polyamides such as PA10, PA11 and PA12) and Nurel (responsible for polyamide-6).

The recycled monomers will reach Kordsa by means of the following stages: (1) Plastic waste management and supply (PA66-based waste materials from several industrial products such as technical fibers and plastic parts); (2) Depolymerization of the polymers, extraction of fillers/additives from the polymers and the purification of the recycled monomers (Figure 2).

Kordsa will develop new techniques for the polymerization of new raw materials. The usability of the new polymers that will be synthesized from the recycled monomers will be assessed by polymer users such as fiber producers, compounders and thermoplastic composites producers. In addition to conducting synthesis, Kordsa will perform in-house compounding (engineering plastics) and lab-scale monofilament fiber processing of PA66. Depending on the waste source, recycled raw materials may have different properties. This can pave the way to new polymer formulations and new products for the market besides the standard PA66 polymer.

The project will have three main benefits for Kordsa. Firstly, it will allow the company to develop its know-how for new technologies and materials. Secondly, it will give Kordsa the chance to participate in shaping the business models of the future recycling industry. Finally, it will encourage the company to initiate new funded Horizon Europe projects, Horizon Europe being the successor research and innovation framework program to Horizon 2020.

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In the automotive industry, the demand for visually-appealing carbon-look composite parts continues to grow.

Whitespot, Waterspot and Visually Fault-Free Prepreg for Composite Materials

CEM ÖZTÜRK

Technology Manager, Kordsa

Previously, the time-consuming techniques for manufacturing traditional composite materials made it not desirable for composite materials to satisfy the demand for matching curing time with the takt time found in the automotive industry. This, in turn, limited the deployment of the earlier generations of prepregs in automotive mass production and meant that composite use remained restricted to high-end segments. To solve this problem, Kordsa developed and introduced a carbon-look class-A surface giving CM11 resin and its prepreg system which was not just isothermally press-curable in under three minutes at 150°C but also hot-demouldable, thus yielding an ideally suited system to the needs of the automotive industry.

In the automotive industry, the demand for visually-appealing carbon-look composite parts continues to grow. The resin systems used in prepreg materials include different epoxy resins, curing agents, catalysts and performance/process-improving additives. Transparent and colorless epoxy resins, curing agents, catalyst and additives are chosen in the manufacture of carbon-look prepregs to improve visual apperance. However, while the composite part may be transparent immediately after demoulding, environmental conditions, UV-exposure, heat/cold and humidity usually affect their visual appearance in time and may cause them to change colour and lose their gloss and transparency.

The use of latent amine curing agents in modern hot-melt epoxy prepreg materials brings the advantage of lower health risks for workers compared to the use of boron- and anhydride-based curing agents. The drawback of latent amine curing agents, however, is that when dicyandiamide (DICY) in particular interacts with humidity and CO_2 in the atmosphere or is exposed to other types of environmental influences, the result may be the problem commonly called white wash, water spot or white spot.

There are five potential causes of white spot, water spot and similarly white/opaque apperances (which commonly many types of surface defects are confused with white spot although their mechanism is different however the appearance of fault is very similar and very undesirable):

Figure 1: Carbon look composite part following incidence of white spot due to exposure to humidity

1. Opaque tougheners or additives with a large particle sizes (such as fillers or silica) accumulate in certain regions and precipitate out from the resin mixture during cure (although this problem is unrelated with white spots the end result can be very similar in appearance).

2. When excessive amounts of solid curing agents or catalyst pastes are used in epoxy or the resin flow is too high, these agents or pastes filter out from the fibers and then excess solid curing/catalyst agents precipitate.

3. The curing cycle when it is not sufficient to melt the solid curing agent/catalyst (wrong choice of curing cycle) so it can react with epoxy; because of this, solid curing agents and catalysts may appear as white spots.

4. Epoxy resins by nature have a low resistance to heat cycling/humidity and UV. If the resin flow is too high or the resin content of the prepreg is low for the specified curing cycle parameters then in turn on the surface of fibers, the resin layer will be too thin to protect the fiber-epoxy interface from being harmed by humidity, heat and/or UV.

5. The epoxy/curing agent/catalyst system contains additives or components with high hygroscopicity; upon exposure to water or high humidity levels, the surface of the epoxy film absorbs water and the fiber/epoxy interface is then harmed.

Kordsa was determined to eliminate water spot or similar colour-inhomogeneity problems from its new hot-melt epoxy prepreg matrix. Its new generation resin systems contains no silica, fillers, coloured toughener or coloured additives. Also, the new resin system exploits new UV-absorbers and anti-oxidants which do not change their colour, neither from transparent to opaque nor from colourless to coloured. Since Kordsa prioritises the health of its workers and customers, it decided not to use any harmful anhydrides or boron-containing curing agents. Kordsa's new approach involves the careful calculation of resin matrix epoxy/curing agent/catalyst stoichiometry and the optimisation of the curing cycle to enable its customers to benefit from the maximum degree of cure. Kordsa has designed its own composite matrix from scratch and created a unique resin formulation, a new generation fast-press curable resin called CM14 and its autoclave curable counterpart OM15, which eliminate waterspot and whitespot problems, thus providing high visual clarity.

Figure 2: Composite part made with waterspot/whitespot-resistant CM14 resin system containing prepreg

The Construction Industry and Kordsa

YASA KILINÇ

Sales and Marketing Manager, Kordsa

The construction industry has transformed Istanbul and other cities, renewed and extended Turkey's transport infrastructure and built new housing projects and other facilities all around the country. Related industries such as those pertaining to construction machinery, building materials (including cement and steel) and construction chemicals, as well as engineering and architecture services, employ tens of thousands of people. With the domestic market providing a strong base and Turkish contractors having successfully diversified their markets and projects in recent years, the construction sector is well positioned to continue growing. Given the favorable conditions in terms of population and income growth, the market should be able to maintain its expansion in the years ahead. Measured on the basis of constant exchange rates, tthe 2018 output value for the country's construction industry amounted to US$198.7 billion.

The industry's value is expected to rise further in 2023, thanks to investments in residential property, transport infrastructure, energy, commercial and industrial projects, as well as improvement in consumer and investor confidence. The government aims, by 2023, to transform the country into one of the top 10 global economies and to increase its manufacturing capacity and exports– for this reason, the government is developing road, airport and port infrastructure projects throughout Turkey.

During the period 2019 to 2020, the construction industry's annual growth rate is anticipated to remain at an average of 1.6-2.0%. The industry is consequently expected to increase in value from US$198.7 billion in 2018 to US$247.3 billion in 2023, measured at constant 2017 US dollar exchange rates according to GlobalData.

Residential construction was the largest market in the industry during the review period, accounting for 58.0% of the industry's total value in 2018. The market is anticipated to follow a similar trend, with residential construction accounting for 62.2% of the industry's total value in 2023. The market will be supported by ongoing urbanization, population growth and positive developments in regional economic conditions. Moreover, rising demand for Turkish property among foreigners due to currency depreciation is expected to contribute to the growth of the market.

Infrastructure construction is the second-largest market, accounting for 17.7% of the industry's total value in 2018. The market is expected to retain its position in the period 2019 to 2020 and account for 15.4% of the industry's total value in 2023. The market output is expected to be bolstered by the government's plan to improve the country's transport infrastructure through public-private partnerships (PPP). Forecast-period growth will also be supported by the government's focus on developing transport infrastructure as part of Turkey's "Vision 2023". By 2023, the government aims to have constructed 13,478km of new roads across the country.

Commercial construction accounted for 9.42% of the industry's total output in 2018, followed by energy and utilities construction at 9.35%, institutional construction at 3.61% and industrial construction at 1.88%.

The total construction project pipeline in Turkey, including all mega-projects, stands at 2.3 Trillion Turkish Lira (US$ 468.2 billion). The pipeline, which includes projects at all stages of preparation from pre-planning to execution, is relatively skewed towards early-stage projects, with 53.4% of the pipeline value being in projects in the pre-planning and planning stages as of January 2019.

Turning briefly to the global construction industry, it can be predicted that the Asia-Pacific region will continue to account for the largest share of the global construction industry, including the massive markets of China, Japan and India. Growth is likely to slow, however, given the projected slowdown in China's construction industry as well as certain weakness in South Korea. The emerging markets of South-East Asia will invest heavily in new infrastructure projects, supported by private investment. Meanwhile, construction growth in India will gather pace following a poor performance in recent years. Construction output in Australia has been volatile owing to major shifts in the oil and gas sector; however, if we exclude oil and gas from our prognosis, we can speculate that the construction industry will be boosted by solid growth in infrastructure and non-residential buildings.

Construction activity is gathering momentum across Western Europe. The region's output will expand by 2.4% a year on average in 2018–2022. In 2016, there were sharp contractions in construction output in many Eastern European countries followed by a major reversal in 2017. Assuming EU funding continues to flow into these territories, the region will expand by 4.3% over the forecast-period. Russia's construction investment will be focusing on road and railway projects. In addition, a recovery in the Russian oil and gas sector is expected to nurture a recovery in Russia's construction output.

In line with its infrastructure plan, the USA is expected to increase infrastructure spending to a value of approximately US$1.5 trillion. However, much of this construction expenditure is contingent on approval from Congress. Nevertheless, the construction outlook for the USA in 2019–2020 remains solid, and the country is expected to witness ongoing investment in the construction industry.

The Middle East and Africa region as a whole will be the fastest growing region in 2018–2022, with an annual average growth of 6.0%. Countries in the Gulf Cooperation Council (GCC) have suffered from a drop in in oil prices in recent years, as government revenues have been greatly reduced. Assuming oil prices stay relatively high, large-scale investment in infrastructure projects – mostly related to transport – will be a key driving force behind growth in the region. Qatar's construction industry will remain one of the fastest growing in the world, driven by a number of multi-billion dollar infrastructure and superstructure development projects, as well as preparations for FIFA 2022.

The pace of growth in sub-Saharan Africa will be particularly strong, averaging 6.6% a year in 2018–2022. There will be a steady acceleration in construction activity in Nigeria during the period to 2022, supported by government efforts to revitalize the economy by focusing on developing the country's infrastructure. Ethiopia will be Africa's best performer, with its construction industry continuing to improve in line with the country's economic expansion.

Following recent declines in Brazil, Mexico, Colombia and Chile, construction activity in Latin America is predicted to expand in the following years, with the region growing by 1.2% in real terms. The expansion, though, will continue to be subject to downside risks in Brazil and Mexico.

Following this brief overview of the global construction industry; I am proud to confirm that Kordsa has started the production of polypropylene monofilament fibers at its plant in Izmit, Turkey.

This new investment is a new version of KraTos, an innovative concrete reinforcement synthetic fiber currently being used in many prestigious projects in the construction industry.

We aim to offer our new synthetic fiber products **KraTos Macro PP 40 mm** and **KraTos Macro PP 54 mm** for use in a range of infrastructure and superstructure projects. They are expected to be chosen by sector professionals in Turkey and abroad and exploited in applications including industrial floors, concrete roads, screed, topping, slab on ground, tunnel and shotcrete linings, track slabs, port projects, hydraulic structures, precast concrete and so on. KraTos is easy and fast to use and thus saves time, and due to its homogeneous distribution properties it increases concrete toughness, offering unique structural strength as well as low carbon emissions. Providing material for truly innovative products with high engineering and performance characteristics, KraTos PP is engineered to shape the construction industry.

In 2018, we completed the segmentation of our new products and established a dedicated professional dealer network. Every member of the Construction Business Unit (CBU) possesses extensive technical expertise, enabling us to provide dedicated technical solutions that might differ from case to case. With the support of CBU's strong and dedicated R&D team, we supply project-exclusive on-site technical support and laboratory test services, all of which set us apart from the competition. Our target for 2019 and 2020 is to expand and focus on export markets such as the USA, Europe, the Middle East, Brazil, Indonesia, Thailand and Russia. Together with the members of the Construction Business Unit and our esteemed team partners at Kordsa, we are focused on reinforcing concrete worldwide.

***Financial and Statistical Data Source: GlobalData

On one occasion we were expecting a group of three people from India. Their arrival time was early afternoon, so we had scheduled a meeting shortly after their arrival and sent a company driver to pick them up and bring them to our office.

Some Customers Look a Like

VAHE HANAMİRİAN

Global Accounts and Marketing Director, Kordsa

It is our custom at Kordsa to arrange a car pick-up for our clients arriving in Istanbul. Traffic is always a problem and the quality of taxis quite poor, so customers usually appreciate our gesture. It is preferable for us too, as we can be sure that our customers are being transported reliably and safely.

On one occasion we were expecting a group of three people from India. Their arrival time was early afternoon, so we had scheduled a meeting shortly after their arrival and sent a company driver to pick them up and bring them to our office. As planned, around 3pm they arrived at the office. They were new customers whom we had not met before, so we needed to exchange business cards. To our great surprise and embarrassment, we immediately realised that they were not from India but from Puerto Rico and were visiting a local pharmaceutical company. Our driver had picked up the first group he saw of three people with slightly dark skin, presuming that they were our Indian guests! When we asked him, he said that the Puerto Ricans were the only group of three people he could find that looked like Indians.

We had to arrange two drivers, one to take the Puerto Ricans to the right Turkish company and the other to rush to the airport to pick up the waiting Indian group.

WE REINFORCE LIFE

News

Kordsa Takes Part in New EU-funded Project Within the Scope of the Horizon 2020 Program

Reinforcement leader Kordsa is among 22 project partners participating in the PolynSPIRE project within the framework of the Horizon 2020 program, the aims of which are to strengthen Europe's research and technology development capacity, promote university-industry cooperation and develop cooperation in various fields. The main objective of PolynSPIRE is to demonstrate a set of innovative, cost-effective and sustainable solutions for efficient plastic recycling. KoWi, the European Liaison Office of German Research Companies, hosted the kick-off meeting of the project on September 25th in Brussels. The project partners who came together at the kick off meeting had the chance to get to know each other as well as discussing the project management process and technical details of the recycling processes. At the meeting, Kordsa's R&D team shared their views on their role in, and expectations of, the project.

The PolynSPIRE project comprises 22 partner organizations from 11 countries, led by CIRCE, the Research Centre for Energy Resources and Consumption. The project has a duration of 48 months and addresses three innovation pillars. The first pillar is chemical recycling assisted by microwaves and smart magnetic catalysts. The second innovation is the use of advanced additivies and high energy irradiation to enhance the quality of recycled plastics. These two innovations can lead to a 33% direct reduction in the use of fossil fuels for the

production of polyester, polyamide and polyurethane. The third expected output of the project is the valorization of plastic waste as a source of carbon for the steel industry, which can enable reductions of around 80% in the employment of fossil carbon sources in electric arc furnaces.

[1] This project is a research project funded by Horizon 2020, the EU's new research and innovation program, under grant agreement No 820665.

Kordsa Introduces a New Fast Press Curable Resin with an Enhanced Visual Quality

Kordsa has introduced a new fast press curable prepreg system in composite technologies, with the aim of supplying the best possible materials solutions for manufacturing good quality, low-cost, large-volume composite parts. At its R&D center located at the Composite Technologies Center of Excellence,

Kordsa has developed an innovation that eliminates whitespot problems in visual parts, thus providing high visual clarity for the automotive industry.

This new generation fast press curable resin, especially formulated for a cosmetic-grade visual carbon look, has opened up the possibility of using prepregs in automotive mass production. Due to the long duration of composite manufacturing processes, composite materials were previously not able to satisfy the takt time required by the automotive industry. This is one of the main factors that limited the range of previous generation prepregs that could be used in automotive mass production and which restricted the use of composites to high-end segments. With this revolutionary formulation, Kordsa has achieved an enhanced visual quality, optimized for automotive mass production.

Kordsa Introduces Its Products for the Aerospace and Aviation Industries at CAMX 2018

Kordsa exhibited its products for the aerospace and aviation industries at CAMX 2018, held in Dallas, Texas on October 16-18, 2018. Acquired by Kordsa in 2018, Fabric Development Inc. and Textile Products Inc., strategic material suppliers for the global commercial aviation industry, represented Kordsa at the expo.

Bringing together R&D, engineering, manufacturing, service providers, and end-users of the composites and advanced materials industry all around the world, CAMX 2018 (now in its fifth year) hosted over 900 exhibitors and over 15,000 visitors from 50 countries. Reinforcement leader Kordsa was represented at the fair by its recently acquired US-based companies Fabric Development Inc. and Textile Products Inc. Kordsa presented its fabrics for the aerospace and aviation industry in the US market, reinforcing its commitment to the commercial aviation industry.

As part of its quest to be a strong player in the supply chain for the ever-growing aviation industry, Kordsa strives to build a second Kordsa by safeguarding its leadership of the tire reinforcement technologies sector through investments in composite technologies.

Kordsa at "Road2Tunnel" Fair with Its Synthetic Fiber Reinforcement KraTos

Participating in the 3rd International Roads, Bridges and Tunnels Fair "Road2Tunnel", held in the Istanbul Congress Center between 3 and 6 October 2018, reinforcement leader Kordsa displayed its innovative KraTos synthetic fibers for concrete reinforcement. KraTos ensures lasting and high durability, as well as savings on cost, time and labor. Visitors to the fair were informed about KraTos Macro, which has a non-conductive and anti-corrosive structure, and about KraTos Micro. The latter is a concrete reinforcement fiber that prevents early cracking and enables smooth concrete surfaces. Visitors were briefed on the advantages and fields of use of both materials.

KraTos is the first Turkish product in the international fiber reinforcement market. The fact that it is produced domestically means that it can be supplied fast and easily, which makes KraTos preferable for many infrastructure and superstructure projects.

Among the projects that are reinforced with innovative, high performance KraTos synthetic reinforcement fibers are the toll booths of the 3rd Bosphorus bridge in Istanbul, the Samsun light rail system project, the Eskişehir light rail system project and the Trabzon General Directorate for State Hydraulic Works' pressurized water tunnel project. Recently, Kordsa announced that

KraTos macro synthetic fiber would be used in the construction of the Buca-Bornova Tunnel, which will be the longest highway tunnel in Izmir.

Kordsa at Composites Europe with Its Composites Technologies

At Composites Europe, the specialist international exhibition of composite materials and equipment, where the latest innovative products and technologies are presented, Kordsa exhibited its light-weight prepregs and fabrics. At this fair, which attracts tens of thousands of visitors each year and was held between November 6 and 8, 2018, in Stuttgart, Germany,

Kordsa exhibited its solutions that add speed and efficiency to the automotive industry. On display also were the products of Kordsa's three newly acquired companies: Fabric Development and Textile Products, which provide advanced woven composite for the aviation sector, and Advanced Honeycomb Technologies, which supplies advanced materials for the aviation and aerospace industries.

Kordsa, whose reinforcement technologies have allowed it to reshape the industries in which it operates, has become a major player in the supply chain of the growing commercial aviation and aerospace markets. This is largely thanks to its investments in composites. Taking a solution-partner approach, Kordsa provides its customers with services such as design, analysis, materials library and prototyping support while also developing prepregs, fabrics and resins as well as tailor-made and cost-effective composite intermediate materials.

Kordsa Listed in BIST Sustainability Index for Third Consecutive Year, with Improved Ranking

Kordsa was among the 50 most sustainable companies listed in Borsa Istanbul for the period between November 2018 and October 2019. This year, having improved its ratings for environmental criteria, Kordsa has been deemed worthy of being included in the BIST

(Borsa Istanbul) Sustainability Index for the third year in a row. After the launch of its fourth Sustainability Report, communicating its environmental, social and economic impacts, Kordsa has been honored with the highest score in environmental management criteria and has increased its rating to medium-level for environmental reporting criteria.

The BIST (Borsa Istanbul) Sustainability Index is formed through the assessment of the BIST 100 companies by an independent audit company, which applies international sustainability criteria in measuring companies' sustainability performance.

Kordsa Reinforces İzmir's Longest Tunnel

KraTos synthetic fiber reinforcement will be used in the construction of the Buca-Bornova Tunnel which is the longest highway tunnel in Izmir with a total of 7 km of tunnel length. The Metropolitan Municipality of Izmir has planned to introduce this tunnel with a view to relieve the traffic in Buca and preferred KraTos in the shotcrete application of the tunnel, which is expected to undergo severe deformation due to heavy traffic, for its

long-term durability, resistance to corrosion and high concrete toughness, as well as the time-saving advantage it creates by shortening the construction period of the project.

Being the result of Kordsa's meticulous R&D efforts, the synthetic fiber reinforcement for concrete, KraTos, makes a difference in infrastructure and superstructure projects. It is unique in concrete reinforcement applications in construction projects with the convenience, fast applicability, low workmanship requirements, increased equipment and energy efficiency, high concrete toughness and long-term durability it offers and is also a green fiber reinforcement owing to its low carbon emissions.

Kordsa Leaders From 4 Continents Get Together

The Global Leadership Summit where Kordsa gathers leaders from its facilities around the world every year was held on January 8 with the theme "Source of Force". The agenda of the event included an assessment of 2018 and review of the targets for 2019. The panel discussion organized with the participation of students at universities sponsored by Kordsa attracted great interest.

Trainings by the R&D Academy

The R&D Academy organized internally at Kordsa delivered trainings to R&D employees and engineers for a week. There was a high number of participants at the event where many areas were covered ranging from the stages of cord fabric production to laboratory studies, patents and most recent developments in Kordsa's construction reinforcement and composite technologies.

Kordsa Among Strategic Suppliers of Defense Industry Projects

Kordsa successfully completed the customer audit carried out within the framework of the Assessment of Ministry of Defense-approved Suppliers and Strategic Partnership Agreements without any findings. As a result of the audit, Kordsa was granted the right to be listed among strategic suppliers of defense industry projects.

Indo Kordsa Celebrates Its 33rd Anniversary

Indo Kordsa, Kordsa's company based in Indonesia, celebrated its 33rd anniversary with diverse events. At one of the events where Indo Kordsa's achievements to this day were shared, the Reinforcer Band and the Indo Kordsa Choir staged music performances, and the sports awards of the year were presented.

Projects in the Second Term of the Global Rotation Program are Concluded

Operating on 4 continents with 11 plants, two years ago Kordsa had introduced its Global Rotation program which gives its employees the opportunity to go on short-term assignments in various countries with the projects they develop. The participants of the second term of the Global Rotation program have started to conclude their projects and return to their countries.

New Term in the Generation Next Development Program

The first module of the Generation Next development program designed for engineers and experts at Kordsa was carried out with participants from Indonesia, Thailand, Brazil and Turkey. Focusing on self-awareness, interpersonal communication and conflict management, the development program will be completed with one-on-one coaching interviews and a simulation training.

Excellence Visit to Asia-Pacific

An Excellence Visit was organized to Kordsa's plants in Thailand and Indonesia. Kordsa aims to promote good practices at all its plants through Excellence Visits. During the visit where good practices in manufacturing and technology were shared with participants, seniority awards were presented to employees who have been working at the plant for 20 years and 10 years.

Visit by the Ministry of Industry and Technology to Kordsa

Deputy Ministers of Industry and Technology Mr. Çetin Ali Dönmez and Mr. Mehmet Fatih Kacır visited the Composite Technologies Center of Excellence. During the visit, the production area and field were toured and information was given on advanced composite technologies developed at the Center.

Kordsa's Innovative Product Completed the Innovation Cycle

Kordsa's R&D and technical engineers concluded the transition of Capmax from the completed innovation cycle to the production cycle. Kordsa's innovative product Capmax, which reduces the weight of the tire as well as its frictional resistance is now among Kordsa's standard products.

Kordsa Speaks at the 7th International Technical Textiles Congress

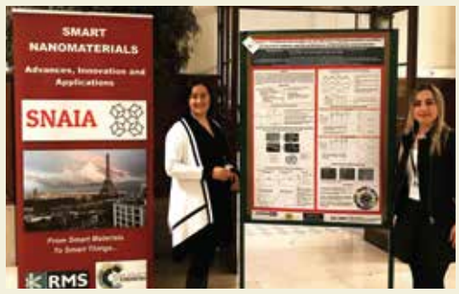
Kordsa's Global Technology Director Devrim Özaydın delivered a presentation at the opening of the 7th International Technical Textiles Congress. At the conference, where industrial experience and scientific studies were shared, Özaydın highlighted the innovative and green technologies developed by Kordsa.

Indo Kordsa Joins Career Day

Indo Kordsa, Kordsa's company based in Indonesia, joined the Bogor Career Day. Throughout the event where 40 companies and institutes operating in Indonesia were represented at their booths, Indo Kordsa received many applications for its available positions.

Kordsa presents at the Smart Nanomaterials 2018 Conference

The joint project of Kordsa and Sabancı University in composite technologies was delivered as an oral and poster presentation at the Smart Nanomaterials 2018 Conference in Paris. As a result of the detailed assessment by the reviewers at the conference, Kordsa's study on thermoplastic composites was awarded the best poster prize.



Kordsa organizes Ideation Workshop

Kordsa organized an Ideation Workshop in order to develop new ideas in tire reinforcement technologies. Many new ideas were generated at the workshop. Efforts to prioritize the ideas have begun in order to initiate new projects.

Quality Day at Kordsa America

Quality teams at Kordsa's Laurel Hill facility in the U.S. organized a quality day. The agenda of the event included improvement projects introduced with a view to eliminate quality problems and prevent the recurrence of all kinds of failures.

New Collaboration Between Kordsa and Sabancı University

Kordsa and the Sabancı University Applied Research Center have partnered for a new

R&D platform. The R&D platform will work on the development of new products in the field of thin films and flexible electronics.

Advances in Mechanical Engineering

Kordsa spoke at the International Conference on Advances in Mechanical Engineering (ICAME) 2018. At the conference, Kordsa's R&D Leader Mert Patkavak delivered a presentation titled "An Experimental Study on the Correlation of Nusselt and Reynolds Numbers to Determine Convective Heat Transfer Coefficients in the Cooling Process of the Yarn Production Line".

Kordsa Explains Its Digital Transformation at the Industry 4.0 Summit

Deputy Ministers of Industry and Technology Kordsa CEO Ali Çalışkan spoke at the panel discussion titled CEO Vision of the CEO Club Industry 4.0 Summit organized by the Capital magazine. Çalışkan shared the concrete outcomes of their digital transformation efforts. He shared how they monitor efficiency in their manufacturing facilities on four continents via mobile devices and how they identify up to 99% of quality defects through their proprietary digital sensor technologies.

Kordsa's Global IT Summit Held in Turkey

The Global IT Summit, where the Kordsa Information Technologies Unit evaluated its activities in 2018 and its goals for 2019, was held in Turkey. Featuring the theme "Advanced Data Analytics", the event brought together Kordsa employees from four continents.

Visit by the Shanghai University

MBA students from the Shanghai University visited Kordsa's facilities in Izmit. During the visit, good practices in employee engagement, recognition, performance evaluation, Total Productive Maintenance (TPM) and digitalization were shared with the participants.

TPM Efforts Continue Full Throttle at Thai Indo Kordsa

Total Productive Maintanence (TPM) week was organized at Thai Indo Kordsa, which runs Kordsa's operations in Thailand, with the participation of employees from manufacturing, maintenance and administrative functions, and participants assessed the annual TPM plan and improvement efforts.

Kordsa's Total Productive Maintenance Efforts Continue

Kordsa's Total Productive Maintenance (TPM) program implemented at all its plants around the world aiming for "zero accidents", "zero defects", "zero failures" and "Satisfied Employees" continues to make a difference at all facilities. Thanks to trainings and the implementation of the program at Kordsa's manufacturing facilities in different regions, improvements have been observed in many areas that influence efficiency like the number of failures and equipment downtime.

Kordsa takes part in the 4th Construction Chemicals Seminar as speaker

Kordsa took part in the 4th Construction Chemicals Seminar, where innovative practices and technical developments in the construction chemicals industry were shared, as speaker. The construction reinforcement R&D unit shared information about Kordsa's innovative synthetic fiber reinforcement and the advantages they provide in a variety of structures. seniority awards were presented to employees who have been working at the plant for 20 years and 10 years.

Kordsa participates in the International Civil Engineering Technologies Congress as speaker

Kordsa delivered a presentation together with Boğaziçi University at the 13th International Civil Engineering Technologies Congress where most recent findings and technologies in different areas of civil engineering were shared. The presentation highlighted Kordsa's innovative construction reinforcement technologies and the advantages they offer.

Kordsa Participates in the Metrorail Forum

Kordsa participated in the 2nd International Metrorail Forum that was held at the Istanbul Congress Center with the participation of many industry professionals, and delivered a presentation titled "Concrete Reinforcement Applications with National Macro and Micro Synthetic Fiber Reinforcement Featuring Kordsa Technology" in the session "Rail Systems and National Production – the Private Company's Perspective".

WE REINFORCE LIFE

CSR Projects

Kordsa Renovates Another School in an Effort to Reinforce the Future

Committed to its vision "We Reinforce Life", Kordsa continues to carry out corporate social responsibility projects. It has made yet another contribution by reinforcing the future of the children of İzmit, the town in which Kordsa's story started 45 years ago. 250 volunteers from Kordsa sites on four continents renovated a primary and secondary school in İzmit, Kocaeli. Over the past years, Kordsa's Reinforcers have renovated three different schools in the same area.

This year, as well as renovating the cafeteria and library of both the primary and secondary school, Kordsa established a science laboratory in the secondary school. We also supplied new classroom furniture, including closets and desks. Kordsa set up a playground in the garden to create a safe and pleasant environment where students can play and relax. With each corporate social project, Kordsa aims to reinforce the people and society of the territories in which it operates.

YTU Racing Team Participates in Formula Student Italy with a Car Reinforced by Kordsa Technologies

Exporting technology from Turkey to the world, Kordsa supports university projects in line with its mission to reinforce the future. Yıldız Technical University Racing Team recently participated in Formula Student, a massive engineering competition held in Autodromo Riccardo Paletti in Varano, Italy. Their vehicle, the fifth to perform in this competition, was reinforced by Kordsa's composite technologies. Kordsa's composite material support helped the YTU Racing Team finish twentieth out of 60 teams.

The Yildiz Technical University Racing Team is one of the university projects sponsored by Kordsa in an effort to encourage students to engage in technology, innovation, R&D and engineering. The Team managed to achieve great success at Formula Student Italy. One of four teams from Turkey to take part, YTU Racing Team passed all the technical control stages and qualified to participate in the dynamic race stages. It finished in twentieth place out of 60 teams in this important competition, which aims to develop enterprising, innovative and well-equipped young engineers driven by team spirit.

Kordsa Reinforces the Future in Indonesia

Committed to reinforcing life, Kordsa, which operates in Indonesia as Indo Kordsa, is once again helping children on the path to a better education. Back in 2017, as part of its corporate social responsibility (CSR) program, Indo Kordsa renovated three schools in Bogor. In partnership with the Bangun Sekolah Foundation, an NGO focusing on renovating schools with limited facilities in 2018. Indo Kordsa renovated the Insan Muda Mulia Junior High School in West Java, which had been damaged by a natural disaster. After the ground breaking ceremony had been held in May, Indo Kordsa inaugurated two local classrooms in September. Kordsa will continue its CSR activities in the surrounding villages in Indonesia, as well as in every part of the world in which it operates, contributing to its goal of building an educated future by providing scholarships and renovating schools.

Kordsa America Meets with Teachers

Kordsa Reinforcers at the Chattanooga facility of Kordsa, which aims to empower the community it belongs to in every country it operates in, visited Dupont Elementary School they had declared to be their twin school. During the visit that has by now become a tradition they organized a breakfast for teachers before the beginning of the new school year.

Kordsa Reinforcers Fulfill the Dreams of a Child

Together with the Make-A-Wish Association, Kordsa's reinforcers made the wishes of a child struggling with a critical illness come true. Accompanied by Kordsa reinforcers, the child who had made the wish spent a day with the Galatasary football team.

WE REINFORCE LIFE

Awards

Industry 4.0 Award to Kordsa at Platin Global 100 Awards

At its Global 100 Awards ceremony, the leading economics and business monthly magazine Platin recognized Turkey's most successful 100 companies. The event was organized to acknowledge the value created by Turkey's export champions in promoting Turkey abroad and sharing best practices, thereby serving as role models for the Turkish business world. As such, the Platin Global 100 Awards is considered to reflect the strength of

the Turkish economy. At the awards ceremony, one of the leading companies to be celebrated was Kordsa, which operates with the mission of reinforcing life. Kordsa received the Industry 4.0 award in the textile category. İbrahim Özgür Yıldırım, Chief Operating Officer-EMEA, received the award on behalf of Kordsa. In his acceptance speech, Yıldırım said: "As a global brand that sets the quality standards of the industry, we create new production models with our industry 4.0 solutions. We aim to accelerate production and innovation processes through our smart production systems, which facilitate improved production quality and less error. This award proves the strength of Kordsa in the international arena. I would like to thank all my colleagues for their unwavering commitment."

Sustainable Business Award for Kordsa Sustainability Report

In line with its mission to "Reinforce Life", Kordsa's constant aim is to create sustainable value for society and its stakeholders by developing reinforcement innovations and technologies. Kordsa showcases its efforts in its Sustainability Report, which reflects the economic, environmental and social dimensions of its activities. The report also highlights its R&D activities in every facility in which it operates and reviews its innovative products, technologies and processes. It also covers the company's relationship with its suppliers and customers and, within the scope of environmental management, provides detailed information about its energy emissions, waste and water management, and biodiversity issues.

At the Fifth Sustainable Business Awards, Kordsa received an award in the Sustainability Report category for its fourth annual Sustainability Report. The Sustainable Business Awards aim to promote the transformation to sustainability in Turkey by increasing awareness of best practices in businesses that yield optimal social, economic and environmental impacts.

Kordsa Among Top 150 Best Employers

Kordsa Brazil has once again been included in the 150 Best Employers list prepared by Você S/A., one of Brazil's most prestigious magazines. The list, which was prepared based on interviews with employees, includes the leading employers in Brazil.

Kordsa has been recognized as one of the Best Employers for the second consecutive year. And this is not the only award for Kordsa Brazil. On three occasions, the Great Place to Work Institute (GPTW) has listed Kordsa among the best employers in Bahia, Brazil, and GPTW has also named it the 18th best company among 150 companies in Brazil. Last year, by achieving the highest score among first-time competitors, Kordsa earned the special status "revelation of the year" awarded by Você S/A. For the third year in a row, it was also deemed eligible for the "Best in Internship Practices" award in Bahia, Brazil.

Ali Çalışkan Among Leaders Steering Technology in Industry

Kordsa CEO Ali Çalışkan was listed among the Leaders Steering Technology in Industry, a list prepared by the Capital magazine. The award was given to leaders who are pioneers in the industry with their technological investments, visions and corporate strategies.

Employee-Employer Relations Award

Thai Indo Kordsa was honored with the Superior Employer-Employee Relations award after an assessment made by the Ministry of Labor of Thailand. This is the ninth consecutive year that Thai Indo Kordsa was deemed worthy of this award.

Indo Kordsa Receives Anti-Corruption Award

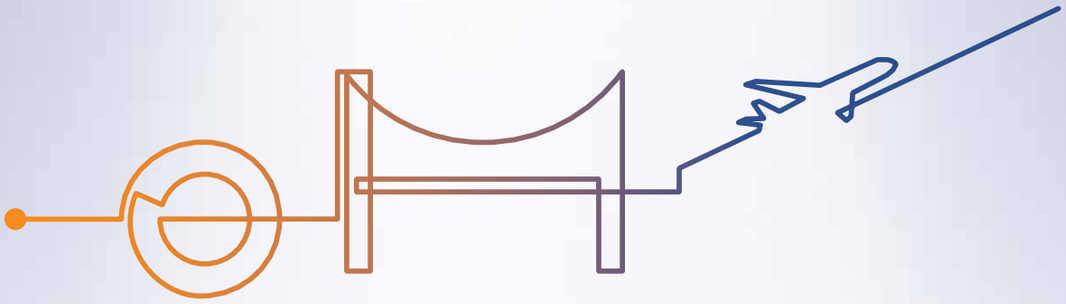
Indo Kordsa received an award by the Indonesian Directorate General for Customs and Taxes for its efforts supporting the fight against corruption. Presented as a result of an assessment of compliance with regulations and ethical values, the award is a significant indicator of Kordsa's commitment to ethical values.

Indo Kordsa Awards Best 5S Practices

Indo Kordsa awarded the best 5S practices executed in 2018. Kordsa implements 5S principles in all its plants with a view to eliminate waste resulting from uncontrolled processes, monitor the location and position of machinery and equipment, and have regular oversight of critical process parameters.

International Award for Kordsa's Leadership Stance Development Program!

Kordsa organizes a three-module Leadership Stance development program that focuses on managing emotional energy and reinforcing physical and intellectual capacity as well as visionary leadership. Kordsa received the "Best for Bespoke Leadership Development Training 2018" award given by the Middle East and Africa Markets magazine for its Leadership Stance program.



KORDSA REINFORCES LIFE ALL OVER THE WORLD

1 out of every 3 automobile tires and 2 out of every 3 aircraft tires manufactured worldwide are reinforced by Kordsa technologies. With its strategic investment, Kordsa now reinforces the hulls and wings of aircrafts with its composite technologies.

Acquiring three companies, which are strategic suppliers of commercial aviation industry, Kordsa continues to reinforce life by extending its technolgy leadership to the whole world.

KORDSA

THE REINFORCER

INSPIRED
FROM LIFE

**WE REINFORCE
LIFE**

KORDSA

THE REINFORCER