

THE REINFORCER

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Determined to Create Value

KORDSA

*Reinforcing life is our new normal,
As it used to be*



We are inspired to reinforce life

We continuously improve in material, water and energy efficiency in production with the inspiration of the nature's productivity. Aware of our responsibility for the environment, and communities around us, we step up our performance every day for a sustainable future.



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Inspired to reinforce life, we will continue to play a key role in developing a better, more sustainable world for future generations. With our highly differentiated capabilities and significant investments, we will strive to find better new ways in the fields we operate, and we will continue to deliver value for all our stakeholders.





Foreword

ALİ ÇALIŞKAN

CEO

Dear Esteemed Partner,

As the world adapts to a “new normal” with COVID-19, our mission remains anchored in reinforcing life through innovation and customer satisfaction. We are surely gearing up for this new normal and undoubtedly are emerging stronger and more competent after the pandemic. The new normal requires flexibility, the new normal requires transformation. As the Reinforcer, we have been in a transformation over the last years to build a better future and we remain committed to our transformation, leading the way for our people, our clients, and communities.

Crisis requires complex problem-solving. At Kordsa, we believe different backgrounds, perspectives and experiences bring benefits to complex problem-solving. Kordsa’s rich culture; embracing different regions and perspectives, makes us more adaptable to changes and challenges, as it did during this period. As a company operating in a wide range of geography from North America to Asia Pacific, we have created a global culture fostering an environment where all Kordsa employees learn from others and support each other.

The pandemic has also permanently changed the way we engage with the world and has transformative effects on trends that will influence production and economy. And sustainability has hit the mainstream and moved closer to the center of decision-making of companies. These will likely become the new normal. Now the driving companies review and revise their assumptions and scenarios regarding this changing world.

This period proved our previous strategic actions right as hot topics on our agenda like waste management, circular economy, lightening vehicles, mobility-based subjects, sustainable material usage ratio. Driven to deliver exceptional value, we embrace new opportunities to create a sustainable future.

I am positive Kordsa will be at the forefront for these hot trends.

Concerning sustainability and responsible use of resources, compounding, our new business line based on the circular economy principle, has become even more critical for us. With our compounding model, we generate the waste accumulated during the production process into Nylon 6.6 chips to be used in the engineering plastics industry. These raw materials provide resistance to high temperature and abrasion. Thanks to their high chemical resistance and easy-to-process properties, they are being used for different applications in various industries such as electronics, white goods, lighting and automotive interior panels. With this recycling process, while meeting customer needs for high-quality raw material, we also create environmental and financial added value.

Adding a new one to our sustainable products and technologies, we have started to use recycled nylon yarns in our tire reinforcement technologies. To top it

all, this sustainable product, is already used in tire production by our business partners. With this technology, which does not compromise on quality and safety at all, we are reinforcing our position in the industry and take a big step forward to become the leading material supplier of the future.

We care to reduce our carbon footprint not only with our technologies but also during our production process. The Carbon Disclosure Project (CDP), the first and only NGO that assesses how publicly traded companies manage climate change risk, has raised our score from C- to B in 2019, and to A- in 2020 as a result of the efforts we carried out to manage risks and opportunities related to climate change. Kordsa is now among the Climate Leaders. I am proud to say that our sustainability efforts are also confirmed with a Gold rating by Ecovadis, the international provider of business sustainability ratings. We received this award among over 40.000 companies surveyed for their sustainability works between 2015-2019 in areas concerning the environment, labor and human rights, ethics, and sustainable procurement.

For sustainable mobility, we keep expanding our competencies and broadening our operation field. The main goal is reinforcing while lightening with sustainable technologies. Today we are in the supply chain for the aerospace industry with our US-based Fabric Development, Textile Products, Advanced Honeycomb and Axiom Materials.

As part of our effort to expand the areas where our products are applied, I am thrilled to announce a collaboration which will take us to the farthest place in space. Fabric Development is now producing fabrics for NASA’s multi-purpose spacecraft Orion. Orion, which will carry astronauts into deep space, and then return them, is very critical for the space industry because its flight will be the farthest humans have ever traveled into space. It is an honor to have the Kordsa signature on the orange balloons used during the construction of this significant space vehicle. The fabric that Fabric Development had started weaving for NASA’s Orion capsule was actually first produced in 2011 under the name Style 2150.

As the world goes toward an emission-free era, electrical cars will soon become a commercial reality. We contribute to this shift with our tire reinforcement technologies providing better rolling resistance and with our composite technologies lightening vehicles.

With our carbon fiber fabrics that are used in the process to deliver continues -fiber thermoset composite parts at high volume for the fast-expanding EV market, we aim to contribute to world’s successful transition to sustainable transportation. In this regard, we have recently secured a supplier agreement with TRB Lightweight Structures, a global high-volume composites manufacturing company. TRB is using Kordsa’s carbon fiber fabrics in the manufacture of their composite battery enclosures for EVs. This partnership enables the use of our carbon fiber fabrics in EV battery packs, helping reduce their weight without compromising their quality.

While we reinforce life, we always start with reinforcing ourselves. I am content to announce our efforts to reinforce our people first is appreciated once more with an honorable award. Kordsa, this year too, is the winner of the “Most Amazing Place to Work in Brazil” Award. The award is based on the Employee Experience survey with 150.000 employees of 100 companies. It is a real success to be among the top ones of the leading 100 companies. As you know this is not Kordsa’s first award in Brazil in this regard. Kordsa was also listed as the Best Employers in Brazil by the prestigious magazine Você S/A last year, was among the best employers in Bahia four times in a row and has been named the 18th best company by the Great Place to Work Institute (GPTW).

Such awards are the silver lining that adds meaning to what we do and motivate us to go further especially in times that we are pushed out of our comfort zone. But there is also one more thing that motivates to go further and that is cooperation. I want to express sincere appreciation to all stakeholders for their efforts, support and contribution to make this challenging period smooth and efficient. Inspired to reinforce life, we will continue to play a key role in developing a better, more sustainable world for future generations. With our highly differentiated capabilities and significant investments, we will strive to find better new ways in the fields we operate, and we will continue to deliver value for all our stakeholders.

With this new issue of the Reinforcer, we are inviting you to explore more on Kordsa’s operations, projects and plans in the past months and in the future ahead. Wherever our industries are evolving, and the future is being shaped, Kordsa will be at the forefront of innovation.

I wish you an interesting read!

Due to the reduced fire risk and the low occupational safety risk of using water-based phenolic instead of solvent-based phenolic in the production of phenolic honeycombs, Kordsa-AHT enjoys the advantage of more sustainable production than its counterparts in the USA and Europe.





Production Steps and Requirements of Phenolic Honeycomb Cores for Aviation Parts

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If they are to be used in aviation internal parts, Aramid Honeycomb Cores are required to have low fire smoke toxicity, to be flame-retardant and to comply with FAR 25.853 FST. For internal composite parts/sandwich panels to be used in aviation, where low FST properties are required, the material of choice is phenolic resins.

Test Name	Test Modes	Test Methods	Maximum mean values required	
Flammability vertical, 60s flaming	Burn Length	AITM 2.0002A	< 100	mm
	After flame time		0	s
	After flame time of drips		0	s
Max. specific optical smoke density within 4 min	Flaming mode	AITM 2.0007A	< 5	Ds
Heat release		AITIM 2.0006	< 35	kW/m2
Heat release rate		AITIM 2.0006	< 65	kW - min / m2
Flammability vertical, 12s flaming	-	-	-	-

Table 1: FAR 25.853 FST requirements.

Traditionally, phenolic resins have been solvent-based, and the most common organic solvents that are used for this purpose are ethanol, methanol, isopropyl alcohol and acetone, or combinations of these solvents with a low boiling point like acetone, isopropyl alcohol, methanol and ethanol cause high Volatile Organic Content (“VOC”) emissions. For example, most of the solvent-based phenolic resins for honeycomb production contain 35-40% ethanol, a mixture of 35-40% methanol and ethanol, 35-40% isopropyl alcohol, or other mixtures

of these solvents, all of which lead to high VOC emissions during phenolic honeycomb production.

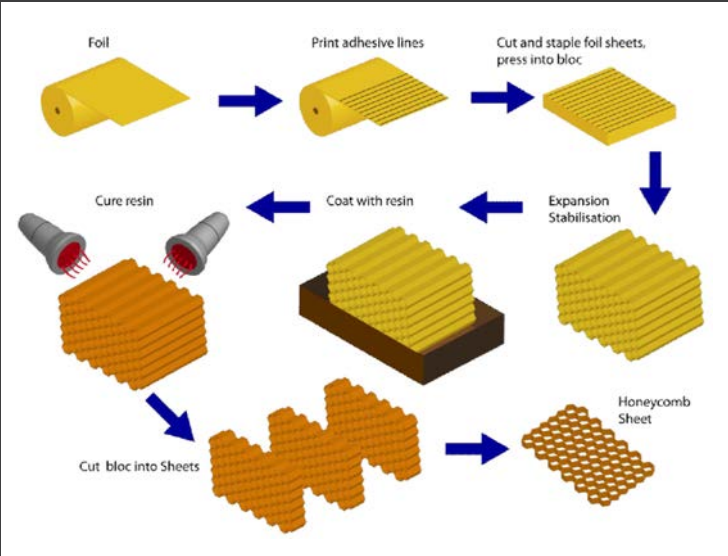


Figure 1: Honeycomb core production process.
Source: <https://www.fpl.fs.fed.us/documents/fplmisc/rpt1796.pdf>

The standard methodology for manufacturing phenolic honeycomb cores is explained in the following source: <https://patents.google.com/patent/EP0440871B1/en>

1. Epoxy-based adhesive lines, which are carbon black-colored heat-curing adhesives and which determine cell size, are printed onto substrate material in a continuous printing line and are automatically cut in the desired sheet length on printing lines.
2. The adhesive line-printed sheets are stacked on top of each other to the desired number of levels and made to temporarily adhere to each other along adhesive lines on a stacking table.
3. Blocks of the stacked sheets, which are temporarily adhered to one another by their edges are placed between platens in a press and subjected to heat and pressure to obtain permanent sheet adhesion along the printed lines of adhesive. Then, a backing material is adhered to the block ends for use in expansion.
4. The block of sheets in which the adhesive has been fully cured is then stretched to the desired length and width dimensions, thus creating the honeycomb structure with the desired cell size and geometry.
5. The expanded block is then coated in phenolic resin in a resin bath. Following this, the coated expanded block is weighed in order to establish whether the required level of coating has been reached. If necessary, it is dipped again in the resin bath to attain the desired level of coating.
6. The phenolic resin-coated expanded block is then cured in an oven (in two temperature dwells), in order that the honeycomb core reaches the desired strength and density.
7. Finally, the cured resin-coated block is sliced into sheets with the desired thickness and then trimmed.

The oven-drying and curing temperatures used in phenolic honeycomb core are at the drying step 70°C to 110 °C and at the curing step 120 to 150 °C respectively. These two steps are where the solvent evaporation, curing and curing exotherm takes place. These temperatures are higher than the boiling point and ignition temperature of the solvents used in phenolic resins, which is why most fire accidents and toxic solvent emissions (VOC) occur in solvent-based phenolic honeycomb production undertaken in curing ovens.

Harmful Emissions and Flammability Risks of Solvent Usage in the Production Process of Phenolic Honeycombs.

The concentration range of a gas or vapor in the air where it is possible that the air-gas or air-vapor mixture is flammable or explosive when exposed to an ignition source is called the Explosive Limit or Flammable Limit. For an explosion or fire to happen, three elements are required:

- 1. A flammable substance (most of the volatile organic compounds),
- 2. An oxidizer (oxygen or air),
- 3. A source of ignition (spark or high heat).

Below the explosive or flammable range, the mixture is unable to burn since it is too diluted, while above the upper explosive or flammable limit, the mixture is too concentrated to burn. The limits are called the “Lower Explosive or Flammable Limit” (LEL/LFL) and the “Upper Explosive or Flammable Limit” (UEL/UFL) (Table 2).

Material	Flash Point (°C)	Autoignition (°C)	Lower Limit (% vol. air)	Upper Limit (% vol. air)
Acetone	- 18	400	2	12
Ethanol	- 11	425	3.1	20
Methanol	11	470	5.5	36.5

Material	Flash Point (°C)	Autoignition (°C)	Lower Limit (% vol. air)	Upper Limit (% vol. air)
Isobutyl alcohol	-12.8	399	2	11

Table 2: The lower and upper explosion concentration limits for some VOCs commonly used in solvent-based phenolic resins are indicated in the table below. Some of the VOCs are frequently deployed as fuel in combustion processes. The limits indicated are for gas/vapor and air at 20°C and atmospheric pressure.

Source: <https://doi.org/10.1021/je100619p>

The density of isopropyl alcohol (relative vapor density) = 2.1 (air=1) (source: http://www.ilo.org/dyn/icsc/showcard.display?p_version=2&p_card_id=0554) and the density of other solvents in the vapor phase, like most of the organic solvents, is higher than air, so evaporated solvents can accumulate at the bottom of the oven or at any place in the oven where air circulation is limited. During the manufacturing of honeycomb materials using solvent-based phenolic resins, flammable substances evaporate and are absorbed into the air of the production facility. During the cure process for honeycomb materials, a high level of heat is applied, usually at temperatures near 150°C and beyond, thus confirming the presence of all the three requirements for an explosion. Using water as a solvent, instead of the volatile flammable organic solvents, eliminates most of the fire risks involved in the honeycomb production process.

Future SHE Trends in the European Union (REACH (EC 1907/2006))

The potential environmental and health risks in the production of solvent-based phenolic honeycombs were investigated in a paper given at the 38th International SAMPE Symposium by S. P. Qureshi et al. (source: Advanced Materials: Performance Through Technology Insertion: 38th International SAMPE Symposium and Exhibition, Anaheim, Convention Center, Anaheim, CA, May 10-13, 1993, pp. 16-27). Qureshi et al. discuss the suitability of water-based phenolic resins in the production of phenolic honeycombs and propose that using water-based phenolic resins brings reduced health and environmental risks compared to organic solvent-based phenolic honeycomb production.

The European Commission on Clean Air for Europe has estimated the value of the impacts for releasing one ton of PM2.5 of NH3, SO2, NOx and VOCs in different Member States (Table 3).

	Average damage per tonnes of emission for EU 25
NH ₃	€16,000
NO _x	€6,600
PM2.5	€40,000
SO ₂	€8,700
VOCs	€1,400

Note: Values derived using median value of Value of Statistical life on PM2.5 mortality and median Value of Life year lost for ozone

Table 3: Average damage per emissions of pollutant gases in EU 25 Member States.

Source: https://echa.europa.eu/documents/10162/23036412/sea_restrictions_en.pdf/2d7c8e06-b5dd-40fc-b646-3467b5082a9d

At first, only organic solvent-based phenolic resins were used in phenolic honeycomb production. However, as manufacturers seek to find formulations that reduce the amount of volatile organic components, solvent-based phenolic resins have fallen out of favor. Governmental regulations often mandate a significant reduction or even the elimination of volatile organic solvents from such formulations, particularly for products with selected uses. The reduction or elimination of volatile organic solvent emissions has provided new commercial opportunities for the application of resins with low levels of volatile organic compounds. Due to damage to the economy of the EU, VOC emissions (Table 4.) are expected to be more strictly controlled and reduced with REACH (EC 1907/2006).

Substance	CAS No.	Regulatory Limits		Recommended Limits	
		OSHA PEL		NIOSH REL	ACGIH® 2019 TLV®
		ppm	mg/ m³	8-hour TWA (ST) STEL (C) Ceiling	Up to 10-hour TWA (ST) STEL (C) Ceiling
Acetone	67-64-1	1000	2400	500 ppm (ST) 750 ppm (C) 3000 ppm	250 ppm
Ethyl alcohol (Ethanol)	64-17-5	1000	1900	1000 ppm	(ST) 1000 ppm
Isopropyl alcohol	67-63-0	400	980	400 ppm (ST) 500 ppm	200 ppm (ST) 400 ppm
Methyl alcohol	67-56-1	200	260	200 ppm (ST) 250 ppm (C) 1000 ppm	200 ppm (ST) 250 ppm

Table 4: OSHA regulatory limits of solvents that are used in solvent-based phenolic honeycomb core production.

Possible Positive Effects of the Use of Water-based Phenolic Resins in the Production of Honeycomb Cores in the European Union

Due to current and upcoming obligatory restrictions in the EU with respect to occupational safety, health and the environment (Table 3 and Table 4), it is expected that avoiding solvents in production and switching to water-based phenolic resins will make it a lot easier to open and maintain new workplaces.

Choice of Solvent-based and Water-based Phenolic in Relation to the End Product Performance of Honeycomb Cores

The the choice of to use organic solvent or water as the base for phenolic resins do not affect the performance of the phenolic honeycomb end product. Despite all the drawbacks of organic solvents, the main reason for not switching from solvent-based phenolic to water-based phenolic resins was believed to be the increasing production time for honeycomb core producers. Since the organic solvents that are used with phenolic resins have a lower boiling point than water, they can be removed faster and more easily during core production. Thus, using using a solvent in the honeycomb core production increases production speed and productivity, which was the main original motivation for some producers to use solvent-based phenolic cores.

Source: <https://doi.org/10.1002/app.27776>

Possible Positive Effects of the Use of Water-based Phenolic Resins in the Production of Honeycomb Cores in the USA and European Union

Due to the reduced fire risk and the low occupational safety risk of using water-based phenolic instead of solvent-based phenolic in the production of phenolic honeycombs, Kordsa-AHT enjoys the advantage of more sustainable production than its counterparts in the USA and EU.





Fiber Reinforced Composites for Structural Retrofitting

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Although the first usage of Fiber Reinforced Polymer (FRP) composites dates back to World War II (Mirmiran et al., 2003), their use as a structural material (either in new structures or for retrofitting purposes) has gained momentum in the last two decades. While the construction industry generally makes use of carbon, basalt and glass fibers bonded or shaped with a resin (i.e. epoxy or vinyl ester), new types of fiber reinforced composites are continuously being developed, boasting various mechanical and physical characteristics (i.e. PET fibers and hybrid fibers with different compounds). Thanks to the outstanding features of FRPs, such as high strength-to-weight ratio, high durability (i.e. corrosion resistance), ease of application and high tailorability (which enables them to be incorporated into specific applications), nowadays several kinds of FRP composite products (sheets, laminates, reinforcements, profiles, tubes, ropes, cables etc.) are being used for retrofitting applications as well as for the creation of new structures. On the other hand, FRPs possess several drawbacks that the composites sector and researchers need to address. These include a low glass transition temperature, low fire resistance, high-tech manufacturing requirements, difficulties in the standardization of the materials due to their high variety, uncertainties in long-term behavior and relatively higher initial costs in comparison to conventional steel reinforcement.

Retrofitting structures to make them resilient to extreme conditions, and tackling issues related to serviceability or the ageing of the structure, has been a crucial engineering problem, particularly in developing countries, where the need to reduce casualties and economic losses are all the more critical. Studies on the use of FRPs for retrofitting were first carried out by Fardis and Khalili (1982), who were followed by several researchers, particularly after the year 2000 (Figure 1). In Turkey, as far as the authors have been able to establish, the first studies on this subject took place between 1998 and 2000 at

Istanbul Technical University, and the results obtained from these studies were published by İlki and Kumbasar (2001, 2002, 2003). In parallel with research activities, various standards, regulations and manuals for the use of FRP materials in the field of retrofitting have been published since the beginning of the 2000s, the aim being to standardize retrofitting design and application (i.e. fib Bulletin No. 14, 2001; ISIS, 2001; JSCE, 2001; TSDC, 2007; GB 50608, 2010; CAN/CSA S806-12, 2012; TR55, 2012; CNR-DT 200 R1, 2013; ACI 440.2R, 2017; TBSC, 2019).

FRP composites are effective alternatives to the conventional materials used for retrofitting applications. In recent years, various retrofitting approaches that utilize FRP composites have been developed in the hope of eliminating different structural deficiencies (lack of bending moment, shear force and/or axial force capacities or deformation capabilities under these internal forces) and for improving the performance of existing structures (including nonstructural elements such as infill walls). Accordingly, FRP composites can be used to improve strength- and deformation-related characteristics, whether they are exploited in external, near-surface-mounted or internal reinforcement supplementing the existing members of reinforced concrete (RC), steel, masonry or timber structural systems. Figure 2 depicts a number of examples of reinforced concrete buildings retrofitted using FRP composites in the form of epoxy-bonded sheets and laminates, as well as masonry buildings retrofitted with textile reinforced mortar (TRM). It should be noted that, thanks to their ease of application to various geometries, low invasive characteristics and high removability, FRPs and TRM are strong candidates for the retrofitting of heritage structures, and their use in such contexts is constantly increasing (Figure 3).

The future of FRPs seems bright not only in the area of retrofitting but also for the design and construction of corrosion-proof (thus long-life) structures that are reinforced externally or internally by FRPs. The first generation of standards and/or guidelines have already been published (i.e. Sonobe et al., 1997; ACI 440.1 R-15, 2015; CAN/CSA S806-12, 2012 and fib Bulletin 40, 2007), which pertain to the use of FRP as a primary reinforcement for concrete structures. In addition, all-FRP structures (mainly bridges) are being constructed all around the world. In parallel with the developments in concrete technology (such as high performance and green concretes) and the use of FRPs as reinforcement, in the near future, it will be possible to incorporate FRPs into the creation of environment-friendly structures that will shape the sustainable cities of the years ahead.

In order to reach the goals of safe, sustainable and long service life structures, it is crucial that research bodies cooperate not just with the sector (material producers and construction industry) but also with public authorities and, most importantly, the occupants or users of these structures. We are pleased to note that FRP providers in Turkey (including Kordsa) have always been eager for this kind of cooperation, which will pave the way for further opportunities for practical applications.

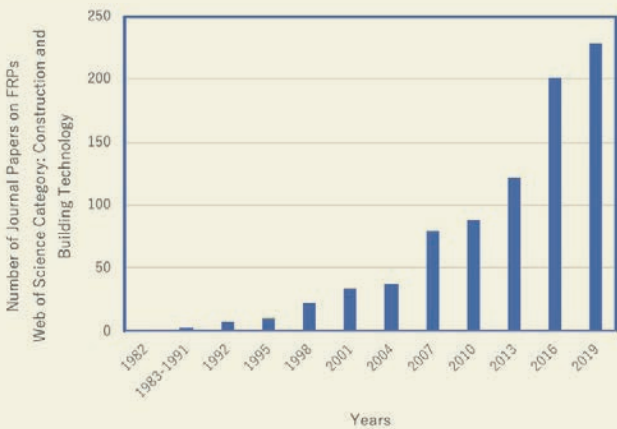


Figure 1: Variation of research studies (SCI and SCIE papers) related with FRP composites for construction (modified from İlki et al. 2011)

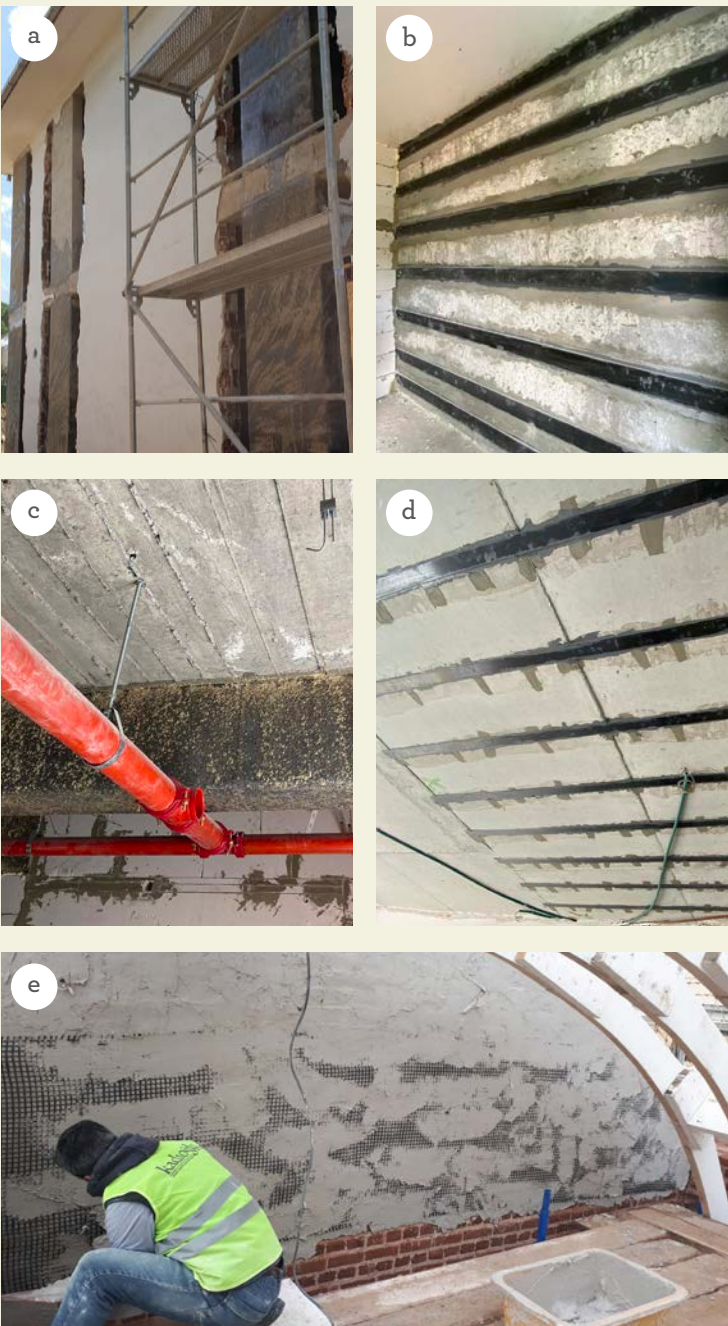


Figure 2: Examples of retrofitting of concrete and masonry buildings: (a) RC columns confined with FRP sheets, (b) RC shear walls with bonded FRP laminates, (c) RC beams retrofitted for shear, (d) RC slab retrofitted with FRP laminates, (e) Carbon textile reinforced mortar for retrofitting of a masonry building



Figure 3: Examples of the retrofitting of heritage structures using textile-reinforced mortar

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A Beneficial Bacteria or a Virus for the Earth? It All Depends on Our Choices!

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Can you imagine anything in the ground that is not recycled or does not renew itself? A tree, soil or water? That's true, nothing fails to recycle itself until humankind interferes with it. Especially nowadays, people are starting to liken humankind to a virus, which increases its population unrestrainedly, survives artificially by destroying nature and is constantly on the look-out for new places to destroy. But is this really the only way to survive? This is the question that everybody has started to ask, whether individually or as a community, particularly in the light of the most dire pandemic of our time, which has manifested itself across the globe. And we have been reminded of those small things that are crucially important for a responsible and better life. We have experienced again what it means to live with minimum requirements, which are quite enough for our physical and mental health and which are actually better for life on earth.

The consequences of destruction have been revealing themselves for a long time: global warming is now obvious to the naked eye, and we can taste the pollution of water sources with all of our senses. We have also started to appreciate how crucial plastic has become for our lives – even single-use plastics have become significantly important during the pandemic. The important thing is how to ensure that plastics and other materials are safe for the earth, how to keep them out of the ecosystem but within the value chain.

This is possible thanks to responsible communities, who are striving for a sustainable future for our children. At Kordsa, we are proud of the pioneering steps we have been taking for sustainability over the years, and we are happy to have been supporting our partners through different solutions.

Sustainability is the trending topic par excellence. Just a few years ago, for example, in the automotive industry OEMs were making regulations that stipulated the upper limit of recycled material within their products. But today, the same OEM companies are asking what the minimum proportion of recycled material is that they can include in the products which we supply to them. In 2018, Volvo Cars announced that at least 25% of all plastics in cars that they will launch after 2025 will be made from recycled materials. Audi says they are using recycled PET bottles to produce seat upholstery in their new A3 compact model and they will increase the ratio of recycled materials in the days to come.



Picture: Audi uses recycled PET Bottles for the seat upholstery in its new A3 Model.
Source: <https://www.audi-mediacycenter.com/en/press-releases/from-bottle-to-fabric-seat-upholstery-made-of-pet-12592>

There is no doubt that a quick transformation is underway, driven by the sustainability requirements in Europe especially, which are strongly supported by the actions and incentives taken by governments. But, the question is, how much are we building sustainable solutions into our businesses, and how fast is this taking place?

Europe has set targets for reducing its greenhouse gas emissions progressively up to 2050. The EU key target for 2030 is at least 40% cut in greenhouse gas emissions (from 1990 levels), and the Union aims to be climate-neutral by 2050, which means creating an economy with net-zero greenhouse gas emissions.

Kordsa is one of the biggest NY6.6 tire cord producers in the world, and we are happy to provide the best quality cord and cord fabric to our customers. For many people, the waste involved in the process just means scrap, unless they see the biggest opportunity hidden beneath it, which for us is “raw material”, material that can represent a new source for us, for our partners, for the automotive industry, for aerospace & aviation, for white appliances and so on. It can be a great source of raw material for the industry, when it is processed with the correct know-how and the right value is derived from it. For many years now, Kordsa's exploitation of waste has been a huge contribution to the NY66 polymer value chain. We keep the plastics within the value chain by re-processing the polymer, as a near-prime reprocessed NY66 chip. This is just one of the examples of actions we have taken for the sake of sustainability, and we are saving 7830 tons CO2 alone by using our reprocessed chips. Thanks to the huge efforts of our R&D and production teams behind the scenes, for many years we have been creating value for our partners in the polymer value chain, and we are justifiably proud of that.

In terms of the Circular Economy, we are proud of being a pioneer in the industry with our sustainable solutions and the contribution to the polymer value chain that we have been passing on to our partners for many years. The industry is still discussing alternative solutions for sustainability, such as bioplastics. However, discussions still need to take place on questions such as “How much of the biodegradable materials are biodegradable and under which conditions?” According to an article in www.plasticstoday.com, IDTechex says that “Only about half of bioplastics are, in fact, biodegradable - just because a material is sourced biologically does not necessarily mean it will break down in the natural environment.” That's why re-use and re-cycling technologies still occupy pride of place in the chain. Authorities within the plastic industry think that biodegradable materials are still a challenge, as they are neither recyclable nor 100% biodegradable, which is why the mantra of reduce/reuse/recycle continues to be important and why Kordsa will continue to develop technologies for a better contribution to our world. The chart below from IDTechex estimates the potential growth of polymer recycling in the global as well as the circular economy:

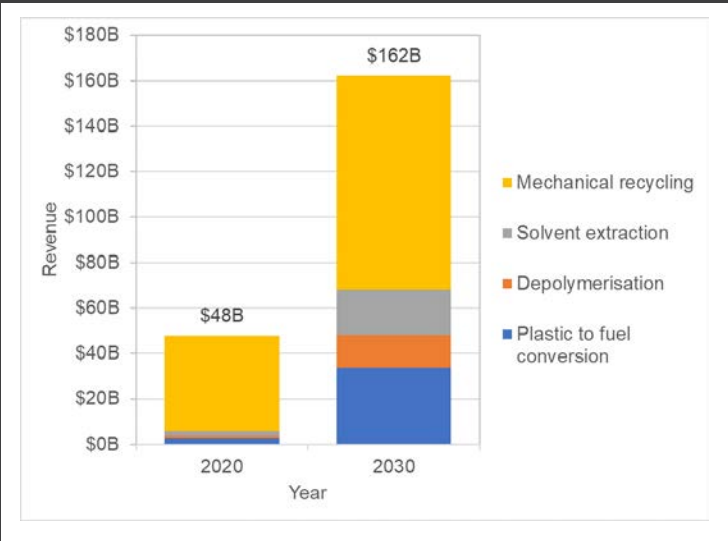


Chart: Revenue-based estimation of Recycling Market according to IDTechex

Source: www.idtechex.com

At Kordsa, we have been following the latest technologies and taking an active role in developing these emerging technologies, and we believe this will bear fruit in us creating ideal sustainable plastic solutions for the earth. As a member of the Polynspire project (supported by Horizon 2020), with our partners, we are looking forward to changing the game through depolymerisation, which will lead on to additional solutions for the plastic industry and for our value chain, releasing pure, alternative raw materials. As Reinforcers in Kordsa, we take pride in being part of this revolution and growing responsibly.

Maybe it's time to reflect on the example of the Martu people, Australian aborigines, who do not waste a single drop of their water. Indeed, they know it's not their water but the entire species' water, and that's why they use it consciously, for the sake of a better goal! Now we also know how to do this responsibly. Humankind is such a small part of our world, which makes it all the more obvious that it is better for our future for us to be beneficial bacteria. Let's create our future responsibly and grow together!

Sources:

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Continuous Carbon Fibers in 3D Printing

KORAY TANSU İLHAN

Project Engineer, Composite Technologies, Kordsa

The development of composite materials, as well as the related improvement in design and in manufacturing technologies, is one of the most important advances in the history of materials [1]. Composites have unique advantages over monolithic materials, such as high strength, high stiffness, long fatigue life, low density, and adaptability to the intended function of the structure [2, 3].

A large number of composite manufacturing processes have been developed over the last 40 years and additive manufacturing is one of them. Additive Manufacturing (AM) is defined as a process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to deploying subtractive manufacturing methodologies [4]. AM technologies offer the possibility of significant cost savings due to reduced material waste and the capability for tool-less production of intricate geometries. For this reason, especially in recent decades, they have gained popularity in line with the latest developments and market trends [5].

The main advantages of AM are its capacity for producing parts with high geometrical complexity at almost no added cost, short lead times, weight reduction and reduced effort required for assembly, and its suitability for customization, low volume production and even the manufacture of single parts. Moreover, some applications may need materials with unusual combinations of properties, which cannot be provided by metals, polymers or ceramics alone. For such applications, composite materials including two or more materials allow the combination of the required properties in a single material. Thus, AM, which can be defined as the production of objects directly from the CAD model through the process of adding materials in successive layers (as opposed to subtractive processes), is gaining significance in critical applications that make use of composite materials [6].

The Fused Filament Fabrication (FFF) process, which is also termed Fused Deposition Modeling (FDM), is the most widely-used 3D printing technology for two main reasons. Firstly, it employs inexpensive devices, and secondly, it is easy to use when building complex parts with thermoplastic filaments, such as PLA, ABS, or nylon [5]. However, parts printed using thermoplastic filaments suffer from the major drawback of possessing poor mechanical properties, which restricts their applications. In recent years, researchers have enhanced the mechanical properties of

thermoplastics by combining them with reinforced materials. Owing to its outstanding mechanical performance and lightweight characteristics, carbon fiber has acquired a crucial role in the field of composites. Short Carbon Fiber (SCF) is a noteworthy reinforced material because of the relatively simple procedure with which SCF-reinforced thermoplastics can be produced [7]. Short Carbon Fiber Reinforced Polymers (SCFRP) may improve mechanical properties, but these properties have been found to be only slightly better than those of pure plastic; they possess heightened porosity, and poor bonding has been detected because of the existence of SCF. The ideal solution for achieving significant improvement in strength is printing with Continuous Carbon Fibers (CCF) [7].

To improve the mechanical properties of a 3D printed part, it is vital to use a 3D printer that fabricates continuous carbon fiber-reinforced thermoplastics (CFRTP). A 3D printer that prints continuous CFRTP is able to reduce weight by optimizing the fiber direction in the components. This technology is well-suited for manufacturing a wide variety of products in small quantities. This could include the production of load-bearing orthopedic implants and artificial legs in the health-care sector or the manufacture of items for the automobile and aerospace industries [8].

In a very recent article, a method was presented for 3D printing of continuous fiber-reinforced thermoplastics based on fused-deposition modeling. The technique enables direct 3D fabrication without the use of molds and may become the standard next-generation composite fabrication methodology. A thermoplastic filament and continuous fibers were separately supplied to the 3D printer and, immediately before printing, the fibers were impregnated with the filament within the heated nozzle of the printer. Polylactic acid was used as the matrix while carbon fibers, or twisted yarns of natural jute fibers, were used as the reinforcements. The thermoplastics reinforced with unidirectional jute fibers were examples of plant-sourced composites; those reinforced with unidirectional carbon fiber displayed mechanical properties superior to those of both the jute-reinforced and unreinforced thermoplastics. Continuous fiber reinforcement was found to have improved the tensile strength of the printed composites relative to the values associated with conventional 3D-printed polymer-based composites [9].

The tensile modulus and strength of FDM-printed PLA composites are reported to be 19.5 ± 2.08 GPa and 185.2 ± 24.6 MPa respectively (see figure 1). These results indicate almost 6-fold and 4.5-fold enhancements in the tensile modulus and strength of the pure PLA specimens, improvements which are very pronounced compared to the properties of short fiber-reinforced PLA composites [9].

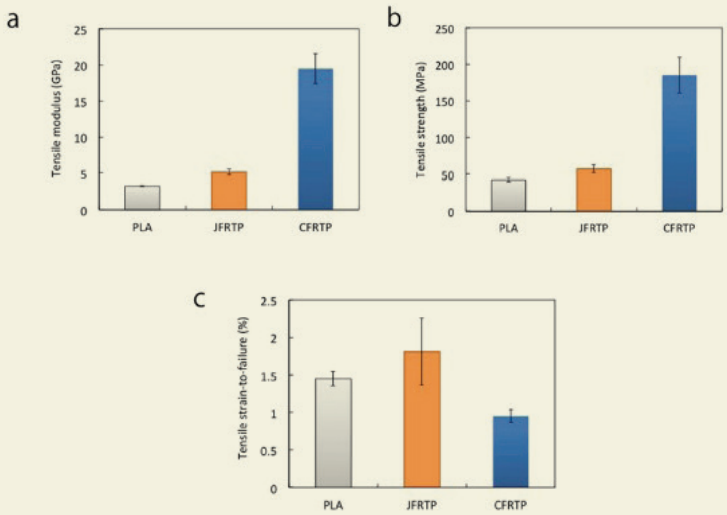
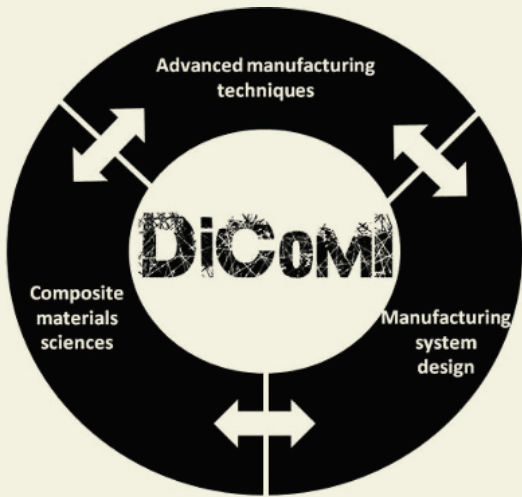


Figure 1: (a) Tensile modulus, (b) tensile strength, and (c) tensile strain-to-failure of specimens fabricated by 3D printing [9].

The Approach of Kordsa to 3D Printing Applications and Directional Composites Through the Manufacturing Innovation (DiCoMi) Project

Although still in its early stages, composite 3D printing is gaining traction within the manufacturing industry. It provides a quick and automated approach to manufacturing composite parts, which used to be labor-intensive and which requires highly-skilled operators. The move to composite 3D printing calls for a re-evaluation of the choice of materials for some applications, replacing metals with equally strong and cheaper polymer composites. The tool-free fabrication technique for composites not only makes the process of fabricating composite parts much faster and less costly but also opens the possibility of multifunctional composite structures for new applications. These advantages are sure to lead 3D printing technology to be accepted as one of the standard techniques in the future composite maker's toolkit [10].

With respect to the future of 3D printing applications in the composite industry, Kordsa aims to increase its know-how in this field by participating in a Horizon 2020 project, DiCoMI, a Marie Skłodowska-Curie Action (MSCA). Marie Skłodowska-Curie Actions support researchers at all stages of their careers, regardless of age and nationality. Researchers working across all disciplines are eligible for funding. MSCA also encourage cooperation between industry and academia and aim to promote innovative training to enhance employability and career development.



The Directional Composites through Manufacturing Innovation (DiCoMI) project aims to bring together leading innovators from across Europe and beyond, to develop a new method of producing composite material parts with optimized fiber directionality. The DiCoMI project will integrate advanced manufacturing techniques, composite materials science, and manufacturing system design. As such, it requires a high level of inter-disciplinary cooperation as well as collaboration between researchers and industry. The outcome will be a novel composite manufacturing system capable of producing low-cost parts with increased accuracy and enhanced functionality.

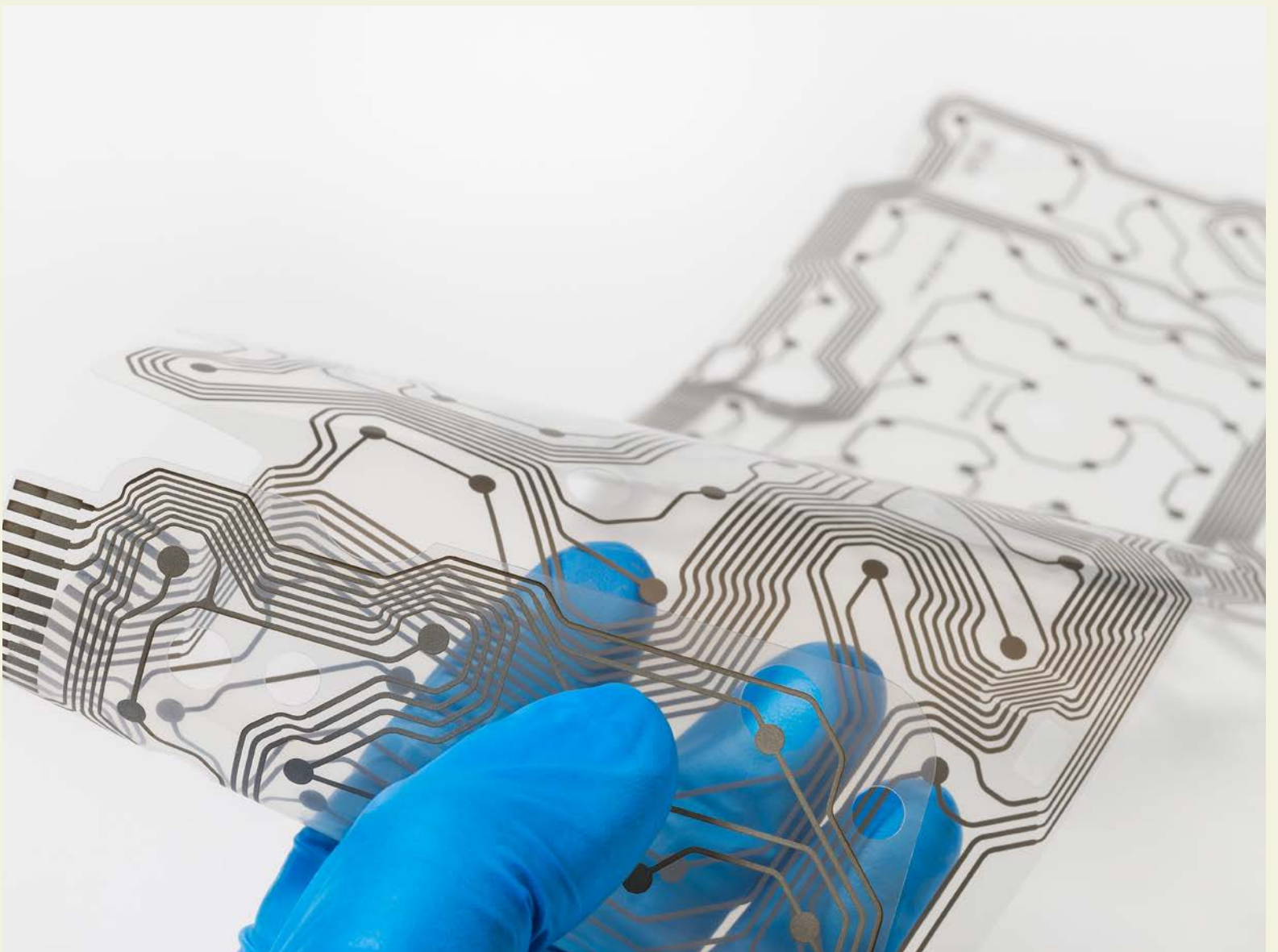
In the scope of the DiCoMI Project, in 2019 Kordsa organized two secondments, with Loughborough University (UK) and the Technical University of Cluj-Napoca (Romania). In January 2020, six researchers and two professors from Loughborough University, the Technical University of Cluj-Napoca and Kharkiv Aviation Institute (Ukraine) visited Kordsa and published research reports. Secondment to our project partners will continue and articles will be written as a consequence of the ensuing research.

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Flexible Hybrid Electronics is an emerging technology which has the potential to reshape the next generation electronics industry.





Flexible Hybrid Electronics Systems: Innovation to Reinforce Printed Flexible Electronics

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Introduction

In the last few decades, the modern semiconductor industry has revolutionized every aspect of human life. The remarkable miniaturization offered by micro- and nano-scale electronics has paved the way to integrate millions of circuits, sensors and logic elements on a small-area silicon microchip. This has not only replaced old, bulkier electronics systems with small and smart Integrated Circuits (ICs) but also enabled us to discover new application paradigms. Within a short span of time, countries like Taiwan, Korea, Singapore and Malaysia have experienced unprecedented economic growth thanks to the electronics industry in general and the IC industry in particular. There lies a huge possibility and investments that Turkey can also mimic the success stories of the above-mentioned countries to keep pace with the knowledge-based world economy and fulfill its local commercial and consumer needs.

Typically, an electronic system is ascribed by the trend commonly known as SWaP-c (Size, Weight, and Power – cost). In the recent years, the electronics industry is undergoing a new trend of the transformation from reliance on its traditional rigid forms to even more sophisticated and complicated forms with added functionalities such as flexibility, bendability and stretchability [1]. Despite the phenomenal benefits of performance and integration density offered by silicon ICs, manufacturing flexible and large-area electronics remains a huge challenge. On contrary, printed flexible electronics mainly employ flexible materials and printing technologies for manufacturing large-area electronics. Nevertheless, the efficiency and reliability of printed flexible electronics remain inferior to that of silicon ICs and of the discrete electronics on standard Printed Circuit Boards (PCBs). Major confrontations arise from logic, built-in memory, analog front ends circuits and power management units, thereby, limits the widespread adoption of printed flexible electronics. Flexible Hybrid Electronics (FHE) augments the strengths of two distinct technologies, i.e. using flexible printed electronics for sensing purposes and silicon ICs for data processing and communication. Complementing printed flexible electronics in conjunction with silicon ICs yields versatile

technology that can be deployed in a diverse range of applications such as:

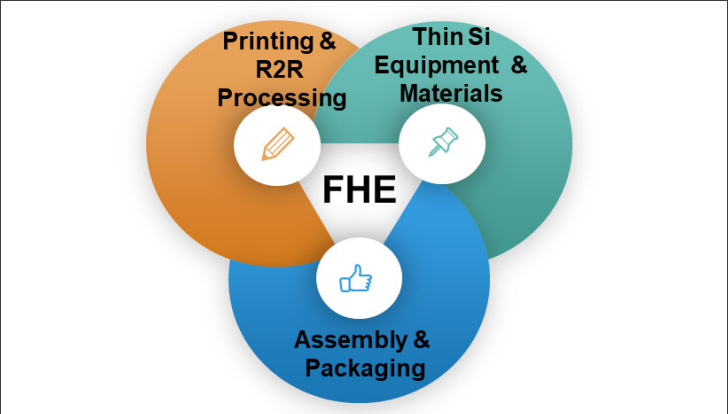


Figure 1: Subjective dynamics of flexible hybrid electronics system (FHE)

wearable health monitoring [2], structural health monitoring [3,4], predictive maintenance [5], automotive [6], consumer electronics, display technologies [7,8], transportation and logistics. These are the emerging domains that employ FHE extensively, as is highlighted in Figure 2.

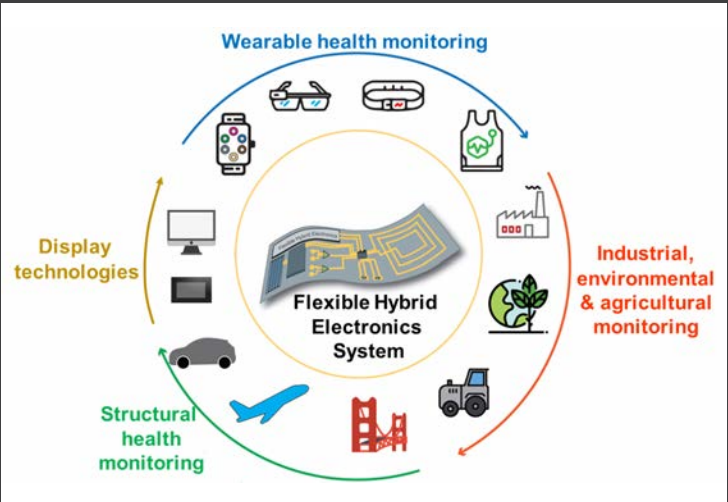


Figure 2: Various application paradigms for FHE (modified figure reproduced with permission [9])

Why Flexible Hybrid Electronics?

Flexible Hybrid Electronics (FHE) is an emerging technology which has the potential to reshape the next generation electronics industry. It constitutes an innovative frontier that enables the integration of sensing elements, thin silicon ICs, data processing and communication units, and power supply on non-traditional flexible substrates. Furthermore, it will aid to usher the novelty in terms of the configuration of sensors, the integration and medium of electronics, and above all the introduction of ubiquitous sensing in terms of the internet of things (IOT). Figure 3 represents the system-level implementation of FHE employing both printed electronics and silicon ICs. According to a forecast by the market research agency IDTechEx, the value of the printed flexible and organic electronics sector will escalate from \$31.7 billion in 2019 to \$ 73.3 billion industry by 2029 [10].

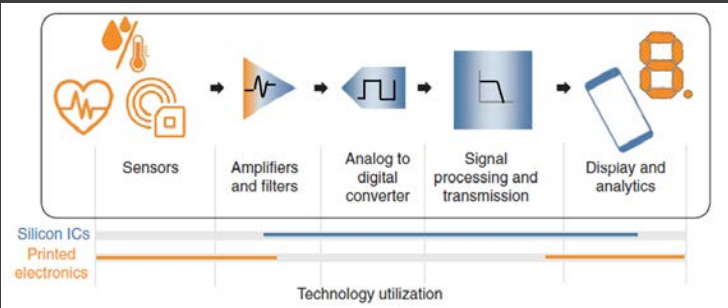


Figure 3: System-level implementation of flexible hybrid electronics (modified figure reproduced with permission [9])

State-of-the-art FHE based systems are not only lightweight and stretchable but also conformable and bendable as well. These added properties are designated by the new form factors for the new-generation FHE systems, which differ considerably from those of their traditional rigid counterparts. Moreover, flexibility, cost-effectiveness and large area manufacturing capability are the key enablers of FHE systems, which make them an attractive alternative to rigid and expensive silicon ICs.

The standard Fabrication process for microelectronics comprises photolithography, vacuum deposition and etching techniques, which is why it is termed a subtractive process. Henceforth, scaling up to large-area is expensive and wasteful. Whilst, the printed electronics is an additive form of processing, utilizing solution-based materials patterned on flexible substrates by means of printing technologies. Selective deposition of materials eliminates the need for photolithography and etching processes, thereby reduces the cost. Large-area, high volume and roll-to-roll manufacturing are the vital merits of printed electronics [11].

Fundamental Blocks of FHE

A FHE system primarily consists of printed sensors that serve to sense and convert physical quantities such as temperature, pressure and humidity, as well as chemical concentrations to electrical signals. These electrical signals can undergo further processes such as amplification, buffering and noise reduction by thinned ICs. Additionally, ICs provide on-chip data storage and communication capability through printed/integrated antennas. In order to power up the system, either printed/discrete batteries or energy-harvesting units are available. All these components are then integrated on flexible substrates. Figure 3 presents the basic FHE system, highlighting the key components [9].

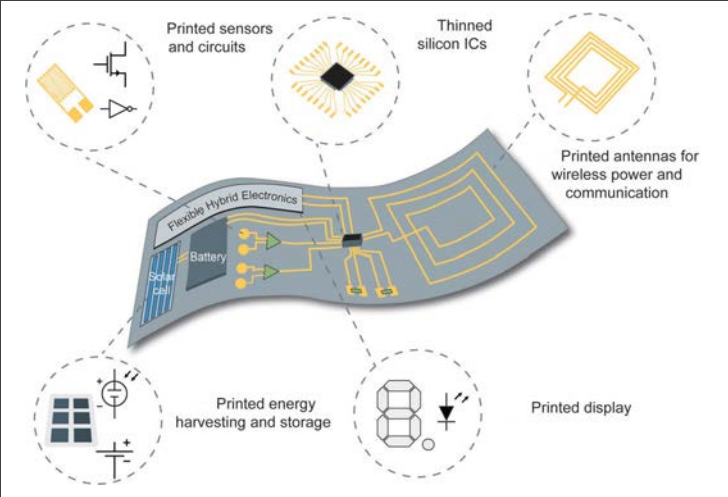


Figure 4: Illustration of a flexible hybrid electronic system, highlighting the fundamental blocks constituting the fully functional prototype (reproduced with permission [9])

Design and Development of a FHE System

The design and development cycle of a FHE system is undertaken by sensor specifications, conception, simulation and design verification and is heavily dependent on printing techniques for the fabrication of sensors. Afterwards, the sensing module is integrated and assembled with ICs and other discrete components for the purpose of signal conditioning and processing. Finally, the packaged FHE prototypes are tested and characterized, as shown in the design cycle in Figure 4.

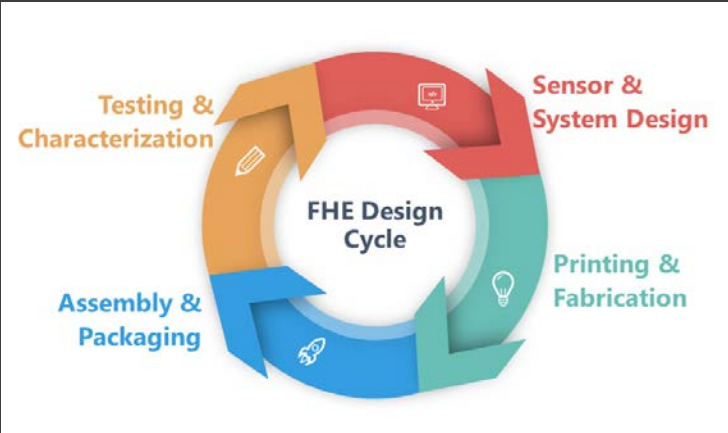


Figure 5: Design cycle for the design and development of FHE systems

Over the last decade, the evolution of printing techniques has assisted in rapid advancement and innovation in the realm of FHE. The choice of substrate materials, compatible inks/adhesives and various printed techniques (as shown in Figure 5 and 6) are the primary parameters involved in the development of the printing process for any specific printed electronics application.



Figure 6: (a) Choice of substrate materials for printed electronics (b) Printable conductive and dielectric materials.

The selection of printing technique depends mainly on ink properties (surface tension, viscosity, etc.) and printed feature dimensions (line width, line spacing). Moreover, ink and substrate compatibility have to be taken into consideration. Silicon ICs are an integral part of FHE [9]. Numerous methods and materials have been proposed for mounting ICs and discrete circuit components onto flexible substrates. In order to obtain thinned ICs, pre- and post-processing of silicon and silicon on insulator wafer is performed i.e selective removal of silicon by grinding, dry or wet etching, or chemical reaction. Apart from thinned ICs, other passive components such as resistors, capacitors and inductors, which are mostly surface mount devices (SMD) are directly integrated onto the flexible substrate to realize a fully functional circuit. Typically, silicon ICs and other SMD are connected to substrates via conductive adhesive or solder pastes with the help of pick & place assembly equipment.

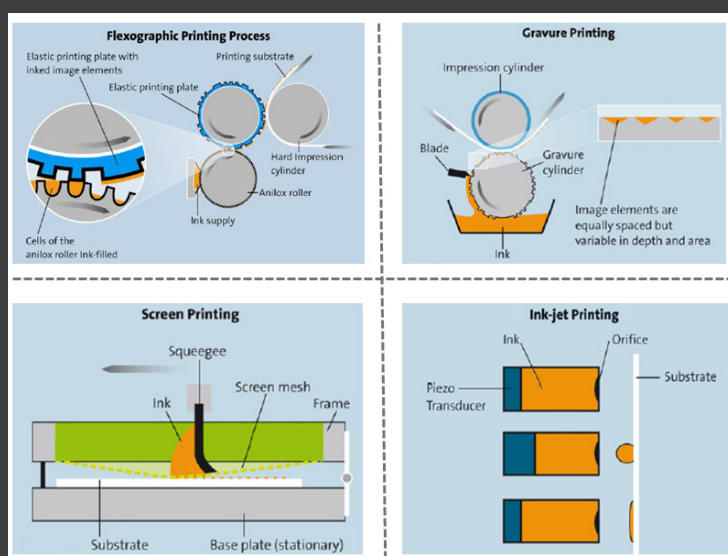


Figure 7: Various printing techniques employed in printed electronics [12]

For wireless power transmission, as well as for data communication, FHE mainly relies on printed flexible antennas, whereby the choice of antenna design and operating frequency depend upon the application. Various standards and printing techniques are well established to serve the communication modes for FHE. Viable substitutes to supply adequate power to operate sensors and circuits in FHE systems include printed batteries and on-chip energy harvesting and storage. These solutions not only eliminate the use of bulky rigid batteries, which hinder mechanical flexibility, but also it does not require also the requirement of ports and cables in case of rechargeable alternatives.

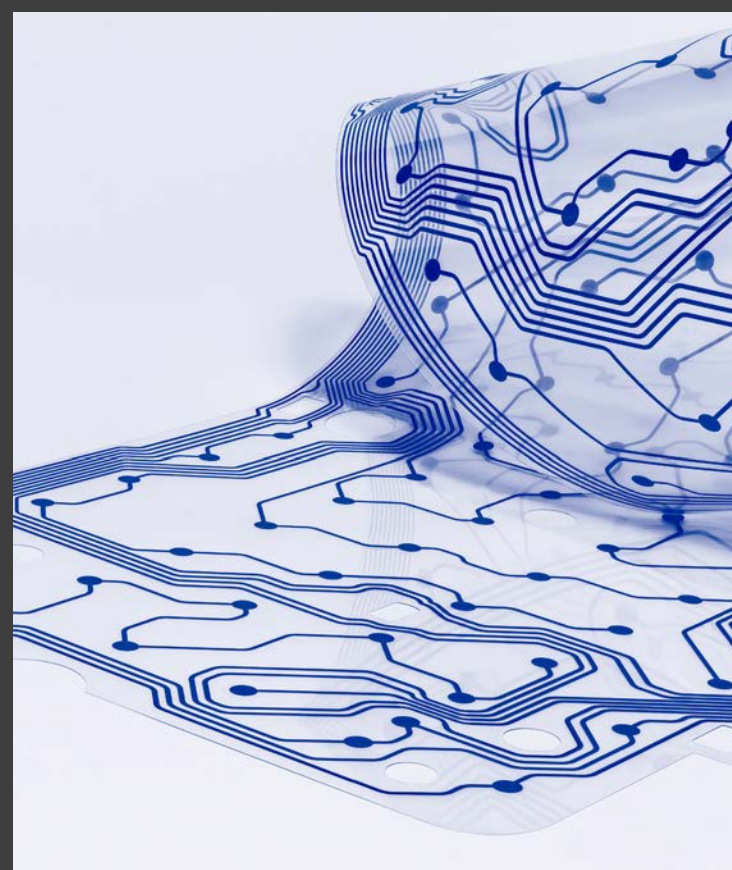
Constraints and Design Challenges in FHE

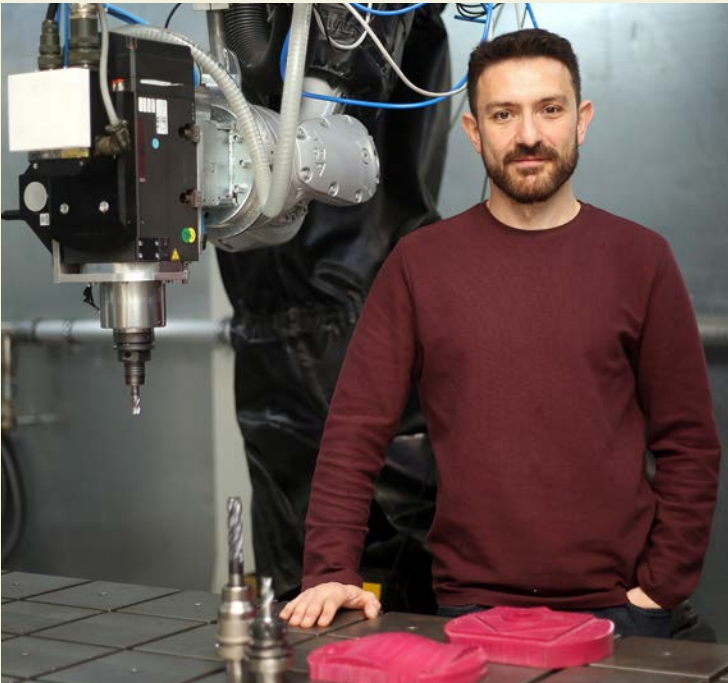
The fast pace of growth and ever-increasing demand for diverse application domains entail FHE to ensure stable and reliable operation under diverse environmental conditions. As FHE is still a growing and developing technology, the reliability of FHE is a major concern. Primarily owing to the durability of printed materials, performance of FHE alleviate, exacerbates further due to the added mechanical features of flexibility and stretchability. Moreover, process variation in the scale up roll-to-roll manufacturing of printed electronics is another factor that can degrade the performance of FHE. In order to ensure the robust and reliable operation of FHE, substantial mechanical and environment tests need to be performed, which include bending and twisting tests, repeated thermal cycling, exposure to high humidity and temperature conditions, and lifetime testing.

To circumvent these constraints and challenges, there is ample room for innovation in design manufacturability and for the optimization of printed electronics. In spite of the current challenges at hand, FHE is envisioned to reshape the electronics industry in the near future, specifically when it comes to large-area sensing, wearable electronics and soft robotics. As a global leader in reinforcement, Kordsa aims to establish a transformative and innovative center for conducting research and development in the field of flexible hybrid electronics. This platform will undertake the design and development of printed electronics in combination with life sciences, so as to transform know-how to working prototypes, which is bound to contribute to the advancement of technology and living standards in all aspects. Our near-term goal is to instigate benchmark studies analyzing the feasibility of new and exciting application paradigms, such as wearable health care electronics, logistic tracking, and structural health monitoring.

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Fibre Placement in the Automation Era for Composite Manufacturing

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Have you ever wondered how such large components of passenger airplanes and jet fighters can be manufactured in accordance with the tight tolerances required by aviation standards? Throughout the long history of aviation, this has been a significantly labour-intensive process and has always been a primary area for technological change. In recent decades, we have witnessed another significant shift in toward automated manufacturing, which affects many actors. This has sparked an ongoing debate between those who fear that automation will lead to a reduction in jobs and those who promote automation as an opportunity to upskill the labour force in this new century. In this article, you are invited to read through the opportunities and challenges in the transformation from conventional to modern manufacturing.

Airplanes are assembled from large-scale parts such as air ducts, wings, nacelle, etc. (see Figure 1). For the last couple of decades, the amount of carbon fibre reinforced plastic (CFRP) composites used in the manufacturing of these critical parts has been increasing exponentially, as shown in Figure 2. The replacement of metals with composites pose several technological and practical challenges in manufacturing, while also bringing benefits in design and performance.



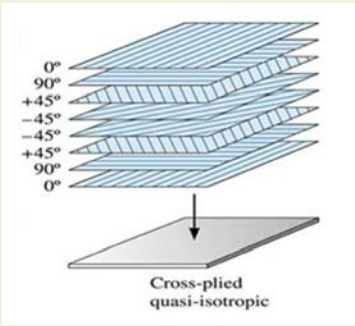
(a) Air inlet duct



(b) Nacelle [1].



(c) Wing



(d) Directions of composite layers

Figure 1: Typical composite parts manufactured in the aerospace industry.

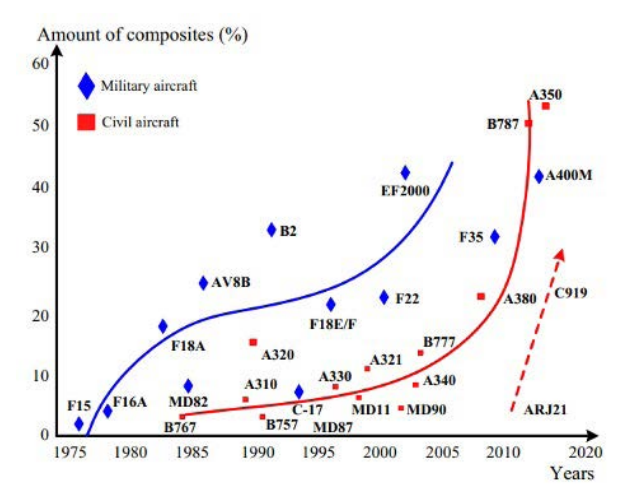
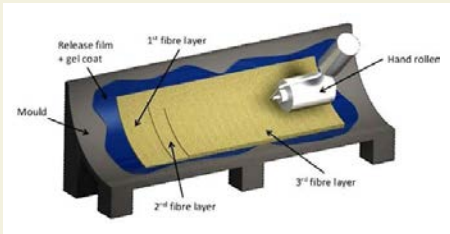


Figure 2: Amount of composites used in other military aircraft and civil aircraft [2].

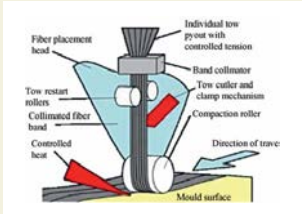
Considering that a layer of carbon prepreg is around 0.250 mm thick, the CFRP design of such parts involves a high number of composite layers, each of which needs to be placed accurately at varying angles with respect to the initial layer, ...i.e. 0, 45, and 90 degrees (see Figure 1d). Conventionally, hand lay-up techniques have been used in the fabrication of large-scale components for the aviation industry, with all the layers being cut to shape and manually placed on the relevant part, as shown in Figure 3a and Figure 3b. Considering the increasing demand for civil and military aircraft, the hand layup technique limits productivity in several ways such as (i) repeatability, (ii) capacity, (iii) shape of the design and (iv) hand skills of workers. At this point, automated fibre placement (AFP) technology is gradually replacing the hand layup effort, especially in the manufacturing of curvilinear parts subject to curvature constraint as well.



(a) Hand layup illustration



(b) Hand layup of wing section



(c) Illustration of AFP process [Coriolis Composites, 2015]



(d) AFP for wing layup.

Figure 3: Manual and automated manufacturing of composite parts. [3].

Automated Fiber Placement is currently the state-of-the-art method for the fabrication of composite structures. Here, continuous fibre reinforced tapes, in the form of tows, are laid on a mould surface. In a typical AFP process, the material band is composed of multiple tapes, with widths of either 1/8" or 1/4". Depending on productivity expectations, the number of tows (tapes) to be placed may vary from 1 to 32 and each tow is individually controlled. Such individual control of tows is vital for a significant reduction in the amount of scrap material when the AFP layup is required to comply with the double curvatures of complex surfaces while the tape is being steered (see Figure 4). In general, an AFP system can lay up thermoset, thermoplastic or dry fibres, with infrared (IR) heat sources being used for thermosets and laser heat source for thermoplastic and dry fibres. The heat will either melt the thermoplastic or increase the tackiness of the thermoset tape, allowing the tape to be stuck onto the substrate when compacted by a compaction roller. As each band is placed, the individually controlled tows are cut in turn and the robot moves to the start of the next band. This process is repeated until a whole ply is complete and the final part geometry is achieved ply-by-ply.

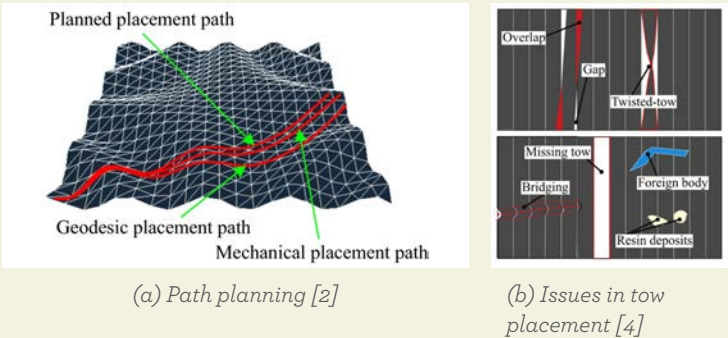


Figure 4: Tow placement control for complex surfaces.

In AFP technology, the AFP head is manipulated by either a robotic or a gantry carriage (see Figure 3d), in order to build the structure one ply at a time while controlling the tows to be placed. In other words, the system can control the number of tows (fibres) to be placed at any portion of the tool path. In addition, each ply can be positioned along the direction set by the designer. In this way, the fabrication becomes highly customized for parts with different configurations and shapes. The use of a robot or gantry-type carriage enables the operator to take active control of the whole process, bearing in mind the variables critical to achieving the objective of high control and repeatability in fabrication. AFP technology can be applied in the fabrication of several composite parts such as concave parts (winglets, fuselage), sandwich structures (engine nacelles and casings) and even closed sections such as pressure vessels.

Although entailing high investment costs (from €2M to €8M), AFP systems enable (i) modular head configurations for multi-material type fabrication, (ii) reliable and repeatable layup for large-scale and complex geometries, and (iii) highly customizable and adaptable layups for research, development and manufacturing of composite structures. However, life in AFP technology is no wonderland and there are still significant challenges and problems in the application of AFP technology to complex structures. Among these are tow buckling, gaps and overlaps. Current research directions for AFP can be named as (i) path generation, (ii) online monitoring of AFP processes and (iii) correction of AFP processes.

In 2019, KordSA and Sabanci University, under the roof of the Composite Technologies Centre of Excellence (CTCE), completed the commissioning of a state-of-the-art robotic AFP System from Coriolis Composites © (see Figure 5). The system is currently known to be the second AFP system in Turkey and the first AFP system in Turkey established as part of a university in Turkey. With regards to the capabilities, it is the only system in Turkey which can lay up thermoset, thermoplastic and dry fibre. The layup head is capable of laying 8 tows (1/4 inch width) at a time. Sabanci University and KordSA are carrying out collaborative research projects in various directions to adopt this promising technology and help Turkish

companies win work in the international composite manufacturing industries such as aerospace. Sabanci University is currently running a TUBITAK funded project (under grant no 218M715) to develop process monitoring techniques and tool path generation approaches for variably steered composites fibres. CTCE welcomes all potential industrial partners who are eager to collaborate in this emerging automation technology journey in the name of composite manufacturing.

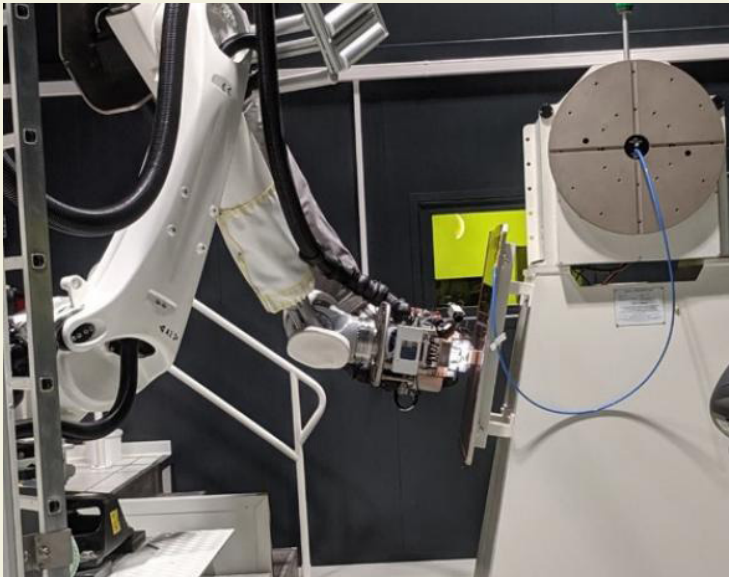


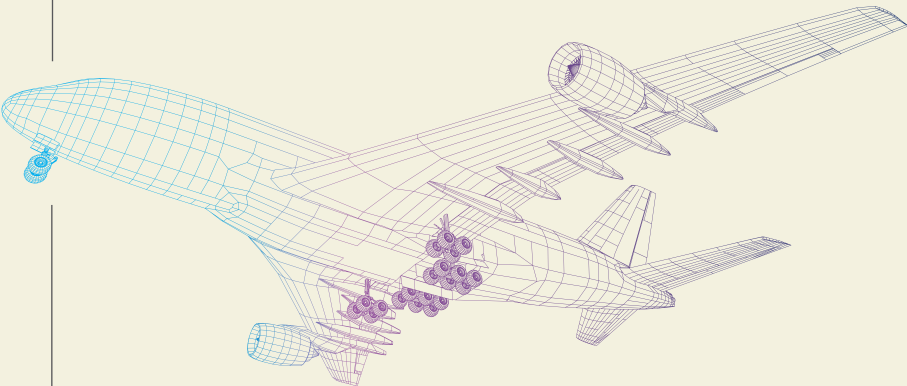
Figure 5: Robotic AFP System commissioned at CTCE.

[1] <https://www.aero-mag.com/safran-nacelles-airbus-a320neo/>

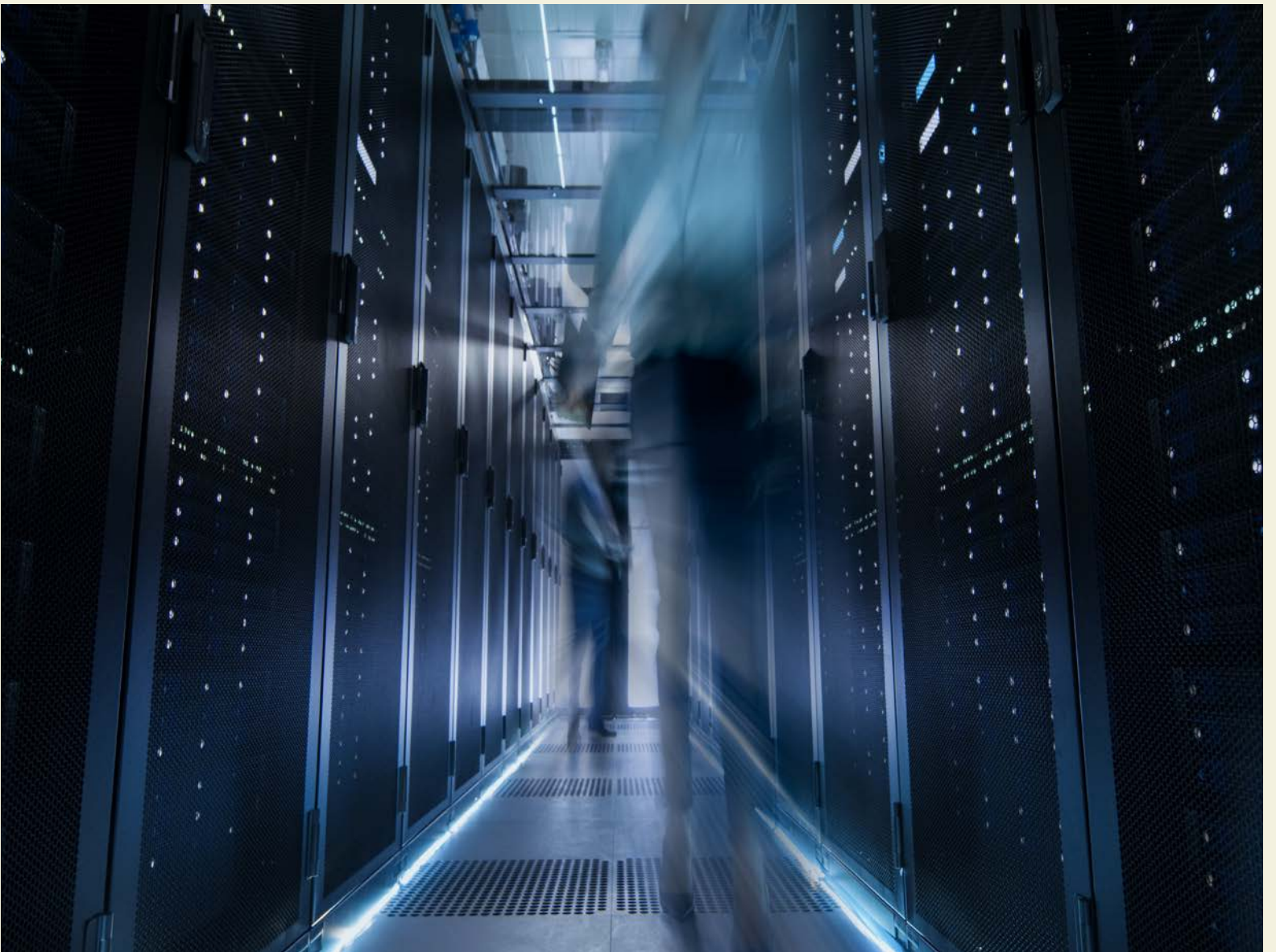
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In line with Sabancı Holding's digitalization goals, making data available for analysis has become an important part of the facility's digital transformation.





Data Collection and Visualization Systems for Production Lines

YAVUZ KOZAK

Global Technology, Project Leader, Kordsa

Kordsa's Turkey facility is home to numerous industrial machineries of different scales. Obtaining, recording and serving data in different forms has been done for many years across different parts of the facility. In 2019, a new infrastructure for data collection was installed in the tire cord fabric production lines. It integrates the process and machinery data from all the treatment lines and dipping chemicals preparation units, as well as registering energy consumption and weather statistics. Data are collected and recorded and made available to production, quality assurance, maintenance and R&D teams with different levels of complexity, detail and visualization and, tailor-made for each team.

In line with Sabancı Holding's digitalization goals, making data available for analysis has become an important part of the facility's Kordsa's digital transformation. To facilitate the use of data in a complex environment where there are many sources of information and where data analysis can serve different use cases, it is vital that data is properly organized, sampled at useful junctures and be acquired in an uninterrupted manner. Data needs to be simple to manage, search and visualize.

In the past, as in many other industrial environments, process data was recorded and kept locally in SCADA computers that controlled individual machines. This approach, however, brought several drawbacks. The collected data content and structure was hard to organize and read afterwards, the data stored in SCADA had to be extracted manually, and it was hard to detect interruptions due to misconfiguration or power outages.

To overcome these drawbacks and prepare production facilities for future requirements, a team was formed, and the data collection system was unified using Kordsa's existing intranet structure while adding layers of security to assure that data is both accessible and secure. All the PLC and SCADA systems were secured behind individual firewalls. To prevent a TCP/IP clash of machinery while ensuring that only the required components can be reached via intranet, a Network Address Translation (NAT) process was used. This architecture allowed Kordsa to centralize and unify data collection across machinery dispersed across a 0.3 kilometer-square area. Moreover, supervision and modification can now be done remotely and without interfering with the working equipment.

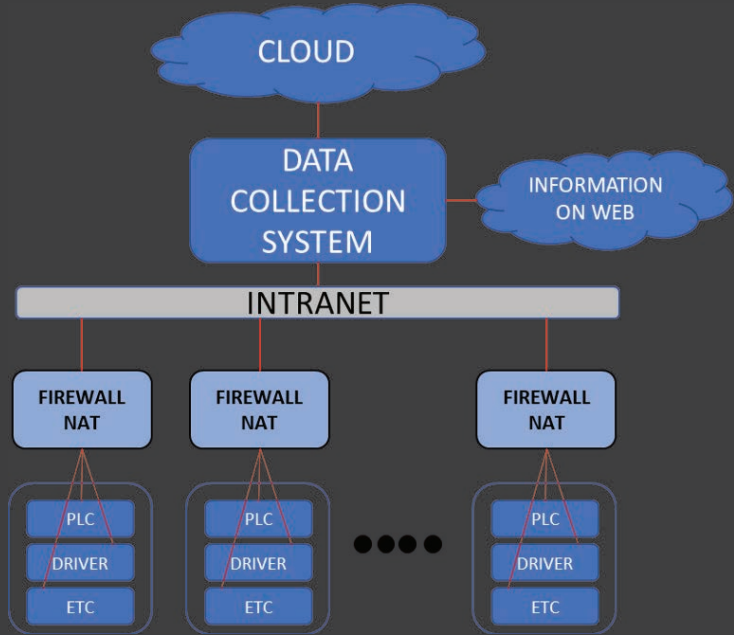


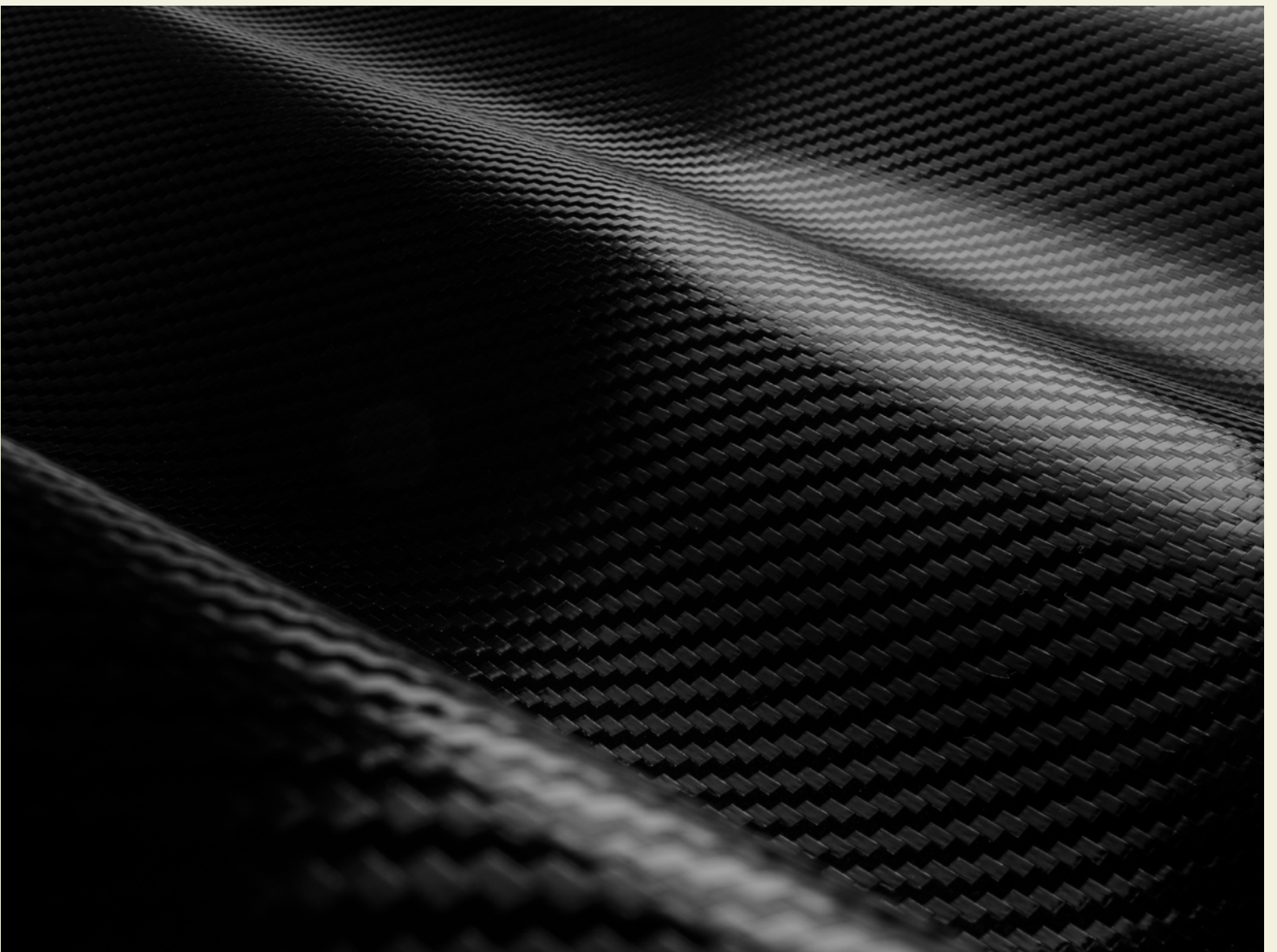
Figure: A generic network topology for a safe and centralized data collection system

Once the collected data is made available on the cloud, it can provide the basis for numerous applications and use cases. Kordsa has already made its data available in raw, processed and visualized forms for applications such as process control, quality checks, auto-generated batch reports and data analysis. Certain data are also live-streamed to ANDON screens for remote supervision.

Currently, on average, 250MB of raw data and 60 batch reports are generated on a daily basis. However, extracting information and creating visually understandable charts as well as processing the data for process control requires domain knowledge as well as data-processing skills. Thankfully, our technical, production, R&D and maintenance teams possess the data-processing and analysis skills (such as six-sigma) needed to maximize the use of data.



Textile Products was founded in 1976 in Southern California. Its mission was to support the fast growing commercial and military aircraft industries.





The Brief History of Textile Products, Industries Associated With, Commonly Used Fabrics and Applications.

KEVIN GEARIN

General Manager, Textile Products Inc.

“Hello everyone, my name is Kevin Gearin, I’m the General Manager at Textile Products. It has been my pleasure to have been an employee of this company for the last 29 years. I would like to share a little bit with you about our history and some of the more commonly produced fabrics here at Textile Products.

Textile Products was founded in 1976 in Southern California. Its mission was to support the fast-growing commercial and military aircraft industries.

The company earned a reputation as a problem solver with the success of the design, development, and manufacturing of non-conductive and conductive fabrics for such famous aircraft as the B2 Bomber and the F117 Stealth Fighter.

From those early successes, the company evolved into an industry leader across a wide variety of markets and industries such as automotive, sporting goods, industrial and marine; while maintaining its core leadership in the aerospace industry.

The company is familiar with a wide broad of reinforcement yarns, such as carbon, aramids, ceramics, metallic wires and glass.

Some of the more commonly used styles in industries are first the Automotive industry. We support that with style 4365 and 4465. These are carbon twill fabrics. They are used to support automotive cosmetic accessories like hoods, mirrors, and spoilers. These fabrics are also used extensively in the carbon tooling market.

Another is the fashion industry; we have designed style 4521. This is a combination of glass and carbon; it was designed to create a “zig-zag” pattern. It is featured in sneakers as arch and sole supports.

Finally, the aerospace industry style 4677. This fabric is a hybrid of carbon and metallic wire. It is used in the production of composite parts to protect the airplane from lightning strikes.”



Style #4465

Material: Carbon Fiber

Type of weave: Twill

Utilized for automotive cosmetic accessories such as spoilers, hoods, and mirrors. Also utilized for composite tooling.



Style #4521

Material: E-Glass & Carbon Fiber

Type of weave: Lightning Weave

Featured in sneakers and used for sole/arch support. Commonly used for fashion and recreation.



Style #4677

Material: Carbon & Bronze wires

Type of weave: Plain Weave

Featured in Commercial and General Aviation aircraft. Used in aerospace to reinforce composite parts to protect aircraft from lightning strike.



Scan the QR code to watch this article live.

Impregnation and thickness variation throughout VARTM processes have been addressed in many studies, in order to obtain an optimized mold filling method that can enable smoother part manufacturing.





Vacuum Assisted Resin Transfer Molding Process: A Review Of Saturation and Thickness Variation

ABDULMECİT ARAZ

Project Leader, Kordsa
PhD Candidate, Sabanci University

Introduction

Processes such as Vacuum Assisted Resin Transfer Molding (VARTM) and Resin Transfer Molding (RTM), which use dry preform in a closed mold, fall under the umbrella of Liquid Composite Modelling. VARTM is cheap, easy to operate and a viable option for fabricating large and complex parts. The VARTM process is an adaptation of the RTM where the mold type differs, leading to the implementation of a different approach when the process is modelled. In the VARTM process, the resin is vacuumed through the fiber preforms in a mold of which one side is solid and the other equipped with a flexible sealed bag. In the RTM process, because both sides are rigid and solid molds, simplifications can be performed during the mold filling process. However, in the VARTM process, compression or expansion occurs in the preform due to the presence of the flexible vacuum bag side, and this gives rise to dimensional changes. This factor cannot be ignored in mass balance calculations and permeability modelling during the flow. Since VARTM processes involve a solid mold on one side and a flexible vacuum bag on the other, the latter constantly being exposed to atmospheric pressure, there is a high possibility that thickness variation will occur along the infusion length. Also, improper infusion of the resin through the porous preform can lead to dry spot formation stemming from low impregnation, which in turn weakens the composite at that spot, the composite which can be a combination of materials such as glass, carbon and kevlar fibers.

Impregnation and thickness variation throughout VARTM processes have been addressed in many studies, in order to obtain an optimized mold filling method that can enable smoother part manufacturing. This article reviews thickness variation and saturation effects in the VARTM process.

Resin Transfer Molding and Vacuum Assisted RTM

Vacuum Assisted Resin Transfer Molding (VARTM) is a modified version of Resin Transfer Molding (RTM), where the top half of the

rigid mold is replaced with a flexible vacuum bag. In Resin Transfer Molding, the mold has lower and upper rigid parts and between them a cavity in the shape of the preform. As can be seen in Figure 1, first the 2D preform is prepared in accordance with the cavity shape. Afterwards, the preform is mounted on the lower part of the mold, then the upper mold is closed. Having fixed the preform into the cavity of the mold, the resin is injected from a pressurized tank using the gates to fully saturate the fibers. After the mold has been filled, the injection is stopped and the curing process takes place. There are different ways to cure the part such as heating the mold or introducing inhibitors after the resin saturation of the part. Upon completion of the curing process, the rigid mold is opened and the preform is removed from the mold [1].

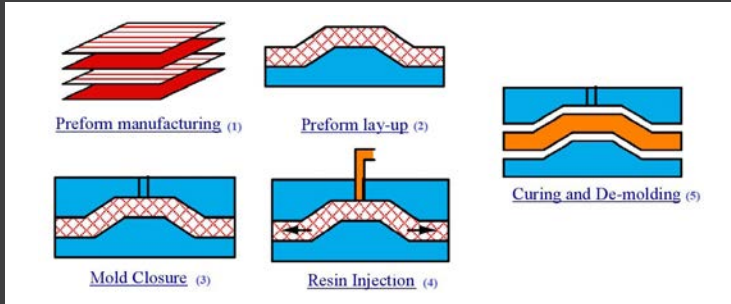


Figure 1: General Steps of Resin Transfer Molding [1, 2]

Similar to the RTM process, in the VARTM process, the preform is prepared and mounted on the lower part of the rigid solid mold, as shown in Figure 2. The upper part, however, is sealed using a flexible vacuum bag. By means of the vacuum, the resin is pulled in from the gates to the fiber preform.

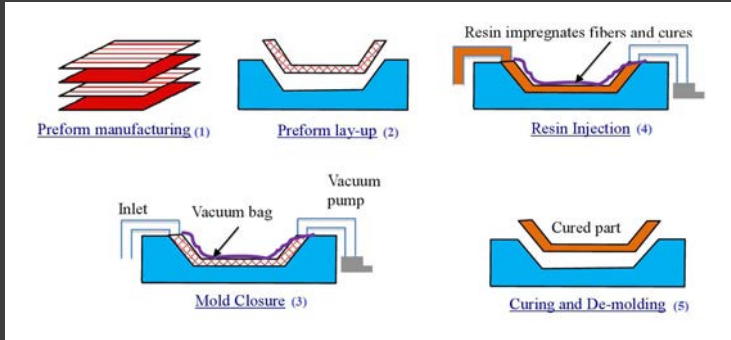


Figure 2: General Steps of Vacuum Assisted Resin Transfer Molding [1, 2]

After the resin impregnates between the fiber preforms, the curing stage is initiated and the part is cured. At the end of the process, the cured part is taken away for use. VARTM has replaced the RTM process due to its low investment cost, its simplicity and ability to manufacture large parts. The main disadvantages of Vacuum Assisted RTM compared to the conventional RTM process is that the use of the flexible bag side leads to poorly finished surfaces and thickness variations [1].

Thickness Variation

The similarities of the VARTM and RTM processes have led the two processes to be modelled in the same way, using identical assumptions. However, these processes differ when it comes to physical modelling, especially in terms of thickness variation and tow impregnation. Since in the RTM process there is a rigid mold at both sides of the preform, it is possible to maintain the pressure caused by the resin and the preform. This point can be taken into consideration when uncoupling the flow behavior from the preform itself, and for that reason the volume fraction and permeability of the preform can be assumed to be constant. However, in the VARTM process, one side of the mold is flexible, and when the vacuum is used to withdraw the resin, the preform starts to expand with the entrance of resin, which the flexible vacuum bag is unable to prevent, as shown in Figure 3. The thickness of along the bag is dependent on the flow front position and varies according to three factors: the

distance from the inlet gate, the initial entrance of resin as a result of preform compaction, and resin pressure. As shown in Figure 3, the injection pressure that induces flow affects local compaction pressure, since the vacuum bag is flexible and can be deformed. The movement of the flow front is liable to lead to changes in fluid pressure as well as influencing the compaction pressure on the reinforcement. When it creates variations in porosity and permeability, this can influence the fluid pressure.

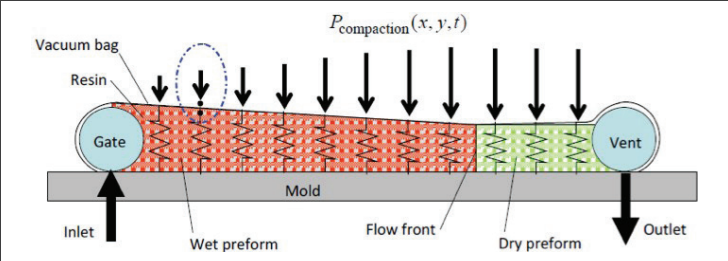


Figure 3: Thickness variation during the resin entrance to the preform [1].

Because of these reasons, in VARTM, flow modeling is coupled with preform deformation, factors which generally need to be addressed in order to predict how these variations will influence the thickness and fiber volume fraction, as well as fill times [1]. Researchers [3, 4] has focused on two sources that cause variations in thickness: structural variations of the fibers and pressure difference.

The studies showed that fiber structure has a lower effect on thickness variation compared to vacuum pressure. One must note that there is a dynamic change in the pressure gradient between the preform and the resin. This is because, during the vacuuming of the resin, the combined resin and preform pressures must be equal to the air compaction pressure. Therefore, unlike in RTM process modelling, in VARTM, flow behavior and preform behavior need to be considered together.

Saturation in VARTM

In the VARTM process, the preform architecture consists of strongly packed fibers called tows. The permeability of the fiber tows is lower compared to the total preform bulk permeability. This results in slower saturation of the tows by the resin equated to the pores between the fiber tows, because the resin flows around the tows and is more prone to micro void creation, which leads to a decrease in part quality [5]. Thus, even if the resin flow front moves away from these tow bundles, there will still be mass loss into them due to the slower rate of their saturation, which needs to be accounted for in the analysis. A lot of research [6] has identified this condition as dual scale porous media where, based on the impregnation level, microscale flow takes place inside the tow bundles while the macroscale flow occurs around the tows.

In general, researchers have focused on how to eliminate the pores that are not fully saturated, by using simulations to optimize the location of the vents and inlet gates and to find the ideal timing for the closing and opening of the gates [7]. However, eliminating the macrovoids that appear in the preform is not sufficient for fully impregnating the unreached regions between the fibers. In most cases, there are also microvoids, which cannot be seen without the use of a precise microscope. These voids form because of the low permeability of each individual tow affects the filling rate compared to that in the other regions. As shown in Figure 4, the micropores continue to fill after the resin has saturated the regions between the tows, and even when the filling is stopped, there will still be a mass loss inside the microvoids as impregnation is completed [8].

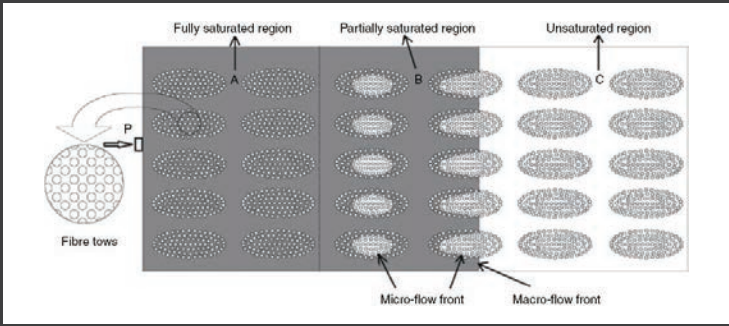


Figure 4: Dual scale porous media (three regions) [9]

In the dual scale flow, an unsaturated and saturated region is created in the fiber preform. The fully saturated region is characterized by Darcy’s law, and full impregnation of the fiber bundles can be assumed. In the second region just behind the flow front, the empty pores between the fiber tows are completed, but inside the fiber tows only partial saturation is achieved. In dual scale mediums, the air can be trapped in closed porosity, from which it cannot exit, and this leads to tows forming as microvoids.

There are several important parameters to take into consideration when modelling the VARTM process:

- The resin pressure dynamically changes the compaction, which leads to thickness variation. Therefore, consideration needs to be taken of the change in preform fiber volume fraction in response to resin pressure.
- Preform permeability changes in parallel with the change in volume fraction.
- The change in compaction affects fluid flow and preform thickness.
- Dual scale porous media behavior in preforms.

This review study focuses on the above-mentioned dynamically varying properties that occur in VARTM processes during resin injection. The aim is that to emphasize the impact of porous media and preform compaction on the overall filling process of the mold.

Model Development

Most of the studies conducted to model the VARTM process have dealt separately with thickness variation and resin impregnation and very few attempts have been made to investigate the effects of these variables by coupling them in the modeling. One can model the resin flow through the fiber beds using Darcy’s Law, which is the most common equation describing the fluid flow in porous media, as follows:

$$u = -\frac{K}{\mu} \nabla P \tag{1}$$

where $K, \nabla P, \mu$ are the permeability tensor in the relevant direction, pressure gradient and the fluid viscosity respectively.

The Kozeny-Carman model is the most commonly-used expression to explain how the permeability value is updated in correspondence to the fiber volume fraction.

$$K_{xx} = \frac{k_{xx}(1 - v_f)^3}{v_f^2} \tag{2}$$

where v_f and k_{xx} stand respectively for the fiber volume fraction and the Kozeny empirical constant that depends on the preform geometry.

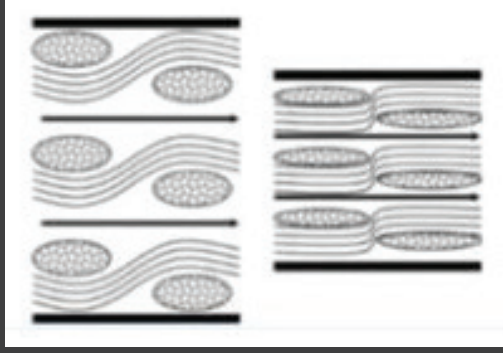


Figure 5: Permeability variation in preforms.

A dynamic change is obtained in the fiber volume fraction during the VARTM process as the applied pressure is distributed between the preform and the resin drawn by the vacuum. Therefore, it should be possible to model a relation for the compaction of unidirectional fiber bundles in terms of atmospheric pressure and fiber volume fraction, and adapting this model to cover all fiber effects is also feasible [10].

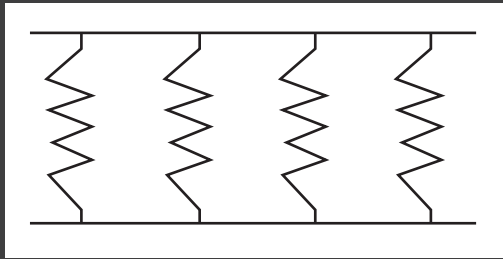


Figure 6: Non-linear spring bed (illustrated for the Gutowski equation)

The Gutowski equation is capable of modeling fiber volume fraction variation by assuming the dry preform to have the form of a non-linear spring bed, the springs within which will vibrate when resin enters, causing thickness variation. The equation can be expressed as follows:

$$\sigma_{zz} = A_s \frac{\sqrt{\frac{v_f}{v_o}} - 1}{\left(\sqrt{\frac{v_a}{v_f}} - 1\right)^4} \quad (3)$$

where σ_{zz} is the stress of the preform, A_s is the empirical constant of the spring bed, v_f is the volume fraction of the fiber, v_a is the maximum volume fraction that the fiber can have and v_o is the initial volume fraction of the fiber. The stress on the preform can be expressed by representing the atmospheric pressure that is applied from the vacuum bag side and the resin pressure P that is generated by the resin as

$$P_{atm} = \sigma_{zz} + P \quad (4)$$

where P and P_{atm} stand for the resin and atmospheric pressures respectively. Using the expressions of 3 and 4, the Gutowski equation can be written as:

$$P_{atm} - P = A_s \frac{\sqrt{\frac{v_f}{v_o}} - 1}{\left(\sqrt{\frac{v_a}{v_f}} - 1\right)^4} \quad (5)$$

As explained above, and as can be seen from Eq. (3) and (4), the atmospheric pressure is equal to the preform stress before the process is initiated. The change in the preform stress starts right after the resin is vacuumed inside the preform cavities, where part of the load is transferred or converted to the resin pressure. The reduction in the preform pressure leads to a decrease in the fiber volume fraction and thus increases permeability according to the Kozeny relationship. Equation (2) to (4) show how the fluid pressure is coupled with the preform compaction, thus validating the complexity of the VARTM process under the dynamic change brought about by compaction with the flow front.

Discussion and Conclusion Remarks

This review study researched into thickness variation and saturation effects on the Vacuum Assisted RTM process and showed that the preform compaction is related to the initial and final fiber volume fraction ratio. Flow and preform behavior were used in the model and incorporated into the governing equations that show the resin flow and its relation within the permeability [10]. In order to maintain optimized process conditions, the inlet and outlet gate pressures must be taken into consideration, as they have an important effect on permeability and alter compaction behavior. The variations in compaction were found to be high close to the injection gate and decreasing as the flow front moves further along the length. The thickness of the preform final structure depends on [11]:

- 1- The initial resin vacuuming and the residence time that leads to gelation,
- 2- The local pressure of the resin, which changes along with the flow front,

Based on the above parameters, one can optimize the design to decrease the thickness variation in the final part by changing the location of the inlet and exit gates of the resin. Also, the increase in compaction leads to higher thickness variation; for this reason, to keep dimensional changes small, the load that results in compaction should be kept low.

Tow saturation displays a similar impact on compaction. When the preform saturates fully, the fill time is less impacted by the saturation, but the quality of the final part is affected [10]. One should note that saturation increases with low permeability values. The main effect of saturation during the filling can be found by modelling the mass loss inside the fiber tows after the flow front has moved forward and micelle formation has taken place. The saturation effect can certainly be observed in the quality of the final cured part.

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In the 21st century, our civilizations owe a lot to these new materials, which perform core functions in furniture, automobiles, construction, adhesives, textile and appliances.





Advanced Polymers for Emerging Technologies

ÜNSAL KOLDEMİR, ASSOC. PROF., PH.D

Kordsa R&D Department Expert Researcher, Chemicals and Materials

This year is the 100th anniversary of Hermann Staudinger's presentation of evidence for macromolecules. In 1920, he published the article "Über Polymerisation", which claimed that thousands/millions of small molecules can be linked together to form ultralong bonds and thus macromolecules or polymers [1]. Since the late 1880s, progress has been made with man-made polymers such as nitrocellulose, Bakelite or vulcanized rubber, which have found their places in our daily lives; meanwhile, these polymers have opened the door to others, such as nylon, polyethylene, polyester and polystyrene [2].

What gives polymers their well-known durability, mechanical elasticity, chemical stability and lightweight properties are the repeating units they contain, the extent of polymerization, and the pattern in which repeat units are arrayed. As such, polymers have become a match for classical materials (metals and ceramics) in terms of their properties and have opened up new application areas from which humankind can benefit. In the 21st century, our civilizations owe a lot to these new materials, which perform core functions in furniture, automobiles, construction, adhesives, textile and appliances.

Nowadays, thanks to developments in chemical sciences and material science, polymers have even more to offer and are ready to solve more complex problems. Molecular-level developments in health/medicine, energy, electronics, robotics and sustainability mean that polymers are called upon to act more "functionally" [3]. In addition, the new century demands that polymers become more sustainable, that they either decompose by themselves or become easier to recycle at a reasonable cost. These demands were not expected of polymers before. This article will therefore illustrate some emerging applications of polymers in materials technology, so as to demonstrate how they are deployed to meet different demands.

Stimulus-responsive Polymers: In the same way that the woodlouse can change its shape into a sphere when it is touched, these polymers can change their physical and chemical states once triggered by a kind of stimulus, be it light, pH, temperature, magnetic or electric field or chemical substance. For this reason, these polymers are especially designed for drug delivery,

sensors, actuators and other on-demand applications [4]. Poly(N-isopropylacrylamide)s are the most widely studied polymer family known for their response to temperature [5]. Below 32 °C, they are in extended form, solvated in their solution, but above 32 °C they assume a globular form and become insoluble, as shown in Figure 1. Through coupling with appropriate co-monomers, their response can be altered to different temperatures, for use in health applications. Biologically active molecules can be dissolved in between Poly (N-isopropylacrylamide) chains in water, and when introduced into the body, upon temperature change the polymer collapses and releases its molecules [6]. As Liu and coworkers have demonstrated, polymers containing spiropyran are able to deliver drugs and aminoacids upon exposure to UV light [7]. When UV light is shined on the polymerosomes containing drug molecules, spiropyran moieties change their structure from hydrophobic to hydrophilic, causing the polymerosomes to open up and release drug molecules. Actuators are types of materials that can change their shape when voltage is applied, thus mimicking body muscles. The most popular polymer of this kind to date is the polypyrrole, which can contract and expand upon the application of voltages less than 1 V [8].

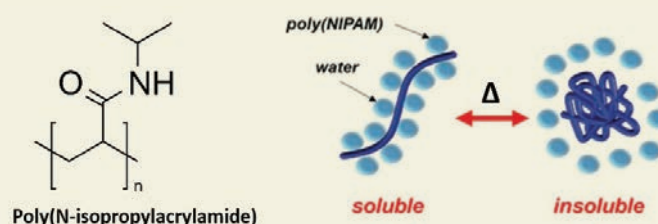


Figure 1: Chemical structure of poly(N-isopropylacrylamide) and its temperature-dependent physical change. Reproduced with permission from ref [5]

Self-immolative Polymers: Similar to that line in James Bond movies – "This message will self-destruct in five seconds"– these polymers can "self-destruct" upon application of a stimulus, as is seen in Figure 2. Conventional polymers have been popular for their structural stability, which enables long-term service life. In contrast, if triggered by a stimulus, self-immolative polymers can depolymerize themselves from one end all the way to the other. This phenomenon is important for the purposes of sustainability, and self-immolative polymers are also sought for drug delivery and tissue engineering solutions. Through the judicious choice of repeating units, one can control the depolymerization pathway, the nature of the stimulus, and the rate of depolymerization. Depending on the nature of the repeat unit, a chemical molecule, pH change, thermal activation or light exposure can trigger depolymerization. Poly(carbamates), poly(benzyl ethers), polyphthalaldehydes, polyglyoxylates and poly(olefin sulfone)s are just a few examples of families that belong to this type of polymer [9]. For instance, ethyl glyoxylate can be polymerized to yield poly (ethyl glyoxylate) with appropriate end groups. When the end groups are hydrolyzed, the polymer depolymerizes back to its starting material.

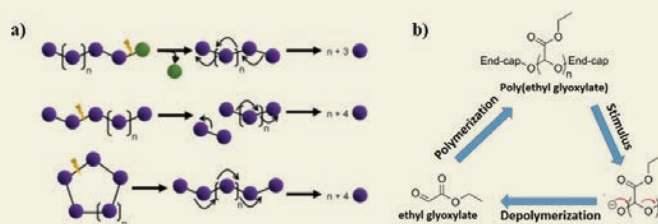


Figure 2: a) Possible end-to-end depolymerization pathways. b) Polymerization of ethyl glyoxylate and depolymerization of poly (ethyl glyoxylate). Reproduced with permission from ref [9]

Self-healing Polymers: The human body is a source of great inspiration in terms of its capacity to regenerate damaged tissues or limbs. Motivated by this phenomenon, researchers have shown great interest in polymers that can return to their original shape (shape memory polymers) or regain their original physical integrity. These type of materials will ensure a long lifetime, require less maintenance and decrease replacement costs. In contrast to conventional polymers, with their strong covalent bonds, these types of polymers rely on reversible covalent bonds or weaker non-covalent interactions. The self-healing mechanism can be controlled at the molecular level by exchanging? bonds, and the application of external stimuli such as light, heat or pH can induce re-bond formation. Martin et.al have utilized sulfide chemistry that can exchange bonding even at room temperature [10]. They have prepared poly (urea urethane) polymers -commonly used in sealants and coatings-crosslinked with interchangeable sulfide bonds. As shown in Figure 3, after a polymer is cut into two pieces, simple contact at room temperature will be enough to regenerate the original polymer.

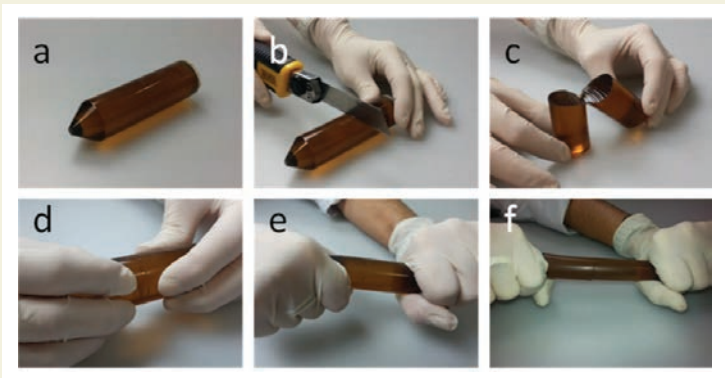


Figure 3: a) Sulfide crosslinked poly (urea urethane) b-f) self-healing at room temperature for two hours. Reproduced with permission from ref [10]

Biodegradable Polymers: Environmental concerns about the accumulation of plastics disposed of in the oceans and in soil have resulted in the development of new polymers that can be easily decomposed by microorganisms [11]. Biodegradable polymers offer the advantage of similar mechanical properties to those of the common packaging polymers used to date, but they can also easily be broken down by the enzymatic action of microorganisms. The most famous example of these polymers are the poly (lactic acid) type polymers obtained by polymerization of lactic acid. Their physical and mechanical properties, as well as their transparency, have made them suitable for use in food packaging. As seen in Figure 4, most of the biodegradable polymers are made of agriculturally important molecules. To prevent disruption to the agricultural system, genetic engineering methods are called for that will enable the production of these monomers in a greener and more efficient way.

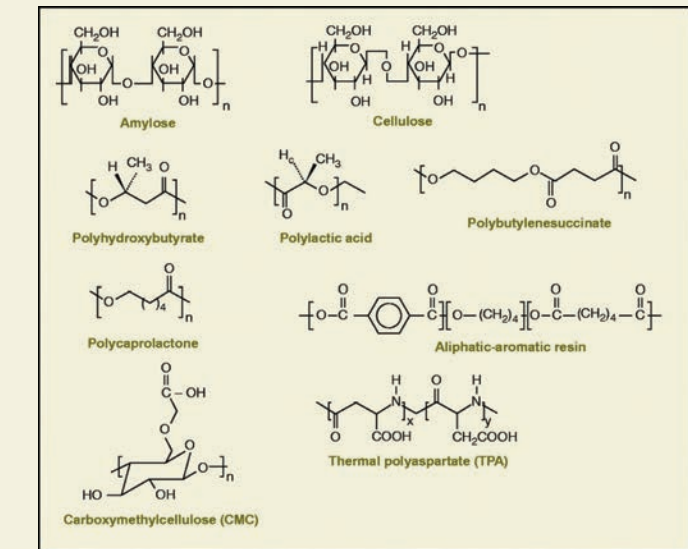


Figure 4: Some common families of biodegradable polymers. Reproduced with permission from ref [11]

Organic 2D polymers: Fish-net like structures (such as those found in graphite) are known to everyone. However, bringing together monomers in a 2D polymer structure has been challenging. Most polymers are linear, with the repeat units being connected via covalent bonds, as Staundiger demonstrated. Work by Prof. Dieter Schluter has shown that laterally connecting polymers at their repeat units and end groups can give rise to 2D polymers [12]. These polymers form sheets that possess very long-range ordering, as in the case of graphene. However, they have the added advantage of multiple end groups with determined porous structure. Recently, Liu et.al. have described how a 2D polymer can be achieved by polymerizing monomer pairs to constitute a polyimide and polyamide with 2 nm thick layers. This is illustrated in a TEM image showing the perfect ordering, in Figure 5 [13]. As these polymers present very high crystallinity in a very thin form with defined porosity, they are well suited for use for separation purposes (gas purification, water purification and desalination).

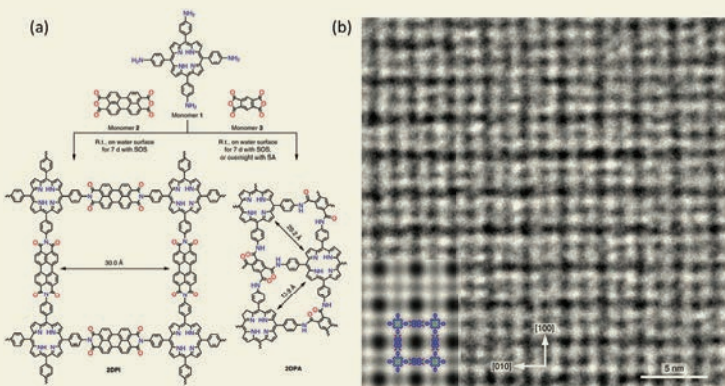


Figure 5: a) 2D polymer structure composed of a polyimide and polyamide. b) TEM image of the polyimide 2D polymer. Reproduced with permission from ref [13]

It has been 100 years since Hermann Staudinger described how small organic molecules can come together to form very long macromolecules. He shone a light that revealed the new opportunities for the production of human-made soft but durable materials. However, as polymer science matures, more functionality is expected of these materials, such as on-demand functional and chemical structural change, responsiveness to outer stimuli, and more crystallinity. To this end, in this new century of polymers, human civilization can be well served by the development of new, cost-effective material solutions for emerging technologies in medicine, electronics, sensors, membranes and sustainability.

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We develop innovative and unique intermediate products and applications for composites technologies with the inspiration we get from the excitement of learning new things and the encouragement that continuous improvement brings in. We are always passionate to achieve better.

KORDSA

THE REINFORCER

When you become a Kordsa citizen, the first thing you see is how small the world is, and this realization pushes you to embrace a global outlook.





Human Resources In Kordsa’s “Global Equation”

MİRAY GÖNÜLŞEN

Talent and Organizational Development Manager, Kordsa

Years ago, when I first heard the motto “Think Global, Act Local”, it shook my world and opened up a new way of thinking, triggering my own personal enlightenment! I did not really appreciate what it meant, but I did know that it was no mere reinvention. It was obviously a bold claim, and for some reason I liked it! I remember that, in the next few years, I uttered this motto in numerous contexts and dropped it into various conversations, and using that phrase felt so right!

The years passed, I forgot the phrase, and it got buried beneath the clutter of university and life...

Looking back, the Miray of 2021 would tell her younger self that, for a multinational culture, this old mantra is only the tip of the iceberg.

When you become a Kordsa citizen, the first thing you see is how small the world is, and this realization pushes you to embrace a global outlook. You accustom yourself to different time zones, different languages and different cultures. While our company is operating 24/7 around the world, I cannot believe in borders. What happens at one end of the world often reaches us and affects us at the other end at lightning speed; every day, geographic reach expands and distance decreases in meaning.

Operating across geographical boundaries certainly brings challenges, and some companies find it difficult to adapt to and internalize diverse cultures. Yet “culture” is what we experience every day of our lives, shaping how we perceive our working environment, which in turn directly affects how we perform. In other words, culture is bound up with the values of all our employees and inseparable from the values of our company.

Kordsa comprises a spectrum of cultures, starting from the APAC nations of Thailand and Indonesia, on to Turkey and then to the Americas (USA and Brazil). Every HR person working for Kordsa cares passionately about attracting, retaining and engaging talent, establishing fair systems of compensation and benefits, developing soft and technical competencies, ensuring healthy industrial relations, and so much more. As a global firm, we are brought together under a single umbrella, yet we also respect social and cultural differences; achieving a balance between the needs of standardization and localization is crucial.

This is easier said than done, though. How do we really reconcile all these needs and challenges?

The more diverse we become, cultivating a broad global perspective requires us to be all the more sensitive to local cultures, to employees’ values, mentality and behaviors, to people, history and the future.

It means we need to build a learning organization.

And this doesn’t happen overnight.

We need to experience it, see it, listen to it and live it. We need to build relationships, develop new ideas and strategies. We need to follow global trends as well as search for new ways to establish and/or modulate them in local and diverse operations. In that case, sometimes you have to invert the “motto” and “think local, act global”. In order to foster a stronger partnership, we have to understand each other and show how our values affect us within the organization. To do that, we have to learn to listen to each other, to acknowledge every voice and value every opinion.

We cooperate mindful of the fact that this partnership exists. In addition, the relationships we nurture ensure productivity and sustainability in our processes and policies. We are open to adopting all the best practices that the various cultures within our firm have to offer. Establishing flexibility in a learning organization is what keeps us agile.

This is Kordsa’s “Think global, act local” formula. It means applying a “Global Lens” to remain alert to the different aspects of a worldwide operation, at the same time as being responsive to unique and diverse local needs when we act. In fact, this global approach eventually enhances national differences. That is how we can create a learning organization in which people want to do their best, to learn from each other and to learn from the differences among them within a multicultural environment.

Building the right strategy to fulfil our mission is vital in all of Kordsa’s functions, regardless of the department. And Human Resources is a big part of this “Global Equation” at Kordsa. We are more than a support function; we are more than a cost center. At the center of Kordsa is “the human”, and we all know that nurturing this center requires effort and investment.

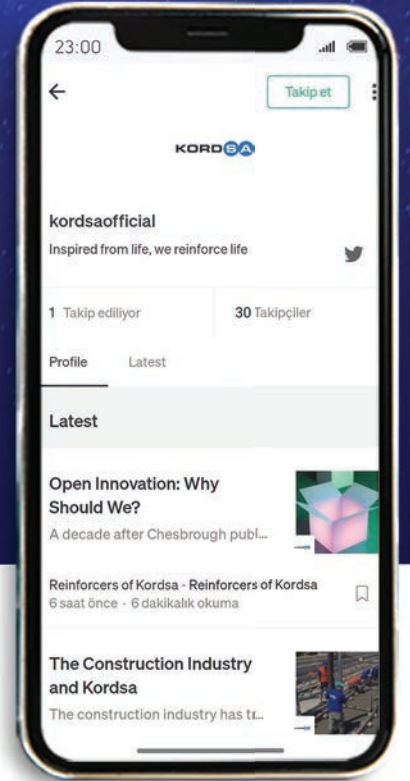
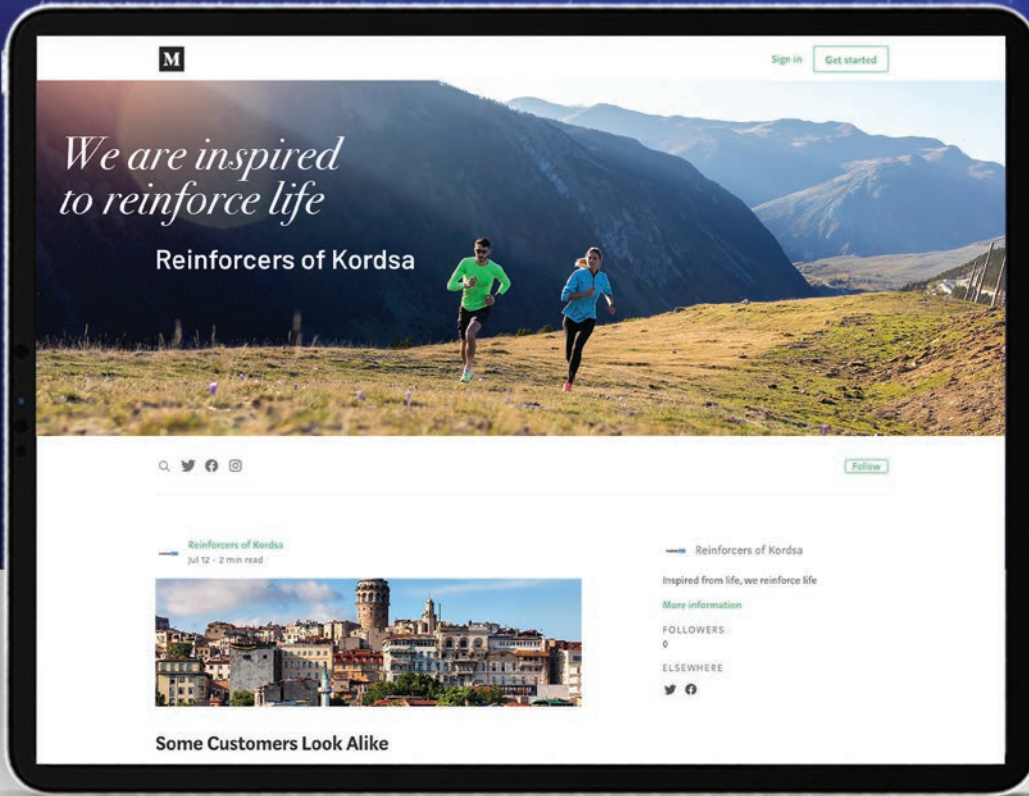
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Shotcrete Application - Design with Kratos Macro Synthetic Fiber

BURAK ERDAL

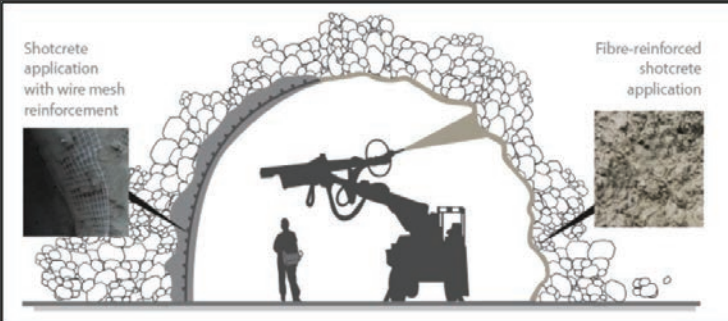
Global Technology Project Leader, Kordsa

UĞUR ALPARSLAN

Technology Manager, Kordsa

Shotcrete Application - Design with Kratos Macro-Synthetic Fiber

Synthetic macro- and micro-fibers became available for use in shotcrete in the 1990s. Synthetic macro-fibers can be viable alternative for a full replacement of conventional steel bars in concrete elements (such as shotcrete) with continuous support. Micro-synthetic fibers provide minimize plastic and drying shrinkage cracks in concrete, macro-synthetic fibers increase toughness, load-bearing capacity and durability. Macro- and micro-synthetic fibers conformity with the EN 14889-2 standard



(Fibers - for use in concrete - Part 2: Polymer fibers - Definitions, specifications, and conformity). Fibers with an equivalent diameter > 0.3 mm are referred to as macro-synthetic fibers, while those with an equivalent diameter ≤ 0.3 mm are called micro-synthetic fibers. The use of macro-synthetic fibers in sprayed concretes are included in the technical specifications of Highways and EFNARC (European Specification for Sprayed Concrete) and it is aimed to determine the amount of macro-synthetic fiber to be used, according to class of rock.

Calculation of Energy Absorption (Toughness) Capacity in Fiber-Reinforced Concrete

Kratos Macro fibers are used to increase the energy absorption capacity and deformation ability of concrete and to reduce the possibility of cracks. Toughness means the ability of fiber-reinforced concrete to continue carrying loads after cracks have emerged due to tensile stresses. Toughness is referred to as the sum of the area under load-displacement curves. Its unit is the joule (Newton*meter or kN*millimeter).

Experimental Study

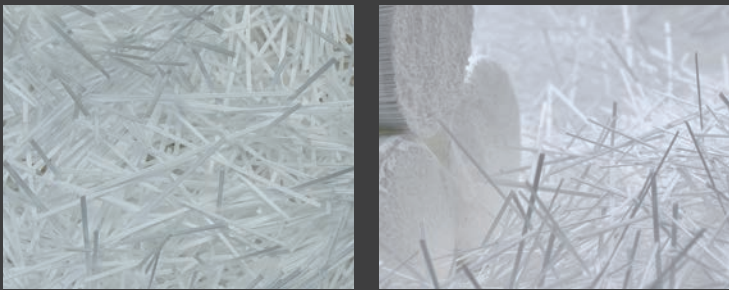


Figure 1: Kratos Macrosynthetic fiber for concrete

* It is made of Polypropylene

Concrete Mix Design

Sample	1 m ³ Concrete, kg/m ³
Water	180
Cement	450 (CEM 1 42.5 R)
Coarse aggregate 2/10	176,9
Fine aggregate 0/6	1559,3
Super plasticiser	7,2 (%1,6) (SIKA NP5)
Kratos PP 70	5

Table 1: Concrete mix design

Concrete is considered in compressive strength class C35/45 at 28 day.

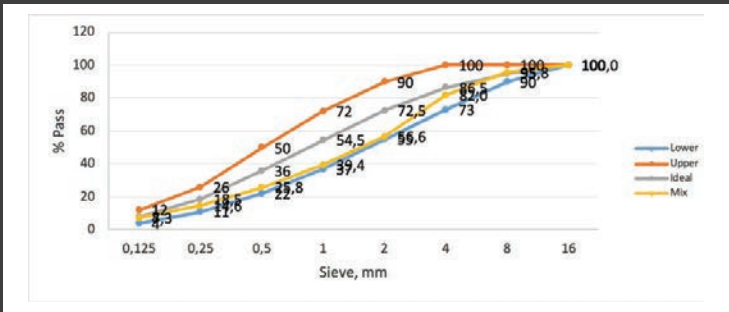


Figure 2: Aggregate Sieve Analysis

Length	54 mm - 70 mm
Equivalent Diameter	0,72 mm
Tensile Strength	550 MPa
Elastic Module	8,5 GPa

Table 2: Kratos Macro Synthetic Fiber Technical Specifications

Test Description

EN14488-5	
Test type	Centrallyloaded determinate panel
Height	Center of panel (under loading point)
Cast side	In direction of loading
Specimen type	Square panel (60*60*10 cm)
Supports	Continuous support
Test control	Closed-loop control- LVDT
Test speed	1mm/min
Calculated parameters: Energy absorption P	P25mm = Energy absorption until deflection of 25mm

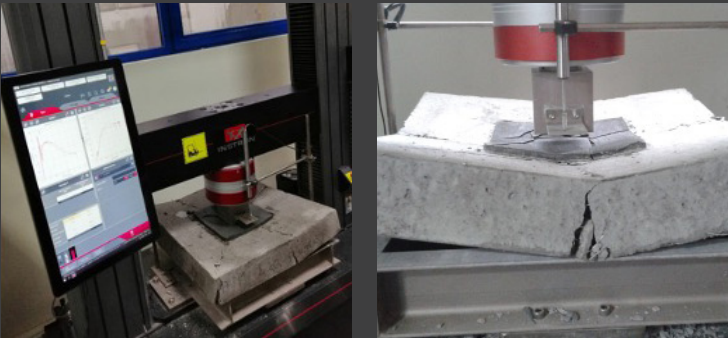
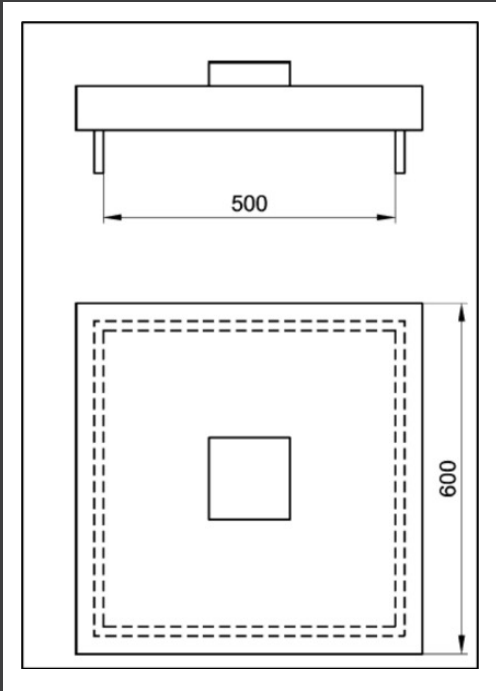


Figure 3: EN 14488-5 Test

In the test , fiber-reinforced concrete specimens were casted 60*60*10 cm, which were tested according to EN 14488-5 (EN14488 Testing sprayed concrete - Part 5: Determination of energy absorption capacity of fiber reinforced slab specimens). The test was carried out in a closed-loop displacement controlled machine. Displacements were measured by LVDT (Linear variable differential transformer). 4 specimens were tested with 1 mm / min. loading speed.

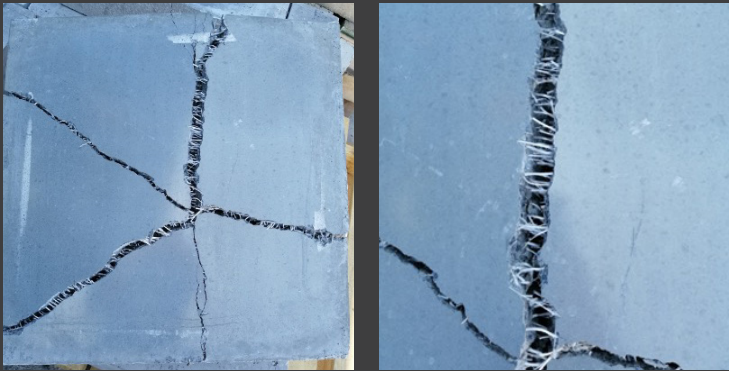


Figure 4: Test samples (Kratos fibers hold the concrete together thanks to the bridging effect)

Specimen no, 5 kg/m³	Max. Load, kN	Average absorbed energy, 25 mm
Kratos PP 70-1	64	1181
Kratos PP 70-2	61	1013
Kratos PP 70-3	63	1043
Kratos PP 70-4	63	1079
Average	63	1079

Fiber	Dosage kg/m³	Specimen, cm*cm*cm	Compressive Strength (MPa)
Kratos PP 70	5	15*15*15	44,5

Table 3: Test Results

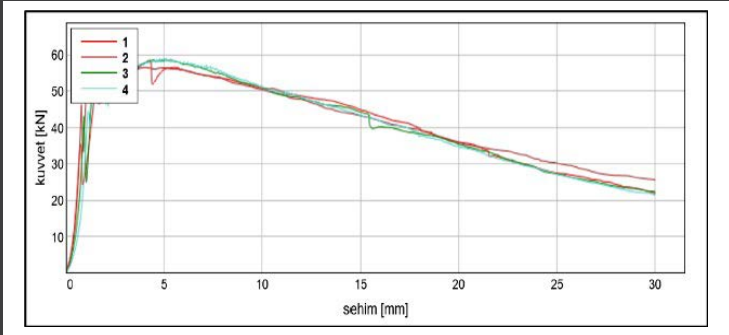


Figure 5: 5 kg/m³ Kratos PP 70 - EN 14488-5 Load - Displacement

Determination of Energy Toughness Class

The energy absorption capacities of the fiber-reinforced samples will be equal to or greater than the values specified in Table 4. (Highway Technical Specifications 2013)

Toughness Class	Average absorbed energy, 25 mm
A	500
B	700
C	1.000

Table 4: Toughness Class

Rock quality structure is important in determining the energy absorption capacity of fiber-reinforced shotcrete. The energy absorption capacity of concrete varies depending on the concrete mixture and fiber dosage (kg /m3). Depending on the rock structure, macrosynthetic fibers can completely replace traditional steel reinforcement. Microsynthetic fibers are used to minimize plastic and drying shrinkage cracks in shotcrete in which the cement dosage is high.

Example of Comparable Moment Capacity
Calculation for Wire Mesh & Macro-Synthetic Fiber-
Reinforced Concrete According to ACI 544. 4R-18

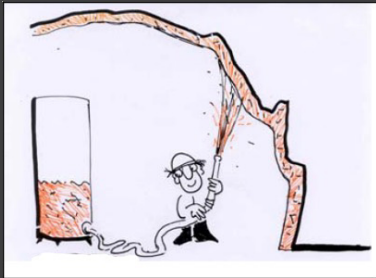


Figure 6: Shotcrete

Wire mesh – Moment Capacity

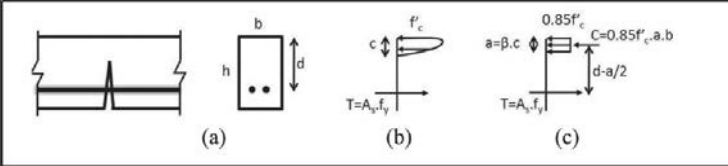


Figure 7: Schematics of stress block for a cracked reinforced concrete flexural member without fibers: (a) reinforced concrete beam section; (b) actual distribution of normal stresses; and (c) simplified distribution of normal stresses.

$M_{nRc} = A_s \cdot f_y \cdot (d - a/2)$
Concrete Height: 20 cm
Wire Mesh: Q188/188 (One Layer)
Concrete Cover: 10 cm
Concrete Class: C25/30

b	1000	section width, mm
A_s	188	cross sectional area of steel, mm ²
f_y	500	specified yield strength of steel, MPa
f_c'	25	specified compressive strength of concrete, f _{ck} , MPa
a	4,42	depth of compressive zone, mm
h	200	section thickness or height, mm
h'	100	concrete cover, mm
d	100	depth of reinforcement, mm
Moment Reduction Factor	0,9	ϕ
M_{nRc}	8272884,706	N-mm
	8,27	kN-m
M_{nFRS}	1,38	f ₁₅₀ residual strength of fiber, MPa (ASTM C 1609)

Table 5: Wire mesh – Fiber-Reinforced Concrete – Moment Capacity

Fiber-Reinforced Concrete Moment Capacity

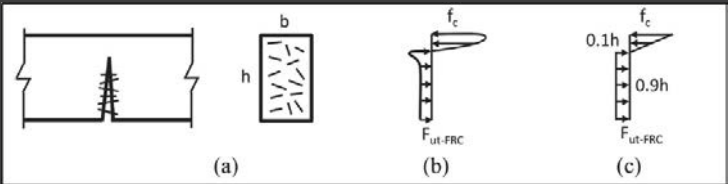


Figure 8: Schematics of stress block for a cracked FRC flexural member. (a) FRC beam section; (b) actual distribution of normal stresses; and (c) simplified distribution of normal stresses.

$M_{nFRC} = f^d_{150} \cdot \frac{b \cdot h^2}{6}$

$f^d_{150} = 1.38 \text{ Mpa} = Q188/188 \text{ wire mesh Moment Capacity}$



Figure 9: ASTM C 1609 Test

Specimen	First Peak Load Pp (kN)	First Peak Strength f1 (MPa)	First Peak Deflection (mm) δ	Residual Strength (L/600 deflection) f'600 (MPa)	Residual Strength (L/150 deflection) f'150 (MPa)	Toughness (Joule) T'150	R's (Equivalent Flexural Ratio)
Kratos PP 54 2 kg/m3	36,69	4,89	0,05	1,81	1,61	41	38
Kratos PP 54 3 kg/m3	36,01	4,80	0,04	2,07	2,07	48	45
Kratos PP 54 4 kg/m3	35,16	4,69	0,04	2,53	2,57	59	56
Kratos PP 54 5 kg/m3	35,71	4,76	0,04	3,03	3,28	72	67
Plain Concrete	33,40	4,45	0,04	0,43	0,00	0	0

Table 6: ASTM C 1609 Test Results

Kratos PP 54 2 kg/m³ f^d₁₅₀ = 1.61 > 1.38 MPa.

When Kratos macro-fibers are used in concrete to replace steel reinforcement, they can provide enhanced ductility, toughness and durability. Kratos fiber dosage can be engineered to provide a desired level of crack control, post-crack tensile and flexural capacity. Similar to steel bars, for which the size and spacing are calculated to provide the required reinforcement ratio, the dosage of fibers are also calculated to satisfy engineering requirements.

Kratos PP 54 2 kg/m³ dosage can be used completely as an alternative to Q188/188 traditional steel reinforcement.

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- ACI 506.1R: Guide to Fiber Reinforced Shotcrete
- ASTM C 1609 : Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam With Third-Point Loading)

WE REINFORCE LIFE

News



Kordsa is Among Turkey's Most Valuable and Strongest Brands

Kordsa has entered the Turkey Brands 100 list, the annual report on the Turkey's most valuable and strongest brands, for the first time this year, claiming 50th place with US\$ 65 million brand value mark. Turkey Brands 100 is a study run by Brand Finance for 13 years and this year, Kordsa is the third most valuable among new entrants.

Dedicated to a better understanding of marketing finances, Brand Finance is the world's leading independent brand valuation and strategy consultancy. For more than 20 years Brand Finance has helped companies to connect their brands to the bottom line, building robust business cases for brand decisions, strategies and investments. Every year Brand Finance values over 5000 brands across all sectors and geographies. Global top 500 companies are published in the media to raise awareness of brands as valuable business assets.

Kordsa Has Attended On Air Value Creating Brands 2020 Program

Ali Çalışkan, the CEO of Kordsa, has given a speech at the Leaders' Session in On Air Value Creating Brands 2020 Program organized by Fast Company magazine where CEOs of five brands in the first 100 list of the Most Valuable Brands have attended. Çalışkan has shared with the audience the Strengthening Life vision and global perspective of Kordsa which made Kordsa, ranking #50 in the list, a valuable brand.



Kordsa Has Published 2019 Activity Report

Kordsa, offering reinforcement technologies throughout the world with its 12 plants in 4 continents with its mission of "Our Passion is Strengthening Life" has published 2019 Activity Report. You may access the report including 2019 activities and financial information of Kordsa through this link: <https://bit.ly/2V2Mj75>



Kordsa Has Attended World of Concrete Fair

Kordsa, has attended with Çimsa the International Concrete Fair - World of Concrete (WOC) 2020 - which is one of the most prestigious fairs in concrete. Kordsa has met with the pioneers of the construction sector with its KraTos brand, innovative synthetic fibers distinctive in concrete reinforcement practices



5 Awards to Kordsa

Korda’s digital transformation journey received 5 awards from the IDC DX 2020 Awards organized by International Data Corporation (IDC). While Kordsa CEO Ali Çalışkan won the third prize in the DX CEO category, a total of 4 projects

in the Operating Model Master, Digital Transformation and Talent Development categories brought Kordsa the second and third prizes.



Kordsa’s DiCoMi Project Partners Have Completed Their Researches

6 researchers and 2 professors from the partners of Kordsa in Ukraine, Romania and England of DiComi project on manufacturing composite materials with 3D printer technology and is conducted within Horizon 2020 program which Kordsa is also involved have completed a month long research they have conducted at the Composite Technologies Center of Excellence.

Kordsa is Among the Ethical Companies of Turkey

Kordsa is deemed worthy of 2019 Ethics Award of Turkey by Ethical Values Center Association (EDMER) being in service to create, develop and extend sense of ethical approach awareness in Turkey. As a result of the evaluation carried out, Kordsa has been among 24 companies receiving an award with its ethical practices in compliance with international ethical standards.



Kordsa is on the Fortune 500 Turkey List

Fortune Turkey and CRIF jointly carried out Fortune 500 Turkey list since 2008. Kordsa is in the list this year too, claiming 61st place with TL 5.1 million revenue. Being among top 100 companies, Kordsa can be expected to make further headway in the future. The Turkey’s 500 largest companies generated TL 1.8 trillion in revenues and TL 78.1 billion in profits in 2020. Together, this year’s Fortune Turkey 500 companies employ millions of people across Turkey and worldwide.

The Fortune 500 Turkey is an annual list compiled and published by Fortune magazine Turkey that ranks 500 of the largest Turkey’s corporations by total revenue for their respective fiscal years. The list includes publicly held companies, along with privately held companies for which revenues are publicly available.



Advanced Honeycomb Technologies Achieves AS9100 Revision D Certification

Committed to the highest quality standards in aerospace, Advanced Honeycomb Technologies (AHT), which manufactures honeycomb cores for aerospace and commercial applications, has obtained AS 9100 Revision D certification. As the ultimate global benchmark for aerospace and defense quality management, this certification demonstrates AHT’s ability to consistently provide products and services that meet customer needs while meeting applicable statutory and

Kordsa Awarded with Gold Business Partner by Apollo Tires

Tire reinforcement leader Kordsa received the Gold Business Partner Award from Indian tire manufacturer Apollo Tires. Kordsa, successfully completed the audit with 91% score and received the A degree which indicates the excellence and growth partner. Kordsa continues to reinforce its customers with the vision of “Inspired to Reinforce Life”.



Axiom
Materials
Receives
Carbon
Neutrality
Certification



Axiom Materials Inc. has received the Carbon Neutrality Certification for calendar year 2019, demonstrating its commitment to corporate social responsibilities and contributing to reinforcing the sustainable future of our world. Axiom Materials worked with SCS Global Services to calculate its carbon emissions from sources such as utilities, employee commute and waste streams. Axiom additionally completed several projects in 2020 as well as planning other projects in 2021 to reduce the amount of carbon emission generated.

Kordsa Has Attended Tire
Technology 2020 Fair

Kordsa has attended Tire Technology Fair which is one of the most significant meetings of the sector and is organized in Germany on the dates between February 25 and 27. Kordsa has exhibited sustainable and innovative technologies and tire reinforcement products it has developed. The tire manufactured with Cokoon adhesion technology which it has developed with Continental as an environmental friendly and sustainable alternative is also displayed at the fair.

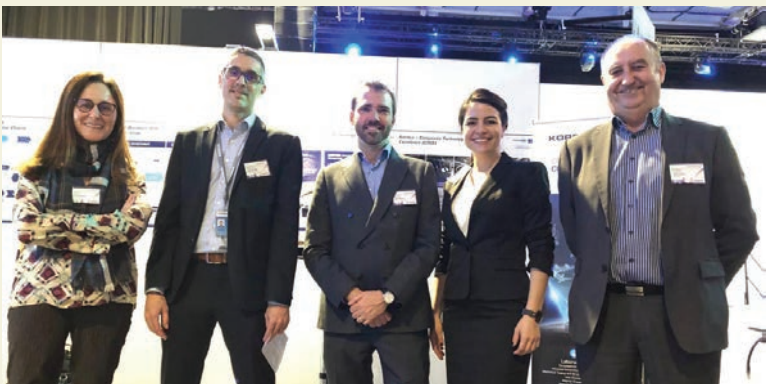


Kordsa Has Introduced KraTos at
Civil Con'20 Event

Kordsa has attended Civil Con'20 event organized by Istanbul Technical University, Preparation to Engineering Club with the participation of significant companies of the sector to introduce the future civil engineers with the working fields they shall work at. Kordsa has shared with students the information on use of KraTos synthetic fiber reinforcement in projects.

Kordsa Has Attended Airbus Supplier
Days

Kordsa has attended Airbus Supplier Day organized in Toulouse, France where suppliers which may perform cooperation with the supply chain and are selected from Turkey along with key supplier companies of Airbus were attending. Kordsa has conveyed its competencies both to Airbus and supplier companies of Airbus with the presentations and negotiations.



Axiom to expand its CMC Product
Portfolio with Carbon/SiC and
SiC/SiC Composite Intermediates
Under License from JST and NITE
Corporation of Japan

Axiom, the global leader in the development and supply of Oxide/Oxide CMC prepreps for aerospace and industrial applications, is to develop a line of Carbon/SiC and SiC/SiC composite intermediates under license from JST (Japan Science and Technology Agency) and NITE (Nano-Infiltration and Transient Eutectic-phase) Corporation of Japan. This will allow Axiom to expand its offerings over a complete spectrum of CMC materials for aerospace and industrial structural applications with service temperatures to 1400°C.



Kordsa Has Attended On-Air Program of Brasil's Human Resources Association

Luiz Carlos França Duarte, the Human Resources Director of Kordsa Brasil has attended on-air program of Brasil's Human Resources Association (ANRH Brasil) explained the importance of human-oriented concept in changing business world dynamics. Duarte has made recommendations for a better society and sustainable business model during on air.

Kordsa Has Raised Its Carbon Disclosure Project Climate Change Report Grade Level

As a result of the studies Kordsa has conducted on climate change and leading relevant risks and opportunities. Kordsa has reached the leadership level by increasing both our climate change and water security program scores from B to -A in the 2020 reporting period. Kordsa reports to CDP Climate Change and Water Programs since 2016.



Kordsa Has Attended Management Meeting of CIRFS International Rayon and Synthetic Fibers Association

Kordsa has Attended Management Meeting of CIRFS International Rayon and Synthetic Fibers Association. Today's economic data and future period scenarios are evaluated at the management meeting of CIRFS which is established to meet the needs of the sector, customers and society sustainably.

Kordsa is the Most Amazing Place to Work in Brazil

Reinforcement leader Kordsa added another prestigious award to its growing list of accolades. The Company is the winner of the "Most Amazing Place to Work in Brazil" Award for 2020. The announcement was made December 1st, at a virtual event in the presence of the 100 best companies nominated for 2020. Kordsa has consistently been listed as one of the best places to work for in Brazil. This is the second time in a row the Company has won an award as a great place to work. Last year Kordsa was also listed as the Best Employers in Brazil by the prestigious magazine Você S/A. The Reinforcement leader had also been previously listed among the best employers in Bahia, Brazil four times in a row, has been named the 18th best company by the Great Place to Work Institute (GPTW), won the "Best in Internship Practices" award for two consecutive years by Instituto Euvaldo Lodi, and has also a special recognition called 'revelation of the year' by Você S/A.



A Visit to Kordsa Indonesia by the Ministry of Industry and Commerce

Bogor representative of Indonesia the Ministry of Industry and Commerce has visited Indo Kordsa, Kordsa's facility in Indonesia and examined onsite the measures taken against Covid-19 pandemics. The Ministry Officials have present congratulations to Kordsa Officials for all measures taken at the facility and completed their visit with a positive evaluation report.

Kordsa Has Completed IATF 16949: 2016 Audit Successfully

Kordsa is entitled to obtain certificate by completing Automotive Management System IAST 16949:2016 audits successfully at Izmit plant. Kordsa's plant in Thailand has also completed two-step audit of IAST 16949:2016 standard without any negative finding detected.



Kordsa Has been Awarded the “Gold” Rating for Sustainability

Kordsa is among companies to partner with Ecovadis to ensure the sustainability of the global supply chain. The Company improved its rating and has received “Gold” status, awarded by Ecovadis. The award places Kordsa in top companies among over 40.000 companies surveyed for their sustainability works between 2015-2019. Shaping the industries in tire and construction reinforcement and composite technologies, making life easier, striving to produce more efficient and environmentally friendly technologies, Kordsa reinforces life responsibly. With this rating, Kordsa’s sustainability efforts have now also been confirmed by Ecovadis based on the assessment in areas concerning the environment, labor and human rights, ethics, and sustainable procurement.

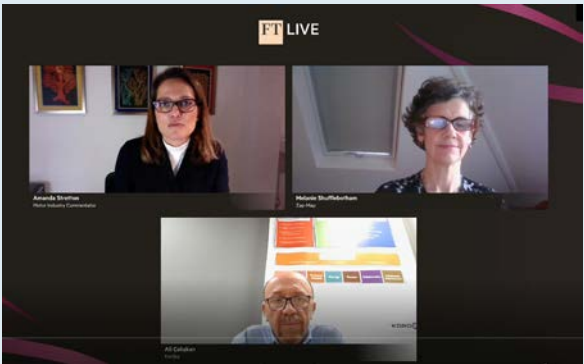


TPM Travel of Composite Technologies Center of Excellence Has Started

Composite Technologies Center of Excellence has started Total Productive Maintenance (TPM) activities to extend the life of the equipment by operating them more efficiently and error-free and improve competencies of the employees by increasing their dominances on their equipment. The Center starting its activities on the pilot machine with Step -1 is intending to accomplish qualifications in 2020 from Step 1, Step 2 and Step 3.

Kordsa Attended Net Zero Car Panel in the Future of Car Summit

Kordsa CEO Ali Çalışkan attended to “Sustainability and the Net Zero Car” in the Future of the Car Summit as one of the speakers to discuss car industry’s exposure to climate-related risk, Net Zero vehicles, the most exciting new technologies to reduce carbon emissions and strategies to reduce operational carbon footprint through supply chains.



Kordsa Showcased Its KraTos Synthetic Fibers at the Global Concrete Summit

Operating with ‘Inspired to reinforce life’ vision Kordsa participated in the Global Concrete Summit, which took place online for the first time in the construction industry. Kordsa was the Gold sponsor of the Summit that provided learning and networking opportunities on the latest innovations, technical knowledge, continuing research,



tools and solutions for sustainable concrete design, construction and manufacturing. Kordsa shared its innovative concrete reinforcement technologies, namely KraTos Macro, KraTos Micro, KraTos Rebound Minimizer and KraTos Pool Fiber.



Canoe Manufactured by Kordsa with Composite Technology is Exported

8.6m long and weighing 10 kg Canoe is manufactured by using carbon prepreg developed by R&D center at Kordsa’s Composite Technologies Center of Excellence and honeycomb core material developed by Advanced Honeycomb Technologies, a company of Kordsa. The canoe which may be easily carried by a person is exported to England after manufacturing in Turkey is accomplished.



Visit of the Members of the Composite Manufacturers Association to Kordsa

Kordsa and Sabancı University have hosted the members of the Composite Manufacturers Association at the Composite Technologies Center of Excellence. Prof. Dr. Bahattin Koç has given a seminar on “Additive Manufacturing Technologies” at the meeting where more than 40 companies have attended. The visit is completed after the laboratory tour.

Kordsa Has Attended Turkey Connecting Business Asia Panel

An online panel is organized by Turkey Connecting Business Asia for strengthening business, commerce and investment relations between Indonesia and Turkey. Ali Çalışkan, CEO of Kordsa attending the panel as the speaker, has shared Kordsa and Kordsa’s activities in Indonesia with the audience and explained the vision and strategies of the following period.

Road To Twinning The Second Round

Turkey Connecting Business Indonesia

Saturday, May 30
4:00 PM Turkey Local Time
8:00 PM Indonesia Local Time

MODERATORS
Anil Demir
JCI Bahçeşehir
2020 LO President

Antony Simon
JCI Medan
2020 LO President

TURKEY

ROAD-TO

Guest Speakers

Ali Çalışkan
Chief Executive Officer of KORDSA

Sjabrian Harahap SE, MBA
Vice Chairman of Chamber of Commerce and Industry (KADIN) of North Sumatra

Mikha Lawrence
International Trading Manager of PT Olagafood Industri

Ali Suat Cengiz
General Manager of ADABTE International



Robot in Charge of Reel Loading in Brazil is in Action

The robot serving in automation project conducted at Kordsa Brazil plant and ensuring the loading of reels sent to weaving on to the the carrying cage once the yarn spinning process is over started its activity. The robot will perform the loading of cages weighing each approximately 14 tons and containing 1500 reels.

Lloyd's Register

Certificate of Approval

This is to certify that the Management System of:

Thai Indo Kordsa Co., Ltd.

1181 Moo 5, Rongse Industrial Estate, Kanchan Subdistrict, Uthai District, Ayutthaya, 13210, Thailand

has been approved by Lloyd's Register to the following standards:

IATF 16949:2016

Another Quality Certificate to Kordsa

Following Izmit plant of Kordsa, Thai Indo

Kordsa, the plant in Thailand, has received Automotive Management System IATF 16949:2016 certificate. Thai Indo Kordsa, accomplishing successfully the audits of IATF 16949:2016 standard generated for Global automotive industry, has become entitled to obtain the certificate.

Two Projects of Kordsa are Accepted by TUBITAK 2244 Industrial Doctoral Program

Two projects of Kordsa are entitled to be supported in 2244 Industrial Doctoral Program actualized by TÜBİTAK to raise personnel with skilled labor in R&D. Kordsa shall conduct thin film applications project it has prepared with Sabancı University and cord fabric and recycling projects it has prepared with Kocaeli University with doctoral students to be selected.

WE ARE PROUD OF OUR PROJECTS ACCEPTED TO TUBİTAK 2244 PROGRAM.

KORDSA

IDC

COVID-19 Impact: Smart Manufacturing

June 11, Thursday / 10:00-12:00

Invitation Request

IDC Turkey Webinars

Kordsa Has Shared Its New Digitalization Strategies

Fatih Akar, Global Information Systems Manager of Kordsa, has attended “Covid-19 Impact: Smart Manufacturing” webinar organized by International Data Corporation, as the speaker. Akar has shared with the audience Kordsa’s strong infrastructure and production systems and new digitalization strategies at the meeting where difficulties experienced by companies from different sectors in pandemics period are evaluated.



New Colored Glass Fiber Prepregs

Kordsa reinforces every aspect of life with its wide range of composite mid-products. Kordsa has recently launched its new colored and glass fiber reinforced prepregs that color and enliven composite parts.

Kordsa’s 2019 Sustainability Report Has Been Published!

The 6th Sustainability Report, in which Kordsa explains the managerial, social, economic and environmental performance data of its operations in 2019, has been published. The report includes

Kordsa’s perspective and goals determined by Kordsa focusing on five of the UN’s Sustainable Development Goals. To read the report: <https://bit.ly/3aq3AxJ>

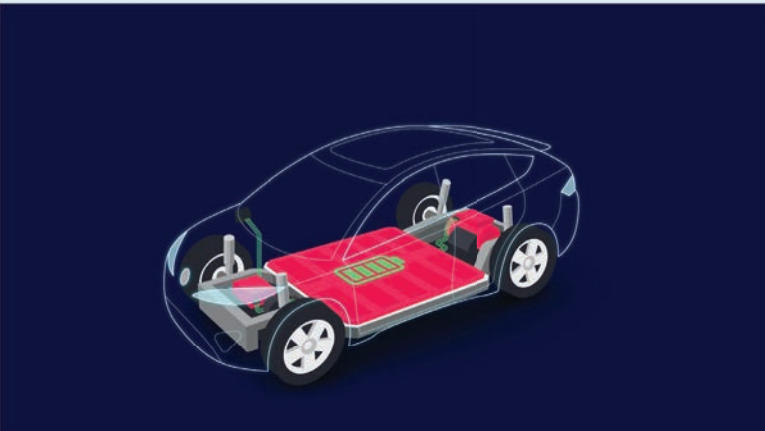


The First Synthetic Fiber Reinforcement Application of the World by Kordsa

Kordsa has published KraTos mobile application explaining usage purpose of KraTos Macro and Micro fiber reinforcements providing advantage for infrastructure and superstructure concrete constructions and enabling easy calculation of dose in concrete. It is possible to access the only application in the World giving information on fiber reinforcements used in reinforcement of concrete from all Android markets.

Kordsa is Lightning EV Batteries with Its Carbon Fiber Fabrics

Lightweight composites are a key element for the development of electric vehicles and sustainable transport solutions. Placing sustainability at the heart of its operations, the reinforcement leader Kordsa is collaborating with industry leaders to support a sustainable future. Kordsa has recently secured a supplier agreement with TRB Lightweight Structures, a global high-volume composites manufacturing company. TRB is using Kordsa’s carbon fiber fabrics in the manufacture of their composite battery enclosures for EVs.



Kordsa Received 2 Awards from TÜSİAD SD2 Program

Within the scope of TÜSİAD's Digital Transformation in Industry (TÜSİAD SD2) Program, the artificial intelligence supported image processing technology "Restricted Area and Personal Protective Equipment Control for Occupational Health and Safety" project, realized by Kordsa in cooperation with Intenseye, received "International Competitiveness" category award. The project also received another award in TÜSİAD SD2 Vodafone category by Vodafone, the Gold Sponsor of the program.



Automation System TAKS+ Developed by Kordsa is at Chattanooga Plant

Kordsa's Thread Manufacturing Automation System TAKS+ is started to be used also at Chattanooga Plant after the plants in Turkey and Indonesia. TAKS+ being quite advantageous with its ease of use, dynamic structure and low cost, is an automation system developed and used by Kordsa within its body, collecting and processing real time data during thread manufacturing, ensuring high traceability and control and integrated to all systems used in thread manufacturing.



Kordsa's Signature in Atatürk Cultural Center Project

Macro and micro fiber accessories of Kordsa's concrete reinforcement brand KraTos were used in the ground reinforcement of reconstruction project of Atatürk Cultural Center located in Taksim. KraTos which allows quick and easy application possibility in comparison to steel accessories and which ensures maximum performance by getting mixed homogenously in the concrete is preferred in numerous infra and superstructure projects.



Green Industry Certificate to Thai Indo Kordsa

Thai Indo Kordsa received the 3rd Level Green Industry Certificate offered by Thailand Ministry of Industry thanks to the environment management system it has built up with the objective of continuous development and sustainability. Contributing to Thailand's more environmentalist and sustainable development objective, Thai Indo Kordsa aims to improve further its environment management system in its following processes.



Indo Kordsa's Ordinary General Assembly Meeting Was Held

Indo Kordsa's Ordinary General Assembly Meeting during which the financial year of 2019 was assessed has been held in Jakarta under the chairmanship of Independent Delegate Andreas Lesmana and with the participation of Indo Kordsa Executive Board Members. Topics in the agenda have been accepted by the shareholders at the meeting where social distance and hygiene rules were perfectly applied and to which some members have participated online.

Loan Structuring Award to Kordsa in Purchasing Category

Kordsa was awarded the third prize in the purchasing category by Bond&Loans Awards which offers prizes every year to the exporters, companies using credit and professionals of the sector for their most successful loan structuring applications. Kordsa won this award thanks to its success in incorporating Axiom Materials last year by means of a 5-years credit structuring.





Composite Technologies Center of Excellence Has Opened Its Infrastructure for Covid-19 Combat

Kordsa and Sabancı University have opened all their design, analysis and manufacturing skills and infrastructures to give support to the Ministry of Health and healthcare staff in Covid-19 combat. Two institutions under the roof of the Composite Technologies Center of Excellence are contributing to design, analysis and manufacturing of prototypes of medical devices and components used in the treatment of Covid-19 as well as the personal protective products of healthcare staff.



Kordsa Has Run at Runatolia for ÖRAV

Kordsa has run for Teachers' Academy Foundation (ÖRAV) at Runatolia, "International Antalya Marathon", organized for the 15th time this year. Kordsa Reinforcers, running for ÖRAV which is making studies for the development of teachers as leaders teaching learning, not knowledge, have reinforced the teachers' and the students' lives once again.



Kordsa Has Attended Engineering Careers Day in Thailand

Thai Indo Kordsa, Kordsa's plant in Thailand, has attended "Engineering Careers Day" organized by Silpakorn University, Engineering and Technology Faculty. Kordsa Reinforcers have given information to engineering faculty students on career opportunities in Kordsa while introducing Kordsa's tire reinforcement technology.

Virtual Reality Experience in METU Campus Development Days

Kordsa has participated in Campus Development Days organized by METU IEEE club with its stand where Kordsa's story is told by virtual reality (VR) experience and a presentation performed by Elif Gül, Kordsa Human Resources and Information Technologies Group Manager. By this means, students had the chance to know Kordsa and learn internship and global career opportunities more closely.



Kordsa is Continuing to Reinforce Healthcare Staff

Kordsa Reinforcers are manufacturing masks voluntarily with their families for healthcare staff at Kordsa's plant in Brasil. Masks manufactured until now are donated to Camaçari State Hospital, a hospital close to the plant. As Kordsa Reinforcers, we're continuing to be on the side of the healthcare staff and strengthen life.

Support to Special Training from Kordsa's Sabancı Volunteers

Within the scope of Sabancı Volunteers Program, Kordsa Reinforcers have started "Special Support to Special Training" project. It primarily aims improving physical potentials of mentally disabled high school level young individuals at Nuh Çimento Special Education Vocational School and strengthening their lives. Kordsa Reinforcers are intending to generate an income for their project by a concert they shall organize:

<https://bit.ly/2z65Z1Z>



İZBURS Volunteers Provide Computer Support to University Students for Their Distance Learning

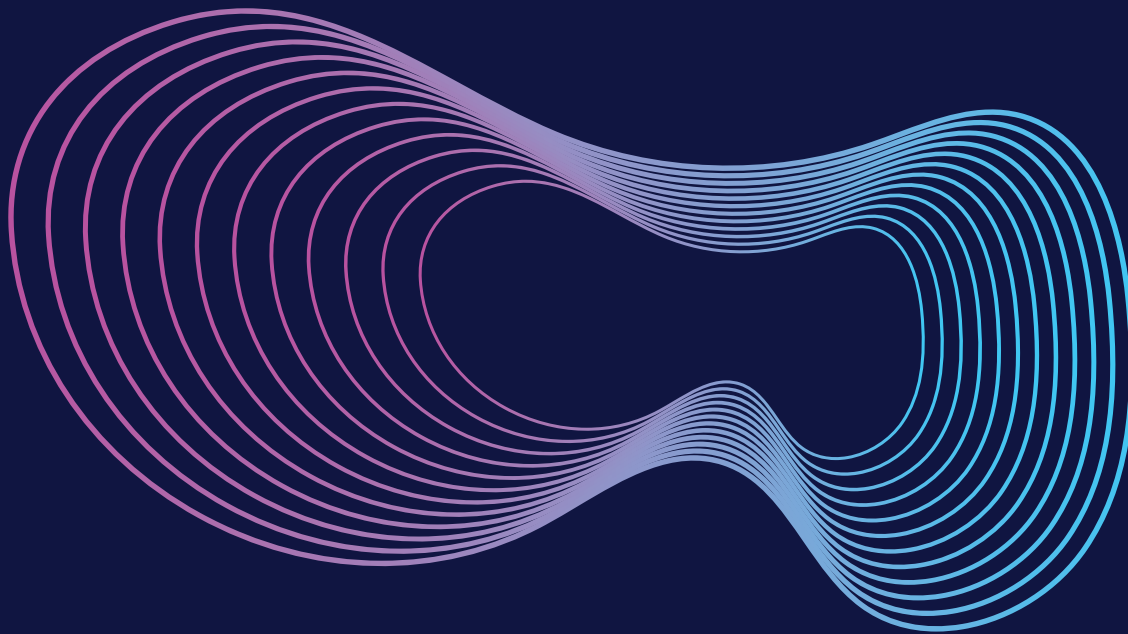
İzmit Burs Derneği (İzmit Scholarship Association) which was founded by Kordsa employees in 2012 and offering a scholarship support to 79 students this year provided computers quickly to 15 students who do not have it in the period where all universities adopted distance learning within the context of fighting against COVID-19. Their objective is to provide computers totally to 50 students in this campaign they launched.



Kordsa Continues to Reinforce the Future

Within the scope of the Reinforcing the Future Project, Kordsa collaborated with ÖRAV (Teacher Foundation Academy) to support teachers in the new digital education system with the pandemic. Kordsa contributed to the professional development of 70 teachers from Izmit through ÖRAV's "Interactive Classroom Design for Online Education" training which aims teachers' adaption to the new conditions.





Reinforcing Sounds

by Kordsa

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Breaker



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Anchor.fm



KORDSA

We are inspired to reinforce life

We are developing new generation and sustainable reinforcement technologies with the inspiration we get from the sheer excitement and the sense of belonging a child experiences exploring the nature. While reinforcing life today, we are working passionately towards helping create a greener world future generations.

KORDSA

THE REINFORCER

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