

Composite Materials Market Research and Export Potential Analysis: A Regio-Global Case Study

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Abstract

In today's global markets, there is a growing demand for high-value composite products. Over the past decade, many countries have shifted their production processes towards these products in order to boost their competitiveness in the global economy. This study aims to examine the current state of the composite industry in Turkey, with a particular focus on Bursa, a major hub for the automotive industry. The analysis includes an assessment of global trade volumes, import-export data, and Turkey's position within this sector. In addition, the study explores current technology and market trends related to composite products. According to the data, Turkey's exports of composite materials increased by 19.48% in 2021 compared to the previous year, reaching 2.7 billion. By calculating the Grubel-Lloyd Index, the study finds that intra-industry trade in Turkey's composite materials product groups is mostly two-way, with a few exceptions. The average index value for composite materials was measured to be 0.6890.

Keywords

composite materials, market analysis, high-value-added, Grubel-Lloyd index, Bursa

1. Introduction

Composite materials consist of the combination of two materials with different physical and chemical properties. When combined, they form a material that is specialized to do a particular job, such as being stronger, lighter or more resistant. Thanks to the lightness, strength, flexibility and resistance they bring to the product, they can be used in almost all areas of the industry. Today, composite materials are most commonly used in areas such as automotive, aerospace, infrastructure and construction. In this sense, the demand for composite materials in the market is increasing day by day, although it has not yet become as widespread as desired [1–10]. As of 2021, the volumetric usage rate of composite material at the global level is determined as 0.55% (Figure 1), but this rate is increasing [11].



Fig. 1. Volumetric ratio of global material use [11]

2. Methodology

A major challenge in conducting market research on composite materials is the lack of a single, generally accepted GTIP list of these products that has been agreed upon by different institutions. Due to the fact that they are used in many areas of the industry, quite different GTIP codes are used in the

trade of these products. In this sense, the following product list (Table 1) [12] was used for our analysis, taking into account the fields of activity of the manufacturers we conducted the research and the GTIP codes they use while exporting. Products with codes 701951, 701952, 701959 and 540211, can also be added to this list.

Table 1. GTIP codes and corresponding products [12]

GTIP codes	Product explanation
391740	Plastic tube, pipe and hose fittings
392030	Other plates, sheets, films, foil and strips of plastics
392290	Plastic bidets, European toilets, water tanks and the like
392310	Plastic boxes, crates, chests and similar goods
392350	Plastic stoppers, caps, capsules and other closures
392630	Fasteners for furniture, bodywork or similar, plastic
392690	Other plastic articles
681510	Graffiti or other carbon articles; carbon fiber included
851220	Electrical lighting or visible signaling devices
854690	Electrical Insulators (Excluding Glass and Ceramics)
870810	Bumpers and their parts
870829	Other parts and parts of bodywork
940550	Lamps and electric fixtures; non-electrical

3. Global Composite Materials Import and Export

When we look at the global import and export of composite materials between 2014 and 2021 (Figure 2) [13] based on the above product groups, we can see that both are very parallel to each other. When we set aside the periodic decreases in 2015 and 2020, it is possible to observe that the composite material sector has increased on a global scale within 8 years. Especially in the period 2020-2021, the sharp increases of 17.13% in imports and 17.33% in exports indicate that the demand for composite materials is high and the interest will increase in the coming period.

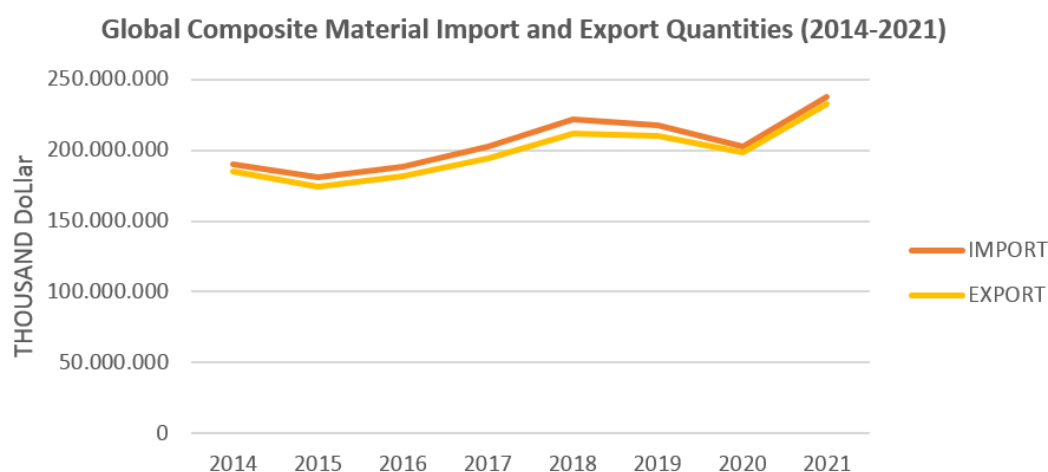


Fig. 1. Global Composite Material import and export (2014-2021) [13]

When evaluated on the basis of product groups, the import and export amounts realized at the global level in 2021 are as follows (Table 2). While the highest amounts occurred in products with GTIP number of 392690 with 80.1 billion dollars and 870829 with 71.9 billion dollars, the lowest amounts were in products with 854690 and 940550 numbers [13].

Table 1. 2021 global import and export based on GTIP codes [13]

GTIP codes	Global Import - 2021	Global Export - 2021
391740	8,380,597	8,078,899
392030	2,634,107	2,680,766
392290	2,280,141	2,132,030
392310	13,128,055	14,185,006
392350	10,442,398	10,188,765
392630	4,769,285	4,839,104
392690	78,966,648	80,172,714
681510	4,707,725	5,817,475
851220	22,465,730	22,724,027
854690	1,576,079	1,380,186
870810	8,060,339	7,779,759
870829	78,901,277	71,927,723
940550	1,107,981	1,100,432

In Figure 3, the top 10 countries with the highest exports in composite materials are listed. In these product groups, we see that the country with the highest export amount as of 2021 is China with 39.5 billion dollars. Again in 2021, China imported 14 billion dollars in the same product groups. Germany is in second place with 33.3 billion dollars, while the USA is in third place with 21.8 billion dollars. An important detail that draws attention in the table is that while China's imports of these products are lower than its exports, the USA's imports are much higher than its exports. This difference shows us that the USA's need for composite materials for domestic consumption is quite high. Similarly, imports of France and Canada are more than their exports. Mexico is the only country whose imports and exports are equal [13].

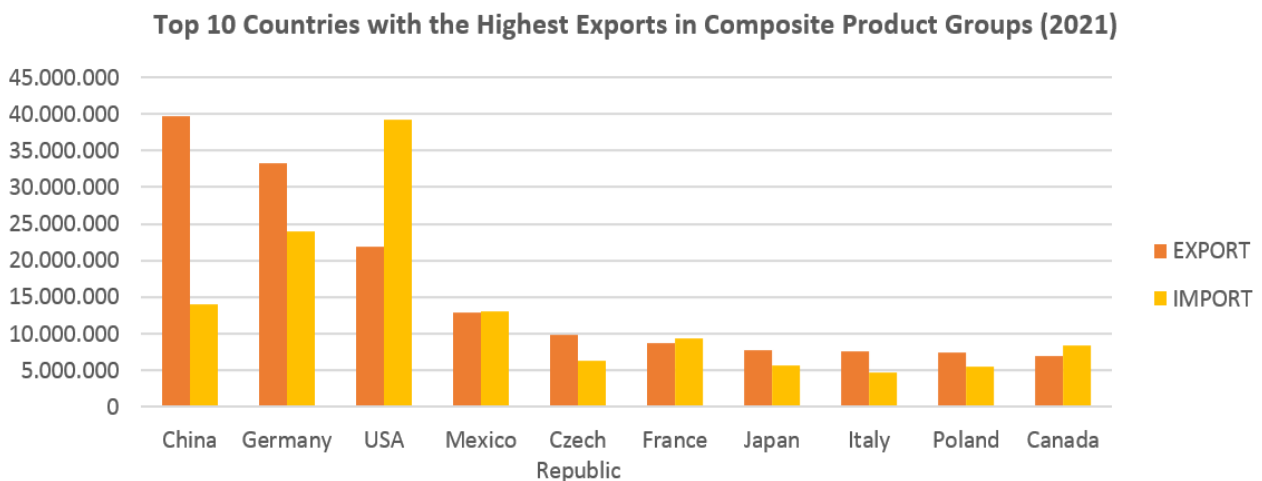


Fig. 3. Top 10 Composite exporter countries (2021) [13]

It will be useful for our analysis to look at the change in the export amounts of these countries, which are in the top 10 in composite material exports, between 2020 and 2021. As can be seen in Figure 4 below, all countries have experienced positive changes in line with the trend in the world, meaning their exports have increased compared to the previous year. Four countries were able to achieve an increase of more than 20%. The country with the highest increase was Canada, while the US experienced the lowest increase [13].

Rate of Change (%) in Composite Material Exports Between 2020-2021

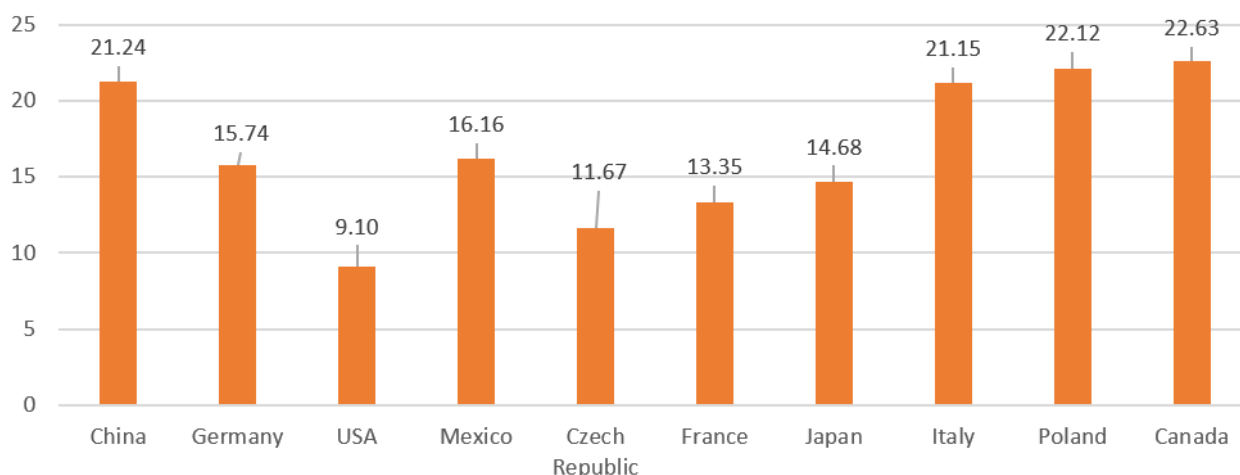


Fig. 4. Change range in composite material exports in period 2020-2021 [13]

Making the comparison between China and Germany for the import and export of composite materials will be useful in terms of showing the product groups in which the two countries are stronger and weaker. Table 3 lists the import and export volumes realized in 2021 in the composite product groups of China and Germany, respectively. The numbers indicated in red font show the export amount of the product group that the country in question exports more than the other. According to this table, while Germany exports more than China in 8 product groups, China exports more in 5 product groups compared to Germany. It comes out as 20.7 billion dollars of exports in the 392690 (Other plastics) product group, which brings China to the first place in exports at the global level. Besides, it is seen that it exports much higher than Germany in the 940550 product group. Although it can be said that Germany carries out a more balanced export when evaluated over all product groups, it can be said that there are two product groups that differentiate it from China's trade; 681510 and 870829. Of these, it should be noted that the 681510 (Graffiti or other carbon goods; including carbon fiber) product group has a higher added value than the others [13].

Table 3. Comparing the imports and exports of China and Germany [13]

China			Germany		
GTIP codes	Import 2021	Export 2021	GTIP codes	Import 2021	Export 2021
391740	394,705	855,474	391740	858,627	1,549,890
392030	157,334	191,954	392030	181,066	444,044
392290	22,736	323,713	392290	205,738	707,374
392310	415,710	2,102,358	392310	929,511	1,367,216
392350	224,385	1,606,794	392350	720,918	1,235,067
392630	75,597	585,361	392630	657,033	887,726
392690	3,916,096	20,793,443	392690	6,478,434	10,142,339
681510	236,791	69,709	681510	605,398	1,111,476
851220	2,117,058	3,146,139	851220	3,399,884	3,163,988
854690	94,402	225,716	854690	92,894	137,940
870810	522,754	486,433	870810	798,873	1,605,557
870829	5,847,774	8,613,104	870829	8,886,809	10,948,189
940550	4,109	752,883	940550	84,914	39,813

4. Turkey's Composite Materials Import and Export and Grubel-Lloyd Index

Turkey's composite industry follows a development process parallel to the developments in the world. It can easily be said that the increases in imports and exports at a global level in 2021 are also valid for Turkey's trade. In this sense, the sector shows a growth trend in general. According to the "Raw Materials Report" published by Turkish Composite Manufacturers Association in 2021, the amount of composite consumption per capita varies between 4-10 kilograms in the world, while this rate is at the level of 3 kilograms in Turkey. However, while the average composite material pricing in the world is 6.9 €/kg, this price is 5.3 €/kg in Turkey. According to the same report, the sectors in which composite products are used the most in terms of volume are transportation-automotive (29 %), pipe-tank-infrastructure (25 %) and construction (23 %).

Turkey's import and export graphs, which we calculated over the 13 GTIP code products listed above, are shown in Figure 5. As can be seen from Figure 5, Turkey's import and export graphs are quite parallel to the global rates in the same period. The exception to this is the decline in import data between 2018 and 2020. Although we can observe that the demand has decreased all over the world during the same years, the decrease in Turkey has been a little bit higher. The impact of the COVID-19 pandemic on this decline is undeniable. The sharp increases in both imports and exports as of last year reveal that the sector is in a revival trend. Furthermore, in the 2018-2020 period, the decreases were very limited on the export side, unlike the imports, and even a partial increase was observed in 2019. While Turkey's exports were 2.7 billion dollars in 2021, its imports amounted to 2 billion dollars. While exports increased by 19.48 % compared to the previous year, imports increased by 10.95 % [14].

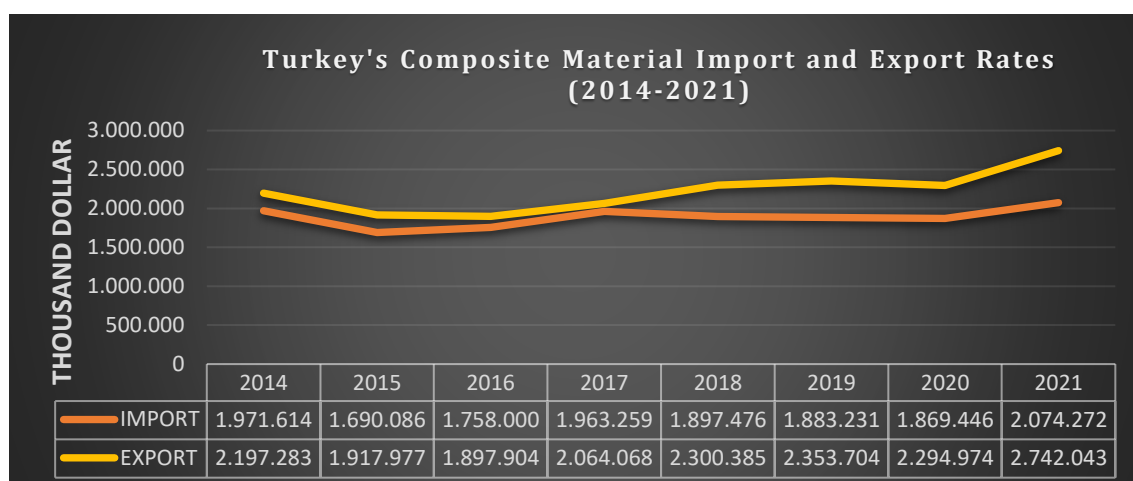


Fig. 5. Import and export rates of Turkey's composite material [14]

When we evaluate the imports and exports realized in the 2014-2021 period on a product basis, it is possible to observe that there is a very high trade volume especially in the 392690 and 870829 product groups. While the import and export figures are close to each other in the 870829 group products, it is seen that imports are much higher than exports in the 393690 product group (Figure 6 and Figure 7) [14].

In order to evaluate these import and export figures, it will be appropriate to examine the prices per kilogram of product groups in 2021. The first striking situation in Table 4 [14] is that the figures Turkey pays in imports in all product groups are higher than it earns in exports. As discussed in the previous section, it can be thought that we pay higher import fees due to high costs in the countries where we buy the products or high brand values. It is clear that this gap will close as we produce high-added value products, and it will turn in favor of Turkey. Another point that can be observed in the table is that the import-export price difference is higher in some product groups than in others. For instance, while the import-export ratio is three times higher in product groups such as 391740 and 392690, this difference is quite low in product groups such as 392030 and 392630. The average kilogram prices of Turkey in imports and exports are 11.51 \$/kg and 7.59 \$/kg, respectively.

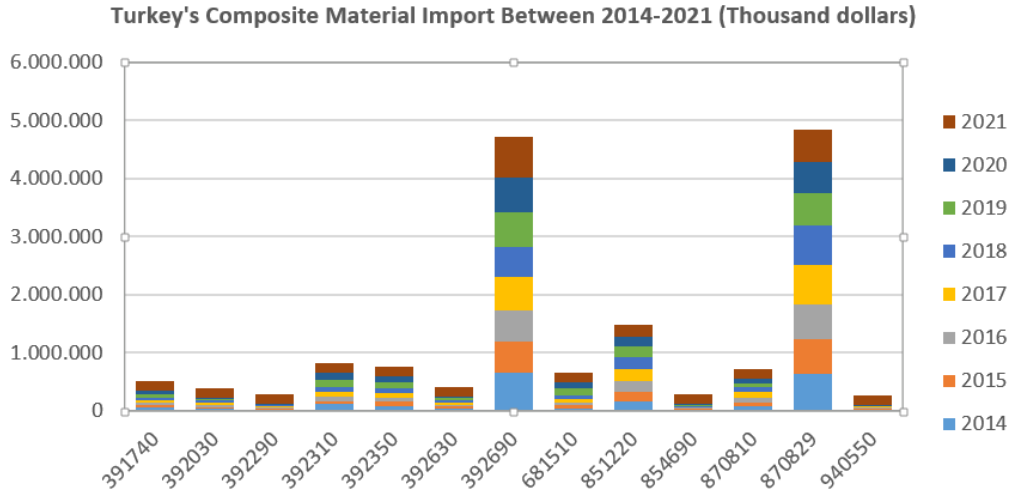


Fig. 6. Import of Turkey’s composite materials in period 2014-2021 [14]



Fig. 7. Export of Turkey’s composite materials in period 2014-2021 [14]

Table 4. Price per kg, in \$, of product groups based on GTIP codes in 2021 [14]

GTIP codes	Product explanation	Import Price	Export Price
391740	Plastic tube, pipe and hose fittings	12.17	4.89
392030	Sheet, plate, strip, film, foil strip from Styrene Polymers	5.18	4.99
392290	Plastic bidets, European toilets, water tanks and the like	6.59	4.20
392310	Plastic boxes, crates, crates and similar goods	3.28	2.78
392350	Plastic stoppers, caps, capsules and other closures	7.46	3.59
392630	Fasteners for furniture, bodywork or similar, plastic	8.46	7.04
392690	Other plastic articles	12.17	4.89
681510	Graphite or other carbon articles; carbon fiber included	23.13	17.07
851220	Electrical lighting or visible signaling devices for motor vehicles	24.24	17.64
854690	Electrical insulators (excluding glass and ceramics)	14.98	8.22
870810	Bumpers and their parts	13.14	6.98
870829	Other parts and parts of bodywork	9.17	5.85
940550	Lamps and electric fixtures; non-electrical	9.67	6.63

When we examine Turkey's Grubel-Lloyd index in composite materials, we can see that there is two-way trade in a large scale. To recall briefly, this index shows the rate of intra-industry trade in a country.

As it is accepted in the literature, while the intra-industry trade rate is high in developed countries, this rate is lower in developing countries [15]. The closer the number resulting from the application of the formula is to 1, the higher the intra-industry trade, and the closer to 0 it is low. As can be seen from Table 5 [14], the index is very close to 1 in the 392630 and 851220 product groups. Thus, import and export rates in these product groups are close to each other. In the 392290 product group, the index is calculated as 0.3755, since our imports are more than four times our exports. In order to make a comparison, it would be appropriate to show the Grubel-Lloyd index average in the same product groups of China and Germany, which share the first two places in global exports. In these products, while China's index is 0.4936, Germany's Grubel-Lloyd index average is 0.7379. In this sense, Turkey's index value is closer to Germany's index value.

Table 5. Turkey's Grubel-Lloyd Index in composite materials [14]

GTIP codes	Export (2021)	Import (2021)	Grubel-Lloyd index	Direction
391740	230,056	63,848	0.4345	Export Oriented
392030	116,848	30,615	0.4152	Export Oriented
392290	87,347	20,188	0.3755	Export Oriented
392310	230,603	122,857	0.6952	Export Oriented
392350	192,871	114,721	0.7459	Export Oriented
392630	37,772	34,397	0.9532	Export Oriented
392690	455,157	701,213	0.7872	Import Oriented
681510	59,304	100,205	0.7436	Import Oriented
851220	214,584	205,110	0.9774	Export Oriented
854690	10,470	20,522	0.6757	Import Oriented
870810	78,408	96,208	0.8981	Import Oriented
870829	1,027,202	560,638	0.7062	Export Oriented
940550	1,421	3,750	0.5496	Export Oriented
Grubel-Lloyd index average for composite materials			0.6890	Export Oriented

5. Potential Trade Markets for Composite Products

The increasing use of composite materials in various sectors around the world and the numerical data supporting this are mainly related to the developments in technology and the vision of decision makers. With the introduction of a more environmentally friendly and sustainable approach in production, the interest in composite materials is increasing. For instance, the fact that electric and hydrogen vehicles will become more widespread in the coming years makes composites a necessity for manufacturers with their lightness and durability features. In this sense, important trade markets for composites are emerging.

6. Market and Technology Trends in Composite Materials

Significant studies have been carried out, especially in the automotive sector, with the use and thus storage of hydrogen gas in new energy resources initiatives [16, 17]. The development and lightening of pressure cylinders can be defined as important topics of this subject. The production of pressurized tubes with different methods, various fiber winding methods and even all of them from composite is a work that requires the use of advanced technology in these matters. The use of thermoplastics has come to the fore in order to eliminate the recycling problem of the blades that are out of use in wind turbines, and deep studies are being carried out in this context. In the automotive sector, the use of composites made of natural fibers (linen and hemp) in parts that do not require sound insulation and high mechanical strength is seriously continued. The lightness of the products coming out of such applications can be shown as another advantage.

In the composite industry, priorities such as high performance and low cost in raw materials are known as decisive parameters in final products. For this reason, continuous innovations in strengthening agents are on the agenda. Cost reduction and increased performance in the production of carbon fiber are the main goals of manufacturers. On the other hand, various high-modulus fiber

production and cost-reducing activities are on the agenda for glass fiber products. The aforementioned activities will naturally reduce the cost of raw materials and lower market prices, thus resulting in cheaper manufacturing of the final composites.

7. Conclusions and Global Developments Affecting the Future of the Composites Industry

The global developments affecting the composite industry are as follows:

Sustainability

UN Sustainable Development Goals create similar results for the Composites sector as for the Technical Textiles sector. The fibers used to reinforce composites need to be sustainable, so there will be an increasing demand for natural fibers, bio-based synthetic fibers and glass and carbon fibers made from sustainable sources in composites. The share of recycled fibers will also increase. These fibers may have different properties than composite manufacturers are used to, so design and manufacturing processes may need to be adapted. The matrix also needs to be sustainable, so a shift to bio-based and recycled materials is essential.

The production process must also be sustainable, so sustainable processing aids such as renewable energy and mold release agents must be used and waste must be minimized.

The fact that products must be recyclable means that there will be a trend towards increased interest in thermoplastic matrix materials for composites because they are easier to recycle than thermoset resins.

Sustainability is also a driving force for the growth of composite use, as the reduced weight of composites directly leads to fuel savings, for example in the automotive sector.

Hopefully the customers of the new center will need services to assist them as below:

- Introduction of new bio-based raw materials for their products (both fibers and matrix);
- Introduction of new bio-based excipients in manufacturing processes;
- Optimization of the production process, for instance minimizing the use of raw materials and energy and the generation of waste, through the introduction of additive manufacturing technologies;
- New product design according to the principles of “cradle to cradle”, including the transition from thermoset resins to thermoplastic matrix materials;
- Life Cycle Assessment services. Because composite manufacturers will need to present these evaluations to their customers;
- Market research services for new sustainable products.

Third and Fourth Industrial Revolution

Advances in digitization, interconnection, data power and artificial intelligence will also affect products and processes in the composites industry, as explained above for technical textiles.

Other developments

Other emerging technology trends not related to sustainability or industrial revolutions will also have a direct impact on the dynamics of the composites industry. These include the development of low-cost carbon fibers, high-performance glass fibers, high-performance polymers (PPS and PEK), and fast-curing resin systems. Composite manufacturing companies need to adapt to these new developments in order to remain competitive.

There is strong growth potential in the pipe industry, particularly in tank and plant construction, which can be exploited by further developing general awareness of Glass fibre Reinforced Plastic composites. This will be particularly important for Turkey, where this sector is of particular importance.

Manufacturing and non-recurring development costs continue to limit the penetration of composites in applications as diverse as sporting goods, marine and consumer goods. Design consistency, process standardization, and maintenance technology are major concerns. The lack of standardization of materials and methodologies forces manufacturers to consider conservative designs that hamper the mass production and economic performance of cars and airplanes. In addition, limited human resources with training and experience in composites constrain wider composite applications.

The traditional glass and carbon fiber composite industry was formerly concentrated in Japan, North America and Europe. However, in recent years there has been a significant shift towards emerging

economies in the Asia-Pacific region and the rest of the world such as China, India and Brazil. Due to the strong demand caused by rapid industrialization, the demand for these composites has increased in the aviation, wind energy and transportation sectors.

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