Composites Market Report 2014

Market developments, trends, challenges and opportunities

The European **GRP** Market – Dr. Elmar Witten (AVK)
The Global **CRP** Market – Thomas Kraus, Michael Kühnel (CCeV)

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The European GRP-market 2014

Author

Dr. Elmar Witten is Managing Director of the AVK - Industrievereinigung Verstärkte Kunststoffe e.V. (Federation of Reinforced Plastics). The AVK, as the German professional association for fibre composite plastics/composites, represents the interests of producers and processors of reinforced plastics/composites on a national and a European level.

Its services include organisation of task forces, seminars and conferences as well as providing market relevant information (www.avk-tv.de).

The AVK is one of the four national pillars of the GKV – Gesamtverband Kunststoffverarbeitende Industrie and an international member of the European composites confederation EuCIA – the European Composites Industry Association.

The AVK is a foundation member of Composites Germany.

The European GRP market in 2014

Continued growth

The volume of glass fibre reinforced plastics (GRP) manufactured in Europe will grow by over 2% in 2014. Growth has therefore stabilised in this segment, which is by far the largest area of the fibre reinforced plastics and composites industry. As the major applications for GRP components lie in transport and construction – vital areas of the overall European economy – the trend for the GRP market tends to mirror that of the European economy

The composites market is extremely heterogeneous not only in terms of company size and the processing techniques used in GRP production but also in the types of components and products manufactured. There are also regional differences: growth is above average in some European nations such as Germany, the UK/Ireland and Eastern European countries. A number of southern European countries have returned to growth – albeit slight – while a contraction is being observed in Scandinavian countries and France.

The dynamics of the market vary widely depending on the industry for which the components are destined.

The European market trend cannot be separated entirely from the development of the worldwide market because even the many small European GRP companies are participants in global developments. Cross-border considerations increasingly affect decisions regarding procurement, production and sales. Even though growth in Europe continues to lag behind the worldwide trend and the European share of the global GRP market is becoming smaller, there are still many opportunities for highly specialised European companies - even in a Europe characterised by slow growth.

Market observations

As in previous years, the European GRP market report 2014 is based on data for those European countries, for which production figures can be recorded and validated. Turkish production is considered but (still) stated separately due to the lack of data for long-term comparison.

In the following report, the term GRP refers to all glass fibre reinforced plastics with a thermoset matrix as well as glass mat reinforced thermoplastics (GMT) and long fibre reinforced thermoplastics (LFT). Data on the production of short fibre reinforced thermoplastics is only available as an overall quantity and are stated separately.

The report also states the sizes of the markets for other reinforcing fibres (natural and basalt fibres). Carbon fibre reinforced plastics (CRP) are dealt with separately in the second section of this market report. GRP production in 2014: Overall development

European GRP production enjoyed an excellent start to the year in 2014. The first six months and especially Q1 exceeded the expectations of most market participants. Although growth is expected to weaken slightly in the second half of the year, the overall trend is one of continuous growth. The European market as a whole is expected to grow by over 2% to an estimated 1.04 million t (see Fig. 1).

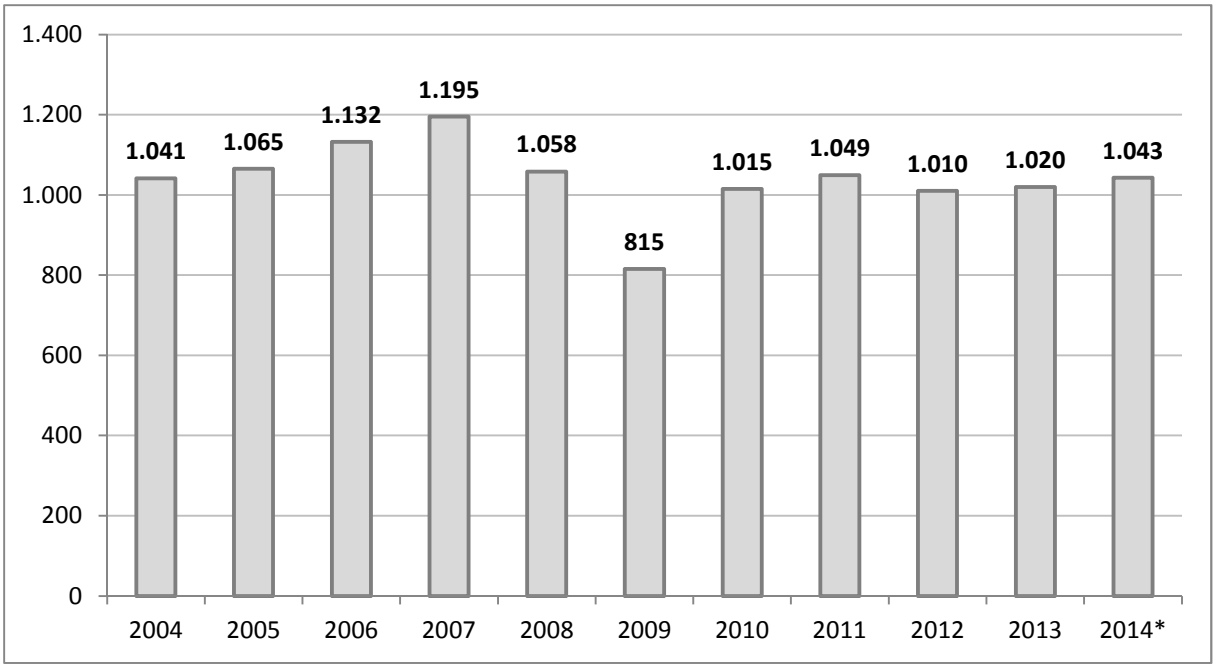

Fig. 1: GRP production by volume in Europe since 2004 (in '000 tonnes)
(2014* = estimate)

Observers of the long-term trend for GRP will see that it tends to follow the pattern of the general economy. This is hardly surprising as the largest buyers of GRP components are in the transport and construction sectors, which play a major role in national economies. As Europe's gross domestic product (GDP) contracts as a share of global GDP, the volume of GRP it manufactures as a percentage of worldwide GRP production also continues to decline. Production and consumption are shifting perceptibly towards the BRIC countries (Brazil, Russia, India, China) whose share of global GDP is growing steadily. GRP production in Europe is expanding but failing to keep pace with the worldwide trend.

In 2014, the European GRP market has returned to the absolute level of 2004 and thus not yet regained the level it achieved before the financial and economic crisis.

However, the market trends vary widely depending on the type of manufacturing process, the requirements of the corresponding application industries and even the specific European country in question. It is therefore vital to differentiate between these in order to make a well founded assessment of the European trend (see below).

Trends in the development of processes/components

	2014* Kt	2013 Kt	2012 Kt	2011 Kt	2010 Kt
SMC	190	184	188	198	198
BMC	74	71	70	69	69
∑ SMC/BMC	**264**	**255**	**258**	**267**	**267**
Hand lay-up	138	142	145	160	160
Spray-up	94	90	90	98	92
∑ Open mould	**232**	**232**	**235**	**258**	**252**
RTM	**132**	**126**	**120**	**120**	**113**
Sheets	84	84	78	77	72
Pultrusion	48	47	47	51	47
∑ Continuous processing	**132**	**131**	**125**	**128**	**119**
Filament winding	79	78	80	86	82
Centrifugal casting	66	66	67	69	66
∑ Pipes and Tanks	**145**	**144**	**147**	**155**	**148**
GMT/LFT	**121**	**114**	**108**	**105**	**100**
Others	**17**	**18**	**17**	**16**	**16**
Sum:	**1.043**	**1.020**	**1.010**	**1.049**	**1.015**

Fig. 2: GRP production volumes in Europe according to processes/components
(Kt = kilotonnes, 2014* = estimate)

Thermosetting materials

SMC/BMC

After enduring a difficult 2013, the automobile industry has provided considerable stimulus in 2014, which has benefited its suppliers and GRP manufacturers. Although China is the largest growth market, there are positive developments in the car and commercial vehicle sectors in Europe and especially in Germany, which is the leading market. These have not only boosted the number of vehicle registrations and production volumes but also, and especially, the number of new orders received by manufacturers of GRP components. Manufacturers of SMC (sheet moulding compound) and BMC (bulk moulding compound) components, the overwhelming majority of which are used in the automotive industry, have been among those to profit. As well as its applications in the electronics industry, BMC is still overwhelmingly used to manufacture headlamp reflectors. After the drop in SMC production last year and despite competition from other materials – especially thermoplastics – the volume of SMC/BMC grew by over 3% in 2014.

This is by far the largest area of the composites market and still accounts for over one quarter of the total volume of GRP manufactured, yet it still receives very little media attention in comparison, e.g. to the CRP market. European production in this area alone is significantly larger than the global CRP market. Technologies for the mass production of components using pressing (SMC) and injection moulding (BMC) processes are mature and have been in operation for many years.

The use of carbon fibre in SMC manufacturing ("C-SMC") is considered promising by industry experts. Even though the quantities produced are scarcely relevant at the moment, a number of manufacturers are working hard to develop new applications for the automotive and aviation sectors.

Open mould

Production of GRP using "open processes" has stagnated in 2014. The number of components manufactured using hand lay-up techniques continues to fall. In contrast, good growth has been observed in the spray-up sector after the stagnation of last year. The many small companies operating in these markets not only have to compete with "closed processes" (e.g. RTM) but also, and importantly, with non-European competitors. Production of individual, large area components has, to some extent, shifted from Western Europe to Eastern Europe, the Middle East and Asia. Little growth can be expected for these barely automated processes in high wage, European countries in the near future. For many years, manufacturers of high quality components have been battling with the damage to their image caused by poor quality products from "low cost suppliers", which have created deep-seated reservations against GRP materials among their potential customers. Nevertheless, the peculiarities and advantages of open mould processes have enabled them to retain a relatively high share of the European market.

RTM

Growth in the production of RTM (resin transfer moulding) components has continued the trend of stronger than average growth (nearly 5%) observed last year. This category includes all components manufactured using a closed mould although the processes sometimes differ significantly (infusion and injection). The automobile industry, in particular, is working very hard to develop and refine these processes and materials, although the volume of these components in series production remains below that of, e.g. SMC. The advantages of this process compared to other technologies lie in the greater variability of process parameters as well as the option for using a wider variety of raw materials and even (dry) semi-finished products.

Continuous Processing

After enjoying relatively strong growth last year, European production of GRP using "continuous processes" has stagnated in 2014. Panels are primarily produced for use in vehicles, e.g. truck side panels, caravan bodies or the conversion of commercial vehicles. The most significant applications for GRP pultrusion profiles are in the construction sector, e.g. in the production of bridge elements, railing and ladder systems or plant construction. Official approval procedures and a lack of standardisation have hindered the widespread use of GRP composites in bridge construction in particular. The continuous processing segment is characterised by its relatively high level of automation. However, the processes of the relatively few manufacturers operating in this sector are adapted very specifically to the requirements of the individual companies and dominated by in-house developments.

Pipes and tanks

GRP pipes and tanks manufactured using the centrifugal casting and filament winding processes are primarily used in the oil/gas and chemical industries. The European market, which accounts for around one quarter of worldwide production, is stagnating. The market is dominated by a few large manufacturers not least because of the relatively high quantities of material involved per order. Worldwide, the largest five suppliers have a market share of approx. 75%. The industry sees significant growth opportunities especially in pipes for water and waste water projects, although the most dynamic markets in this sector are currently to be found outside Europe. The potential is, of course, enormous because these projects involve millions of kilometres of pipelines. In Germany, for example, many of the pipes used by the water supply and wastewater disposal sector are in need of repair or replacement. In other places, such as many Eastern European countries, these systems are still being built and expanded.

Thermoplastic materials

GMT/LFT

Glass mat reinforced thermoplastics (GMT) and long fibre reinforced thermoplastics (LFT) are still growing at an above average rate of over 6% in 2014. Like other processes that primarily serve the automobile industry, companies in this sector have been participating in and benefiting from the development of new applications as well as the general market dynamic in Europe. Moreover, the substitution of components previously made from thermosetting materials (e.g. SMC) offers the possibility of further growth.

Over recent years, an increase in project and research activities has been observed in this area in particular. The processing and use of thermoplastic, pre-impregnated semi-finished materials with a specified fibre orientation is often considered a particularly promising area of endeavour. These are processed, for example, using "tapes" or belts which are laid automatically and with a load-conforming alignment. In addition, many researchers are working on ways to process large surface area, semi-finished materials known as "organosheets". Considerable testing has already been taken place, for example, on overmoulding pre-formed, semi-finished products within a tool.

Short fibre reinforced thermoplastics

The large market segment of short fibre reinforced thermoplastics must be mentioned in addition to the quantities of GMT/LFT stated in the GRP figures in this section of the market report. At approx. 1,160 kt, the European market for thermoplastic, glass fibre reinforced compounds in 2013 was somewhat larger than the market for the GRP products that are the major focus of this report (thermosetting materials plus GMT/LFT) during the same period. Production volumes in this segment are growing significantly faster at around 5% per year due to the high level of automation (injection moulding processes) (*Source: AMAC*). The majority of applications for these compounds, which are primarily based on polyamide and polypropylene, are to be found in the transport sector as well as the electro/electronic and sport/leisure segments.

Application industries at a glance

Despite the slightly different trends observed in the markets for the various manufacturing processes, the proportions of GRP used by the major application industries in Europe remain constant. The transport and construction sectors each consume one third of total production. Other application industries include the electro/electronics sector and the sport and leisure segment (see Fig. 3).

The transport sector includes not only road vehicles (cars and commercial vehicles) but also railway locomotives and rolling stock, boats and aircraft. Lightweight construction solutions, which are required above all to meet official CO_2 emission standards, continue to be the principal market driver in vehicle construction. The production of components for wind turbines – a market driven principally by political decisions – is included in the figures for the construction sector. The number of offshore wind energy projects still awaiting planning approval and the many opportunities for onshore repowering suggest that the potential of this area is far from exhausted even for participants in the European market.

It is, of course, also important to differentiate between the aspects of added value – not explicitly a focus of this report – and volume for the specific applications. Added value tends to be lower in the construction and electro/electronics sectors. However, even within the construction sector, it can be quite high in some areas, e.g. wind turbines. In the transport sector, added value is higher relatively than in other segments – and considerably so in the area of aircraft construction.

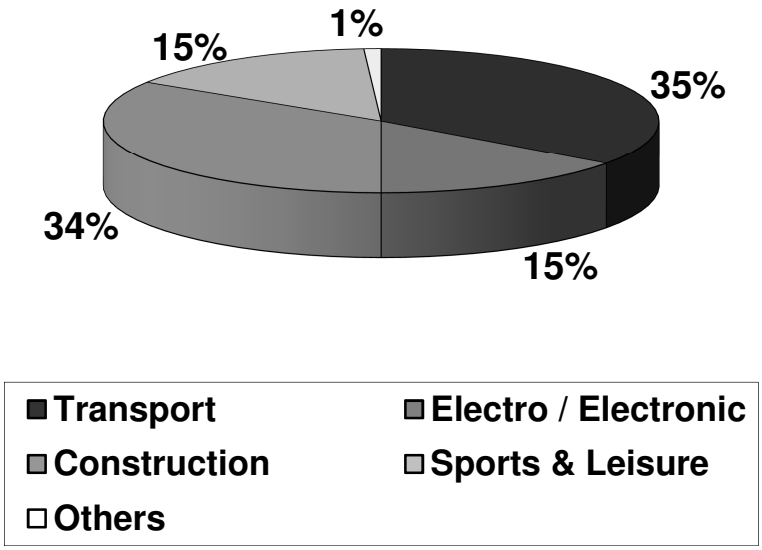

Fig. 3: GRP production in Europe for different application industries (year: 2013)

GRP production in 2014 by country

Fig. 4 clearly shows that there is no uniform market trend throughout Europe. There are regions with above average growth but also others that are contracting. The key growth factors are the state of the national economy of the country in question and the trends for the major GRP applications used in that country.

The continuous, above average growth in Germany, UK/Ireland as well as in Eastern European countries has stabilised. As recently as 2009, Germany was the third-largest producer of GRP in Europe. It climbed to the No. 2 spot in 2010 and – with the currently fastest growing economy in Europe – has been the No. 1 in the composites industry since 2012. This trend is principally supported by the automotive industry in Germany and by the construction sector in the UK. Eastern European composites markets are driven by a variety of different factors and forces, frequently major GRP orders in the areas of pipe and plant construction.

For the first time, there has been a slight increase in GRP production volume in Spain, Portugal and Italy. However, French output has fallen once again. These developments are due to shifting trends in the core industries in these countries, such as the automotive and boatbuilding sectors as well as construction and infrastructure projects. In the former group of countries, there are currently numerous indications of economic growth, albeit at a very low level. The effects of this are also benefiting the GRP industry.

The smaller markets of the Benelux countries, Austria and Switzerland are stable or growing slightly at a low absolute level.

According to the Turkish composites Association TCMA, the sector in Turkey once again experienced above average growth of nearly 5% (*source: TCMA*). The Turkish market has been included (separately) in this market report since 2011. The Turkish GRP market is therefore still larger than that of Germany. The major application industries are entirely different from those of European countries. Pipes and tanks for infrastructure projects account for around 50% of GRP production. This is due to two main factors: firstly, there is great potential for construction of new plants; secondly, decision-makers are much less sceptical of GRP materials than those in other countries. Other projects in the construction sector make up 20% of the market and the transport segment a comparatively low 18%.

	2014* Kt	2013 Kt	2012 Kt	2011 Kt	2010 Kt
UK / Ireland	146	140	134	126	130
Belgium / Netherlands / Luxembourg	43	42	43	42	40
Finland / Norway / Sweden / Denmark	42	44	44	52	50
Spain / Portugal	154	152	160	200	217
Italy	148	146	152	165	154
France	108	112	117	122	116
Germany	200	192	182	172	161
Austria / Switzerland	18	17	17	17	16
Eastern Europe**	184	175	161	153	131
Sum:	**1.043**	**1.020**	**1.010**	**1.049**	**1.015**
Turkey***	225	214	195	180	

Fig. 4: GRP production volumes in Europe – and Turkey – itemised by country/group of countries

(Kt = kilotonnes / 2014* = estimated / Eastern Europe** = Poland, Czech Republic, Hungary, Romania, Serbia, Croatia, Macedonia, Latvia, Lithuania, Slovakia and Slovenia / Turkey*** = Source: TCMA)

Other composite materials

GRP are by far the largest group of materials in the composites industry. Glass fibres are used for reinforcement in over 95% of the total volume of composites (short and long fibres, rovings, mats …).

Europe is expected to manufacture 2.2 million tonnes of glass fibre reinforced plastics in 2014 with global composites production forecast to exceed 8.5 million tonnes during this period. Of these, the GRP products studied in detail in this report will account for 1.04 million t and short fibre reinforced thermoplastics for the remaining 1.16 million t.

Worldwide demand for carbon fibre reinforced plastics (CRP) is estimated at 79,000 t in 2014 (see the second section of this market report).

92,000 t of components made from natural fibre reinforced plastics, mostly used in the automotive sector, were manufactured in the EU in 2012. 260,000 t of "wood plastic" composites were produced in the EU. Germany is by far the largest market for these products. Biocomposite materials as a whole thus account for approx. 15% of the volume of composites manufactured in Europe (*Source: nova-Institut GmbH*).

Interest in basalt fibre reinforced composites is growing for high-performance applications. Properties such as low electrical conductivity and high thermal stability with a good price/performance ratio make these materials particularly attractive although global manufacturing capacity is still many times smaller than that of carbon fibre. Despite a long history, basalt fibre has not yet been able to gain significant market share.

Outlook

For the composites industry as a whole, the market currently presents a number of challenges. The following are also and especially relevant to GRP manufacturers:

Thermoplastic materials

Industrial companies see great potential in thermoplastic materials and are investing accordingly in their future. Consequently, thermoplastics are currently attracting greater attention in the market than thermosetting materials. Researchers are particularly interested in material innovations for structural thermoplastic composites. In the area of series production, it is likely that developments will concentrate more on thermoplastic than on thermosetting materials. The forming of thermoplastic semi-finished products and, above all, the overmoulding of continuous structures are just two examples.

New processes and partnerships for automation:

Machinery manufacturers, in particular, have also identified and committed themselves to composites as a key trend of the future. This is due, not least, to well-publicised flagship projects in the transport and aviation sectors. Recently, it has been noted that larger companies with greater investment capacity are entering the market, which smaller companies are unable to access. Large industrial companies are systematically seeking out new partners, often large companies in their own right. Project demands frequently exceed the expected financial capabilities of smaller partners. New processing techniques or combinations of different technologies are being created, which have until now been common in the plastics processing which does not process composites.

Hybrid materials

Finding ways to combine different materials remains a major challenge for the future. Developers and industry are increasingly working on solutions that are based not on single materials but on efficient and elegant combinations.

Expansion into additional applications:

Over recent years, composites have succeeded repeatedly in finding new applications. For example, the specific requirements of the construction sector offer many opportunities. Standardisation is currently gaining greater attention within the composites industry with the aim of permanently opening up the potential of previously unexplored application segments.

The global CRP market 2014

CCeV and the authors

Thomas Kraus and Michael Kühnel are project architects at Carbon Composites e.V. (CCeV) and took over from Bernhard Jahn as the authors of the CCeV market report in 2014.

Carbon Composites e.V. (CCeV) is an association of companies and research institutes in Germany, Austria and Switzerland for the entire value-added chain of high performance fibre composite materials. It plays an important role in networking scientific research and businesses.

CCeV sees its role as a network of competence for promoting the application of fibre composites with a focus on "marketable high performance fibre composite structures". The emphasis is on fibre composite structures with plastic matrix materials, familiar to the wider public in many applications, as well as on fibre composite structures with ceramic matrices, which have higher resistance to temperature and wear, and high performance fibre composites for the construction industry.

The global CRP market

General

The composites market report produced by Carbon Composites e.V. (CCeV) and the AVK has appeared annually since 2010 and is now in its fifth year of publication. The report is also steadily winning recognition beyond the borders of the German-speaking world. With 251 members (date: August 2014), the CCeV represents a significant number of companies, research institutes and organisations operating in the carbon fibre (CF) and carbon composites (CC) sectors in Germany, Austria and Switzerland.

In the CF market, for example, CCeV members include SGL, Toray, TohoTenax, Cytec and Hexcel who were responsible for approx. 53% of global production in 2013 and an annual CF production capacity of 55,200 tonnes. These figures underline the international influence of the CCeV's membership. The information in this report is drawn from various sources including data provided by CCeV members. This has been supplemented and checked against current market data from reports produced by Lucintel [1] and Acmite [2], among others.

Explanation of terms

Some reports do not provide information about the methods used to calculate the averaged growth rates that are stated in these reports. Sometimes these methods are confused. In order to ensure transparency in this report, we have included the list below, which presents the most commonly used growth rates and the methods used to calculate them:

- **Averaged Annual Growth Rate (AAGR)** = Arithmetic Mean Return (AMR) = arithmetic mean of n annual growth rates (AGR):

$$AAGR(t_1, t_n) = \frac{AGR(t_1) + AGR(t_2) + \cdots + AGR(t_n)}{n} = \frac{1}{n}\sum_{i=1}^{n} AGR(t_i)$$

- **Compound Annual Growth Rate (CAGR)** = annual growth rate between n years assuming constant growth in percentage terms:

$$CAGR(t_1, t_n) = \left(\frac{A(t_n)}{A(t_1)}\right)^{\frac{1}{n}} - 1 \quad \leftrightarrow \quad A(t_n) = A(t_1)(1 + CAGR)^n$$

The growth rates stated in this market report are always calculated using the CAGR method as these better reflect exponential growth relationships when the market growth rates are constant. Consequently, the trend lines shown in the following graphics are also based on exponential curves.

The global carbon fibre market

The 2014 edition of the market report will continue to look at the development of the global carbon fibre market as it has done over recent years (Fig. 1). At 46,500 tonnes, actual global demand for carbon fibre in 2013 was somewhat lower than estimated in last year's market report. Consumption was 6.9% higher than 2012 and has grown by a total of 47.6% compared to 2008 – this corresponds to an annual growth rate of 8.1%. If we take 2009, the year after the financial crisis, as the base year (26,500 t), the annual growth rate calculated is even higher at 15.1%. According to Acmite, global revenues for the carbon fibre market in 2013 totalled US$1.77 billion. In 2012, this figure was US$1.63 billion [2].

If we look at the development of carbon fibre demand over the last few years (Fig. 1), we can see that the market has enjoyed steady and continuous growth since the general economic recession in 2009. During this period, demand for carbon fibre grew from 26,500 t in 2009 to 46,500 t in 2013 with high annual growth rates starting at an initial level of over 20% and easing to a current level of nearly 7%. This corresponds to approx. US$1.7 billion on the revenue side [1].

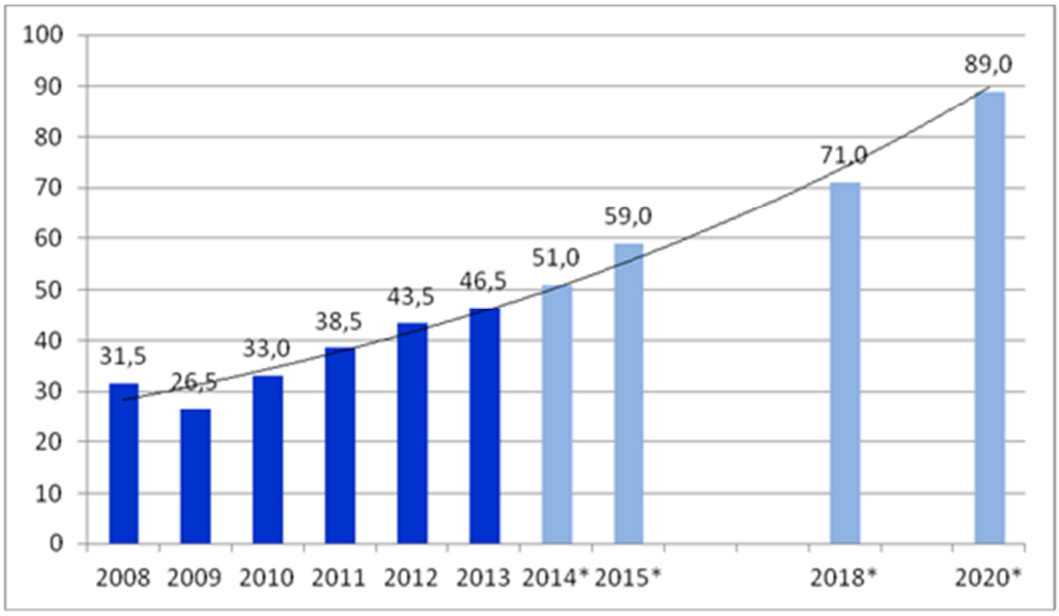

Fig. 1: Global demand for carbon fibre in 1,000 tonnes 2008 – 2020 (*estimate). [1] [2]

The demand forecast provided in the last market report for the next few years has been revised downwards slightly due to the availability of new and more up-to-date data. However, it still anticipates high annual growth rates of around 10% until 2020.

By manufacturer

Between 2011 and 2013 all the leading manufacturers of carbon fibre expanded their production capacity dramatically in order to cope with the continuously growing global demand. In addition, new capacity was built – especially in Russia, South Korea and India. Excess capacity of 41% is being reported for 2013 for carbon fibre based on polyacrylnitrile (PAN) [1]. Consequently, the market leaders barely installed any additional production capacity in 2013 and the first half of 2014. This is probably due to the presence of unutilised existing capacity.

Fig. 2 shows the carbon fibre production capacities of various manufacturers. Overall, the carbon fibre market is concentrated in the hands of 10 market leading fibre manufacturers, who controlled over 91% of production capacity in 2013.

In March 2014, Toray completed its acquisition of Zoltek and thus significantly extended its market leading position [3]. SGL has also announced that it will expand its annual production capacity. SGL and BMW invested US$100 million in a joint project and increased capacity at the Moses Lake facility in the USA from 3000 to 6000 t [4].

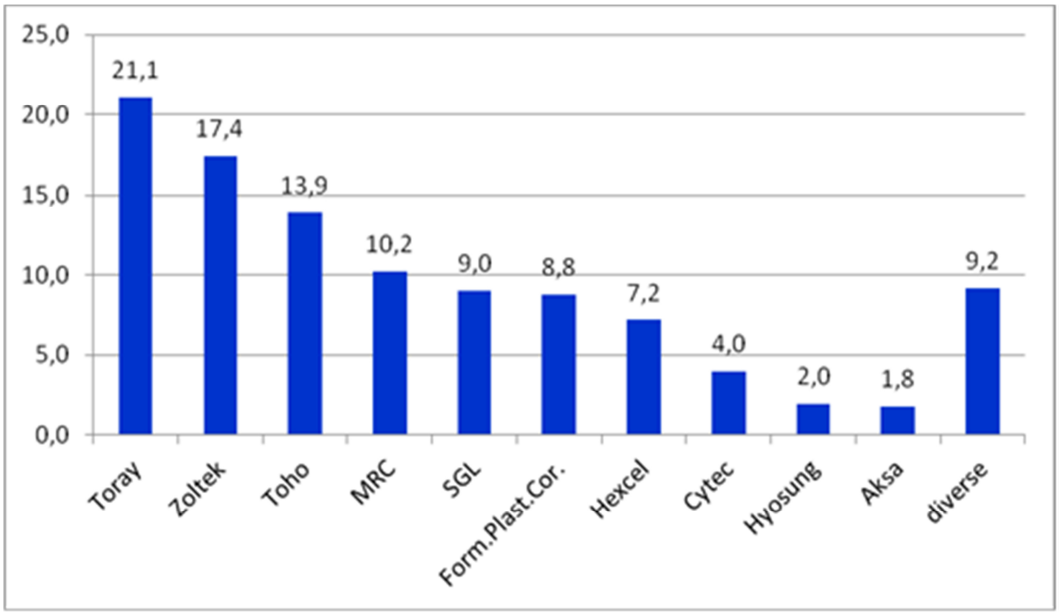

Fig. 2: CF capacities by manufacturer in 1,000 tonnes. (2013)

As these production lines were not yet operational at the time of writing this market report, they have not yet been included in this overview of manufacturers. In 2014, the theoretical total production capacity is around 101,200 t of PAN-based carbon fibre. In Japan, the USA and China, carbon fibres are also manufactured using pitch as the precursor material. The total capacity for this method is around 3,400 t per year.

By region

The theoretical combined total capacity is therefore 104,600 t of carbon fibre in 2014. The annual production capacities by country/region are shown in Fig 3. The most important regions continue to be North America with 30% of production capacity, Europe (24%) and Japan (20%). "Rest of the world" essentially combines the capacities available in China, South Korea, Russia and India. No reliable figures are available for the production capacity of companies registered in the People's Republic of China in particular. Contrary to the official figures, the actual total capacity of all manufacturers in the country is probably still well under 10,000 t. We continue to expect only moderate growth rates here as these companies only have limited access to the necessary technologies for manufacturing precursor materials and carbon fibre [2].

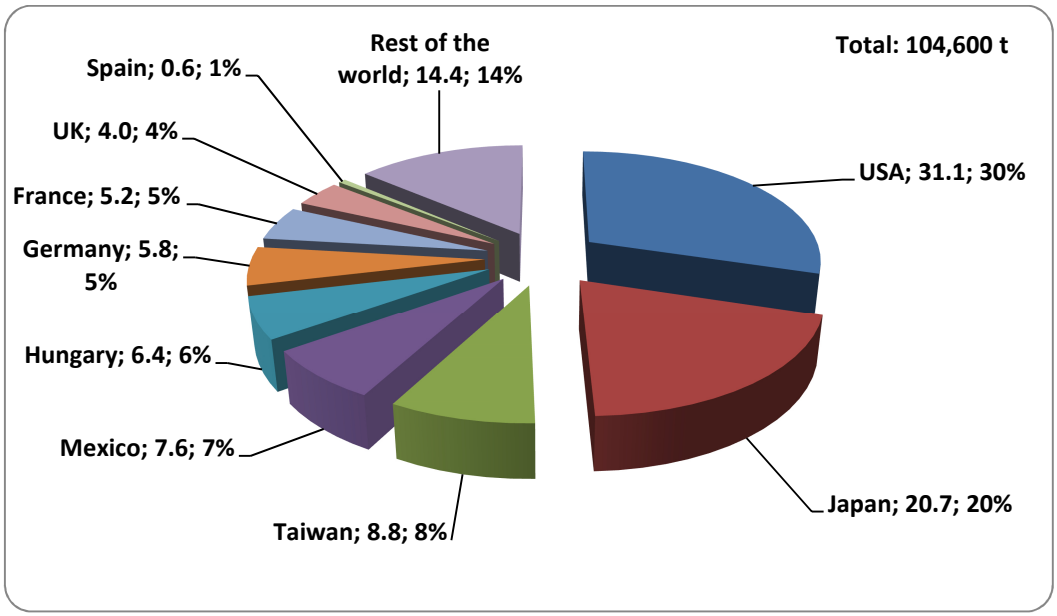

Fig 3: Annual CF production capacity by country/region in 1,000 tonnes. [1]

By application

Over the past year there have been a number of changes in the application areas for carbon fibre. *Aerospace & defence* applications have grown significantly and are now the largest consumers of carbon fibre – 13,900 t or 30% based on a total of 46,500 t (Fig. 4). These are followed by products for the *sport/leisure* sector and *wind turbines*, which each account for 14% of total demand. The *automotive* segment is becoming increasingly important with consumption of carbon fibre more than doubling over the past year to approximately 5,000 t. This is probably due to the ramp-up phase for the production of the i-models from BMW. Other applications include *molding & compound*, *plant construction*, *pressure vessels*, *civil engineering* and *marine*.

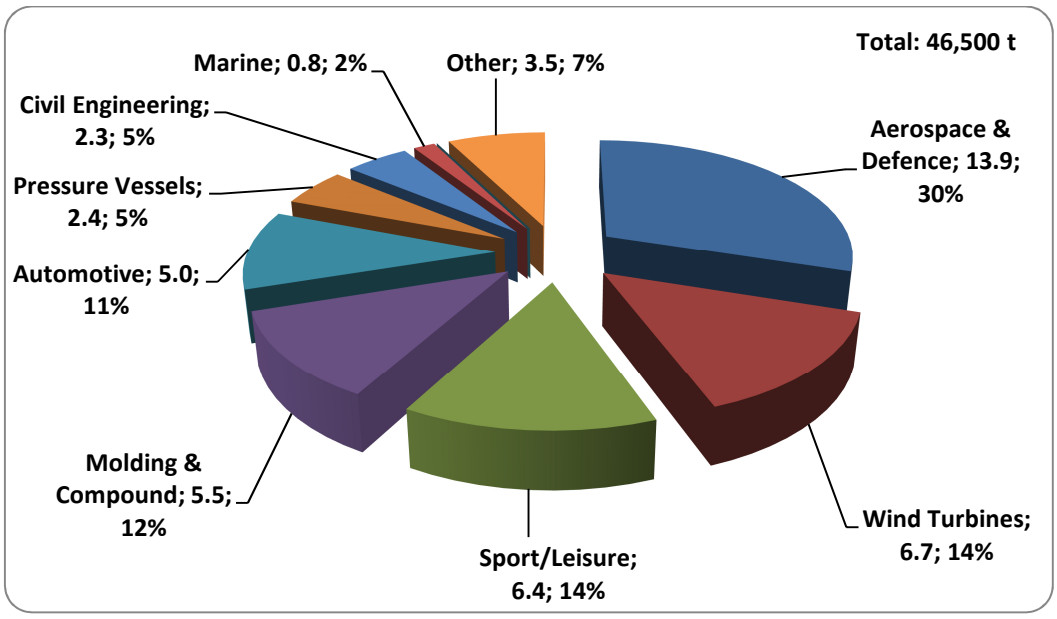

Fig. 4: Global CF demand by application in 1,000 tonnes (2013). [1]

When analysing carbon fibre revenues by application (Fig. 5), it must be remembered that there are differences between the sectors in terms of the standard manufacturing processes and quality requirements. For example, the *aerospace & defence* sector consumes 30% of the carbon fibre manufactured but generates 50% of global carbon fibre revenues. *Aerospace & defence* applications are not only subject to high quality standards but also incur high licensing and material inspection costs.

In all other application areas, the percentage is lower in relation to the quantity of material manufactured. However, the order is the same as that shown in Fig. 4. There has been a significant increase in carbon fibre consumption and revenues generated, particularly in the *aerospace & defence*, *civil engineering* and *automotive sectors,* compared to 2012. In percentage terms, these gains have been at the expense of the *wind turbine segment.*

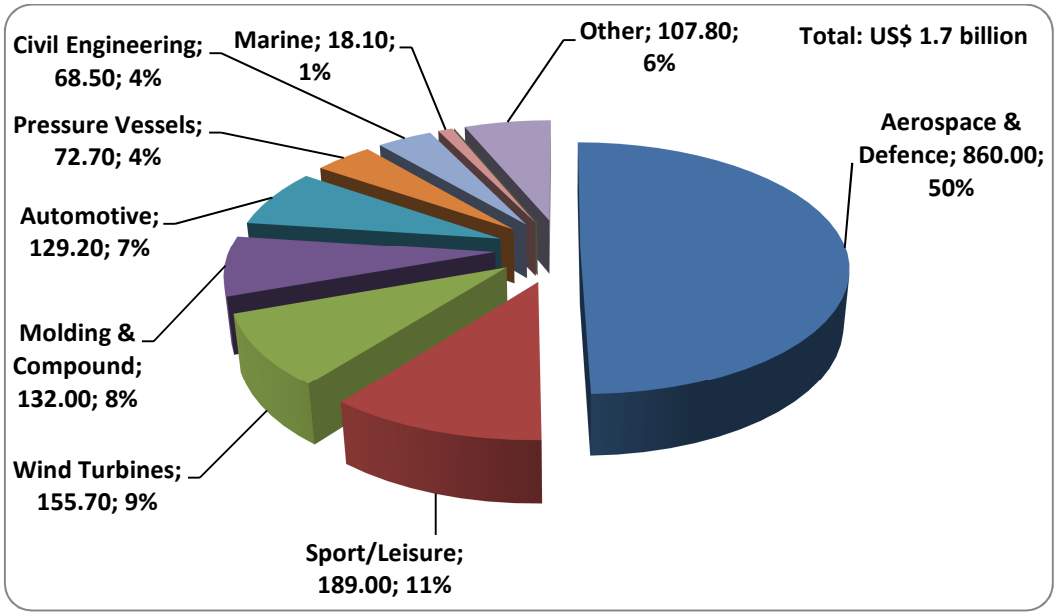

Fig. 5: Global CF revenues in US$ million by application (2013). [1]

The global carbon composites market

Virtually all carbon fibre manufactured worldwide is used in combination with a binding matrix to produce carbon composites. As a result, the growth trends observed in the carbon fibre and carbon composite markets are very similar. The significantly higher tonnages stated in this section are due to the addition of the matrix component.

Fig. 6 shows the development of global CRP demand in tonnes. In 2013, demand for CRP was around 72,000 t, an increase of 9.1% compared to the previous year. Growth in CRP consumption is forecast to continue at 10.6% until 2020, essentially matching that of carbon fibre.

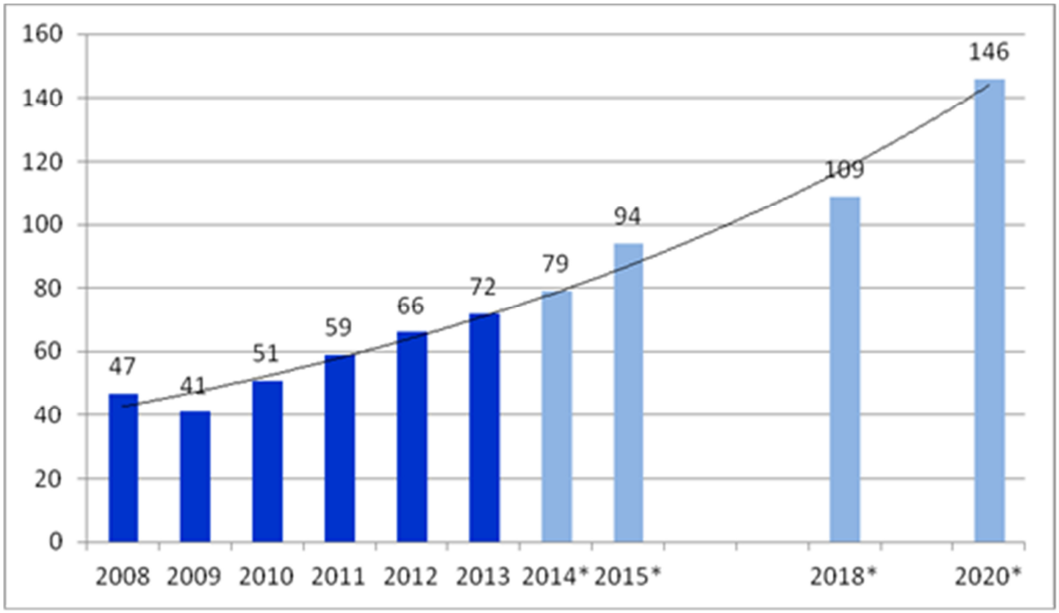

Fig. 6: Global CRP demand in 1,000 tonnes 2008–2020 (*estimated).

By matrix

Carbon fibre reinforced composites are manufactured using a variety of matrices. Although carbon, ceramic and metal matrix materials are used in special applications, the focus of the following section will be primarily on carbon fibre reinforced plastics (CRP). In 2013, carbon composites generated total revenues of approx. US$14.7 billion, of which CRP accounted for US$9.4 billion (Fig. 7). Composites based on a polymer matrix were therefore responsible for 64% of revenues. [2]

The matrix polymers used in CRP production can be further divided into thermoplastics and thermosetting plastics (see right pie chart in Fig. 7). Thermosetting plastics continue to be the polymer matrix used most commonly with carbon fibre. This is also reflected in the revenue shares of these two polymer types in the total revenues for CRP.

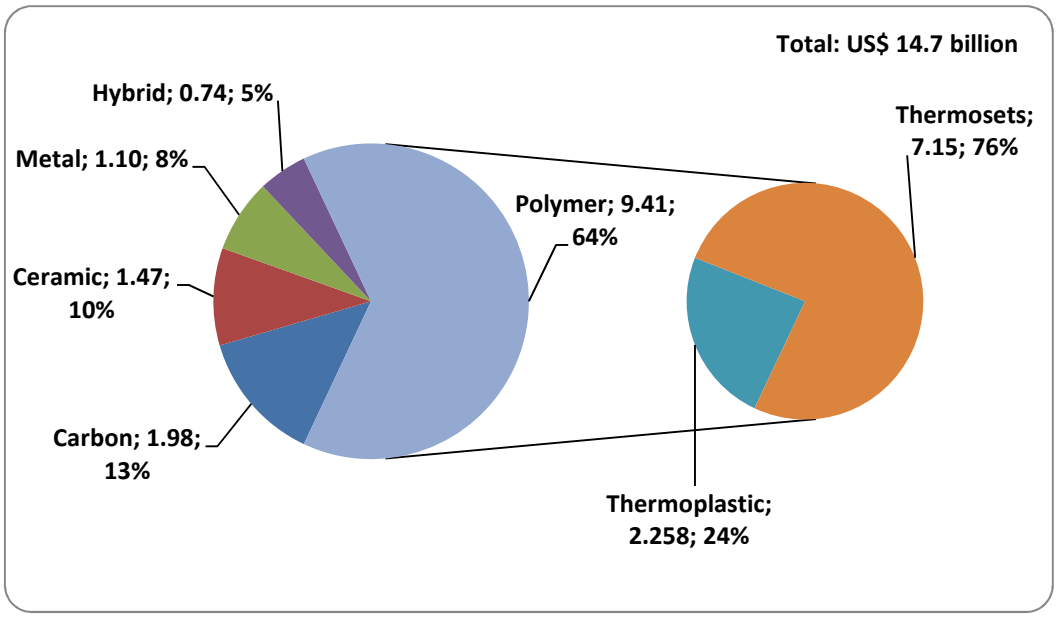

Fig. 7: Carbon composite revenues in US$ billion by matrix material (2013). [2]

A number of factors have contributed to the more established market position of thermosetting plastics, such as:

- good mechanical properties
- temperature resistance
- low moisture absorption
- lower material costs for the user (less value added for the manufacturer of the material)
- large selection of matrix systems, material manufacturers and manufacturing processes.

Thermoplastics, on the other hand, offer advantages, which will probably lead to them being more widely adopted in future, e.g.

- short processing times (no chemical reaction required, unlike thermosetting plastics)
- impact resistant, high damage tolerance
- good formability and weldability
- easy storage
- easy to recycle

So far, elastomer matrices are not widely used although this may change in the future, e.g. for elastic, hingeless shaft connections in mechanical engineering applications.

By manufacturing process

A variety of different production processes are used in the manufacture of CRP materials/components (see Fig. 8). In this year's report, the processes have been classified in a slightly different way from last year. Layup processes using prepregs (37%) continue to account for a major proportion of processes employed. However, pultrusion and winding are gaining importance and now represent a combined total of 40% of the market as they capture market share from prepregs. As well as easy-to-automate pressing and injection processes (e.g. RTM), the manual processes of wet lamination and vacuum infusion/infiltration are also frequently used.

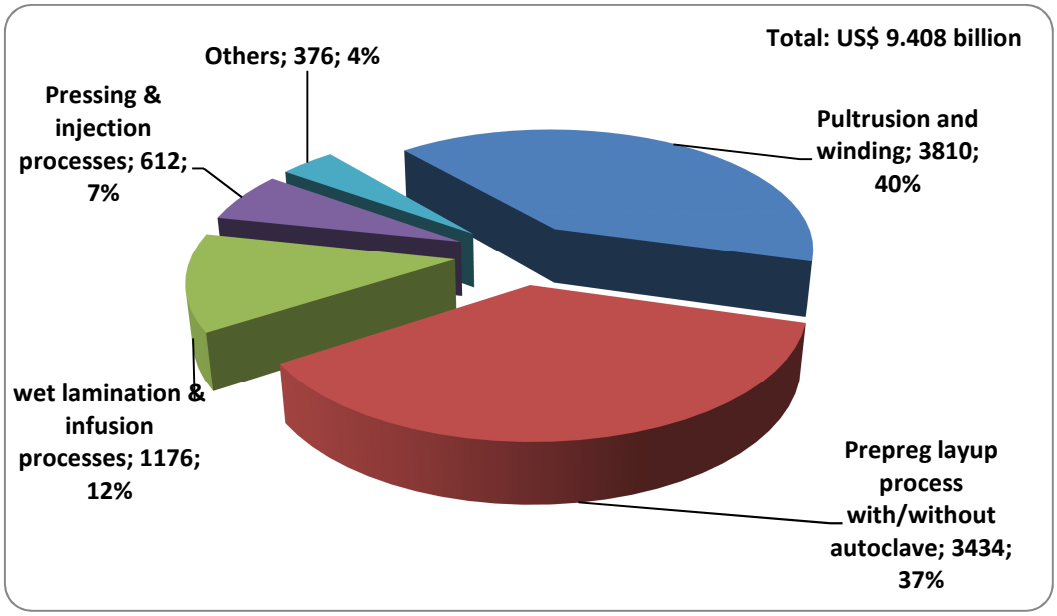

Fig. 8: CRP market share in US$ million by manufacturing process (2013). [2]

By region

Fig. 9 shows carbon composites revenues by region. North America and the USA, in particular, as an important manufacturer of aircraft and military equipment, account for approx. US$5 billion of global revenues – over one-third of the total. According to this breakdown of the market, Western Europe is the second largest region in the carbon composites economy generating around US$4.7 billion in revenues. However, if Europe were considered as a whole, including Hungary (Zoltek), it would in fact push North America down to the No. 2 spot. As well as having an aviation industry to rival that of North America, Europe is also home to many manufacturers in the *wind turbine*, *automotive* and *mechanical engineering* sectors, which also create strong demand for carbon composites. Japan, due to its many fibre manufacturers, is the third largest carbon composites market earning US$2.2 billion in revenues. In Asia (including the Pacific but excluding Japan), China's ambitions in the wind energy sector, in particular, helped to generate revenues of US$1.9 billion.

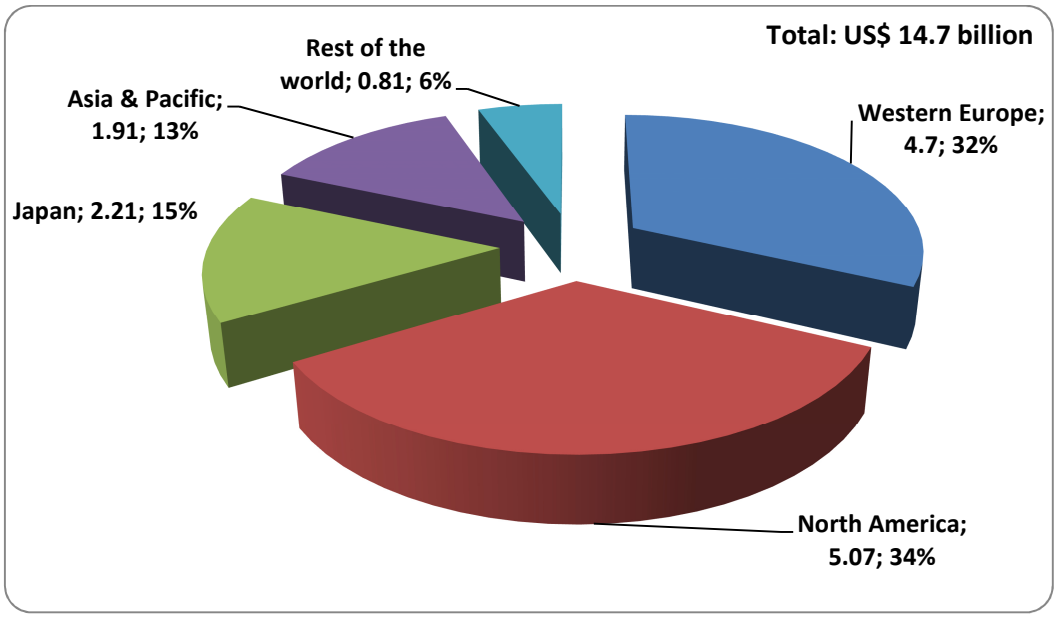

Fig. 9: Carbon composite revenues in US$ billion by region (2013). [2]

By application

The following sections provide a breakdown of the carbon composite revenues for the four most important market segments and their subsegments.

Aerospace & defence

The USA and Europe are the most important economic regions in the *aerospace & defence* sector with demand being driven by aircraft manufacturers such as Boeing and Airbus. The market segment is dominated by commercial aviation and the production of large passenger and cargo jets, which account for approx. US$2.5 billion (60%) of total revenues. Military combat and transport aircraft generate revenues of US$700 million and are the second largest area in this sector followed by business aircraft, helicopters and other products, primarily destined for applications in space and sport aviation.

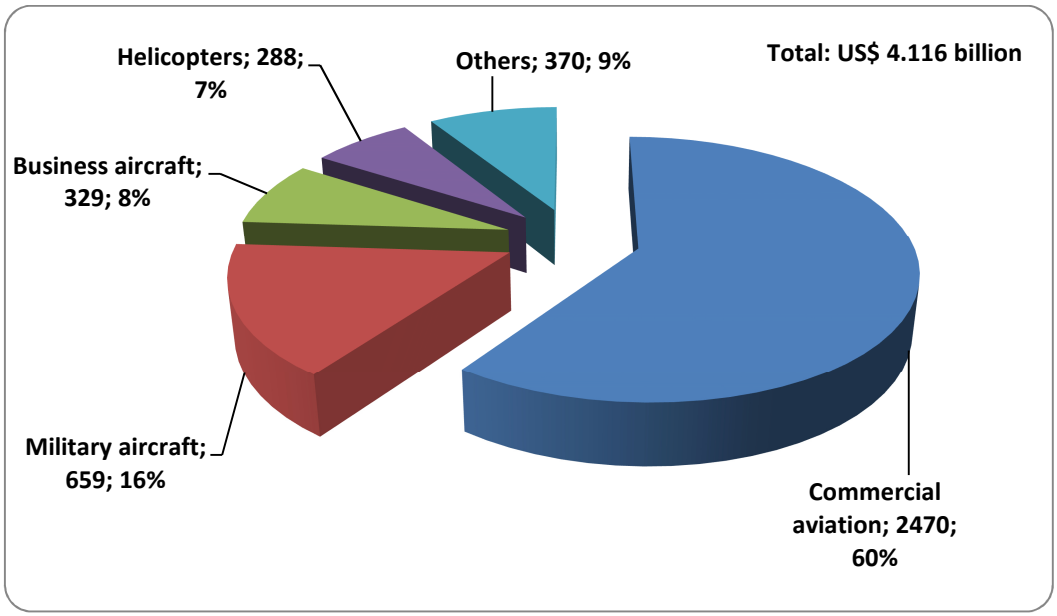

Fig. 10: Carbon composite revenues in US$ million in the market segment Aerospace & Defence by subsegment (2013). [2]

Wind turbines

The wind turbine market is the second largest segment in terms of carbon fibre consumption. Global wind energy capacity has been expanding continuously since 2005 (Fig. 11) and reached a total of approx. 318 GW in 2013. The electrical output of each wind turbine is a quadratic function of its rotor diameter so manufacturers are under pressure to develop ever longer and lighter rotor blades. In 1985, the average rotor diameter was just 15 m with an average output of less than 1 MW. In 2013, wind turbines had an average rotor diameter of 100 m and an average output of 2.5 MW [5]. These multi-megawatt wind turbines are increasing the demand for carbon fibre because it is the only material suitable for the construction of rotor blades with a length of 40 to 50 m.

In 2013, the wind energy market consumed approx. 6,700 t of carbon fibre and generated carbon composite revenues totalling approx. US$1.8 billion. However, demand for carbon fibre in the sector was lower than in 2012 (10,000 t). The reasons for this were the continuing, low level of automation and delays to the construction of offshore wind parks due to financial and technical difficulties. For example, only 35 GW of new wind energy generating capacity was installed worldwide in 2013 (Fig. 11).

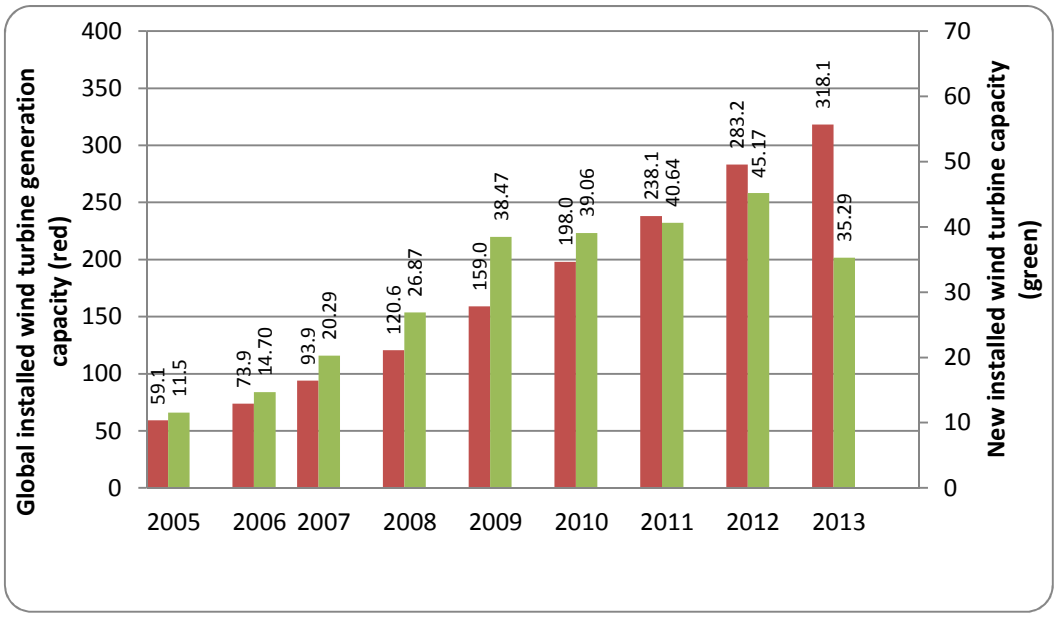

Fig. 11: Global installed wind turbine generation in GW. [6]

This sector is dominated by three major national economies: the People's Republic of China has significantly expanded its capacity over recent years and increased its total to 91 GW in 2013 – almost 30% of global wind energy capacity. This is followed by the USA with 62 GW and Germany with 34 GW of capacity (Fig. 12). [6]

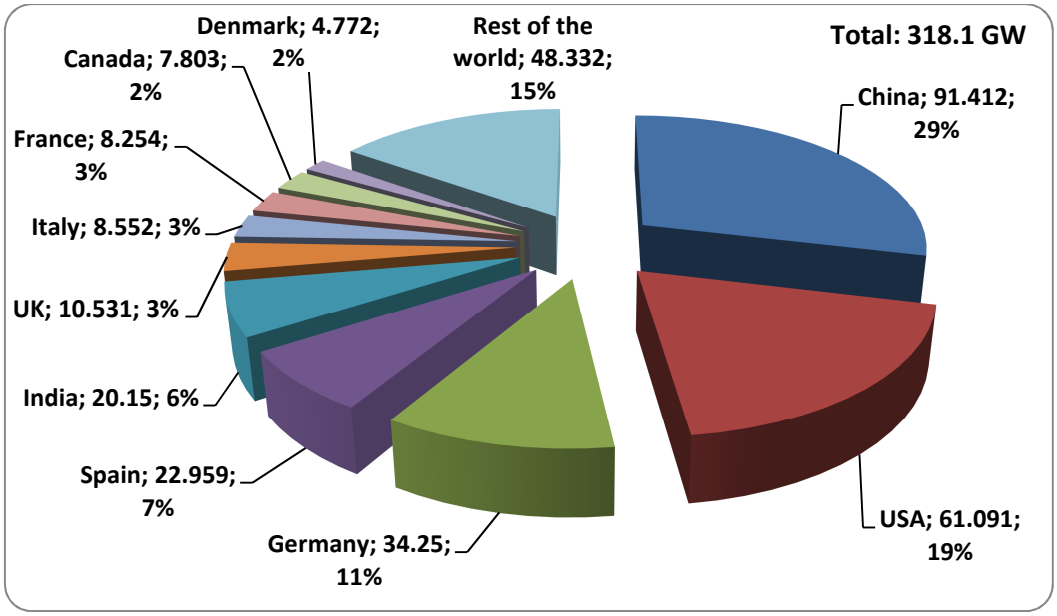

Fig. 12: Installed wind turbine capacity by country in GW (Dec 2013). [6]

Sport/Leisure

The market segment *Sport/Leisure* generated revenues of around US$1.5 billion with carbon composites in 2013. This sector, together with space travel, was one of the first to use and develop carbon composites. Carbon composites are now not only used in professional and high performance sports but also in many products for a wide variety of sports: golf clubs, tennis and badminton rackets, bicycle frames etc. are the most important products in this segment and, taken as a whole, account for nearly three-quarters of the revenues (Fig. 13). There are also many other applications, such as winter sports (skis, ski poles, snowboards) and water sports (paddles, windsurfing masts).

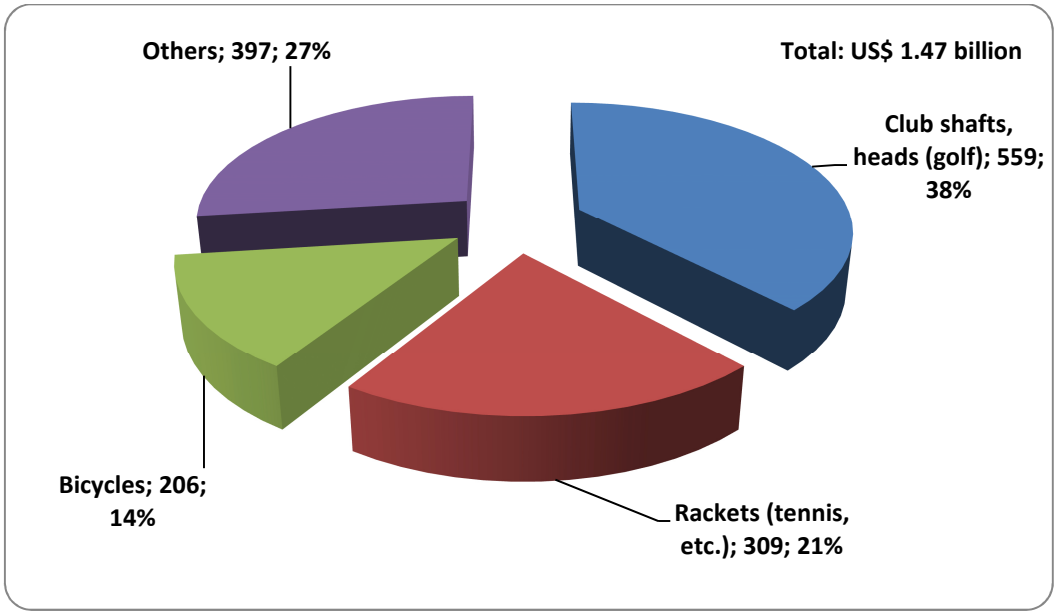

Fig. 13: Carbon composite revenues in US$ million in the market segment Sport/Leisure by sub-segment

Automotive

CRP is considered a key material in many areas of the automobile industry relating to the reduction of CO_2 emissions, lightweight construction and e-mobility. The use of CRP in automotive applications is still at an early stage and offers excellent potential for the future – although this depends on further significant reductions being achieved in the prices of CRP components.

In the 1980s, the first carbon fibre applications, such as drive shafts, began to be adopted outside the motorsport sector and establish themselves in small series production vehicles. Carbon composites are now used in an extensive range of structural and outer skin applications in cars – from ceramic brakes reinforced with carbon fibre to crash elements and monocoques, passenger compartments and semitrailers. Carbon composites are also assuming a greater role in applications for the railway industry, e.g. from small components such as windscreen wipers to complete front ends and underfloor structures.

With approximately US$2.2 billion in revenues, the automotive segment is increasingly important to the carbon composites market. Cars are the most important area generating 46% percent of the sector's revenues. The continuing high cost of carbon composite components has until now restricted their use primarily to luxury cars. The sub-segments trucks (18%), motorsport (15%) and passenger trains (13%) also make noteworthy contributions to the total revenues generated by the automotive sector.

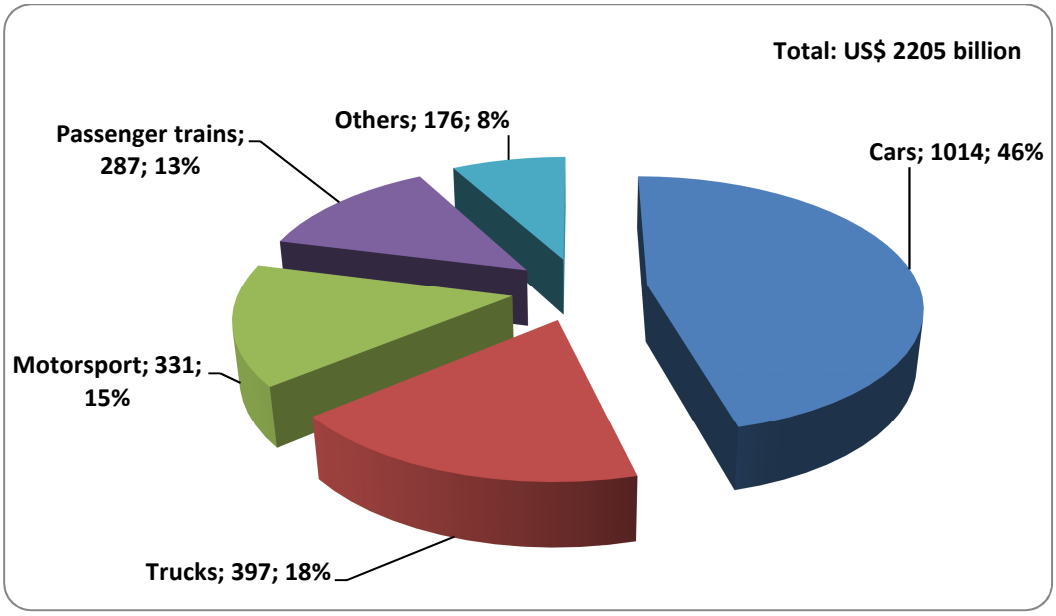

Fig. 14: Carbon composites revenues in US$ million in the automotive sector according to sub-segment (2013). [2]

Trends and outlook

For the next five years, analysts predict an annual growth rate of nearly 9% for the carbon fibre market. This will then rise further to around 10% (Fig. 1). Based on this estimate, global demand for carbon fibre can therefore be expected to reach 89,000 t by 2020 and generate revenues of over US$3.3 billion. Despite the availability of existing excess capacity, a number of fibre manufacturers have announced that they intend to invest in further facilities:

- SGL and BMW will invest a further US$100 million in their Moses Lake facility (bringing the total to US$300 million) in order to expand the production capacity from the 6000 t stated in Section 0 to a medium-term target of 9000 t per year. [4]
- Mitsubishi Rayon will expand production capacity by 2000 t at its carbon fibre factory in Sacramento, USA, by mid-2016 – doubling its total capacity. [7]

The carbon composites market, valued at a total of US$14.7 billion in 2013, is expected to grow at approximately the same rate. CRP is the most important area here generating US$9.4 billion of the total. [2]. The CRP market continues to promise stable and outstanding growth potential. As well as the aviation and wind energy sectors, the growing use of CRP in automotive construction and industry are key factors driving the market. Market studies predict average annual revenue growth of between 6 and 11% over the next five years and then a sustained rate of over 10%. For example, in 2020, the industry is anticipating demand for 146,000 t of CRP and revenues of over US$16 billion. For 2020, revenues for the entire carbon composites market, including other matrices, are forecast to total around US$25 billion. [2]

Aerospace & defence

The aerospace & defence sector will continue to play a critical role in the growth of the carbon composites market. Both Airbus, with the A380, and Boeing, with the Dreamliner 787, have started the production and delivery of their latest wide-bodied passenger aircraft. Both models use a significant proportion of carbon composites in their structures and provide an enduring, growing source of demand.

At the time of this market study, Airbus is building 25 to 30 of these aircraft per year and has received orders for a further 180 [8]. Boeing has also currently received orders for a total of 887 Dreamliners that have yet to be delivered [9]. Future projects, such as the A350XWM, 53% of which will be made from composites [10], or the Boeing 777X with carbon composite wings [11], show that demand for carbon composites from aircraft manufacturers will continue to expand well beyond the lifespan of the A380 or the 787. Industry analysts expect growth of between 8 and 13% over the coming years. Carbon composites revenues of around US$6 billion have been forecast for the passenger aircraft sector alone in 2022.

Carbon composite structures are already relatively well-established in the defence segment. All modern defence projects, such as the A400M, F-22, F-35, Eurofighter or Eurocopter Tiger, are increasingly based on composite materials. However, budget cuts in defence departments and export restrictions imposed by industrial nations will constrain growth. Despite these factors, strong annual growth of between 6 and 12% is also expected in this segment. By 2022, it is expected to generate revenues of US$1.4 billion. [2]

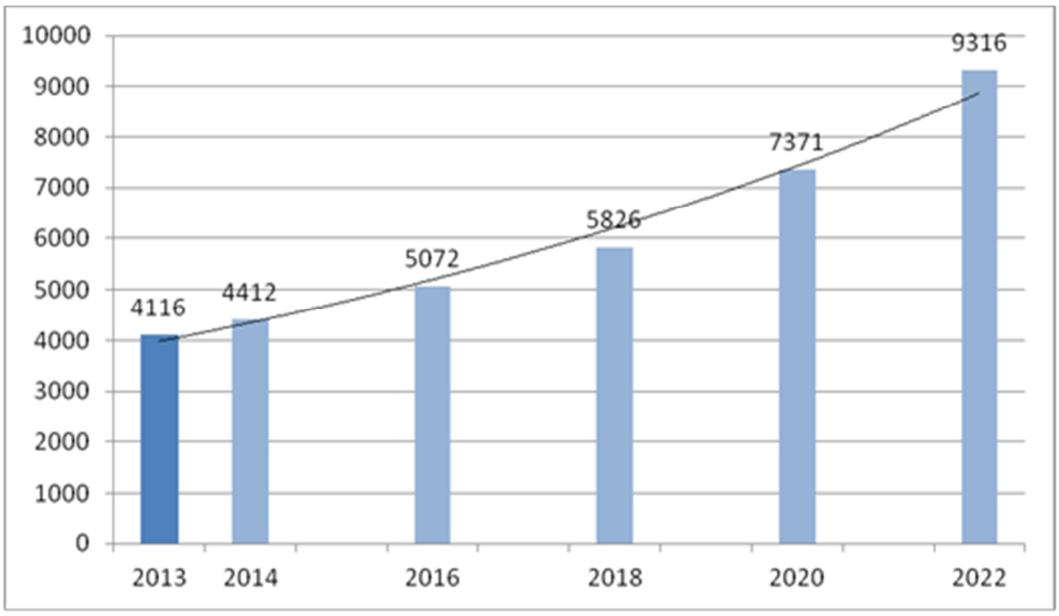

Fig. 15: Development of carbon composite revenues in US$ million in the market segment Aerospace & Defence. [2]

Wind turbines

Above average annual growth of 9.7%, driven by the switchover to renewable energy and the associated expansion of wind farms, is anticipated for the wind turbine segment. Analysts are currently forecasting carbon composite revenues of around US$4 billion by 2022. [2] New multi-megawatt turbines with ever longer rotor blades are being developed and used in both offshore and inland wind farms. For example, wind turbines with an output of 7 MW and a rotor blade length of 83.5 m are due to be operational in the North Sea from 2015 [12]. According to Fraunhofer IWES, 20 MW turbines with even longer rotor blades should be feasible by 2020. They, like the latest high-tech aircraft, depend on a higher proportion of carbon fibre in the supporting structures for the rotors in order to guarantee stability and acceptable weight. [13]

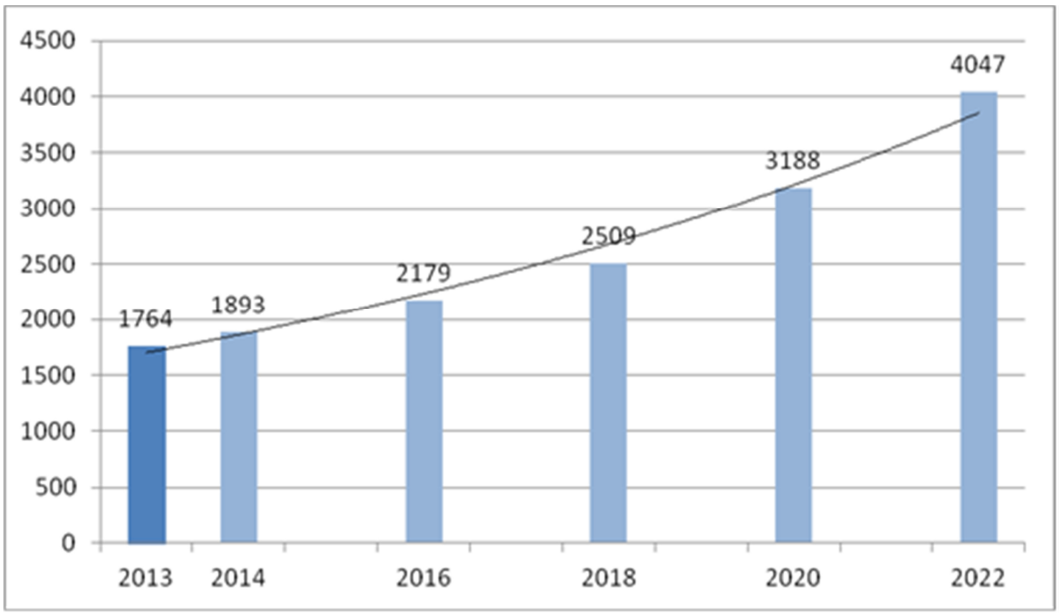

Fig. 16: Development of carbon composite revenues in US$ million in the market segment Wind Turbines. [2]

Automotive

With the large scale production of its new i-series, BMW has taken a pioneering step. Production began in September and was ramped up to around 100 i3 models a day in 2014 [14]. The BMW Group also plans to expand the use of CRP in its other ranges. To do this, BMW is not only extending its carbon fibre manufacturing partnership with SGL [4] but also increasing its own CRP production and processing capacity. Recently, the company invested €20 million in a CRP stacking plant in Wackersdorf [15]. Other manufacturers are also using CRP more widely but are more cautious due to the continuing high cost of carbon composite components.

Revenues are expected to grow by 7% annually until 2018 before accelerating to approx. 12%. By 2022, annual global carbon composite revenues are forecast to reach US$4.9 billion [2] corresponding to 20,000 t of carbon fibre. Automotive applications would therefore rise into second place ahead of wind turbines in the league table of market segments.

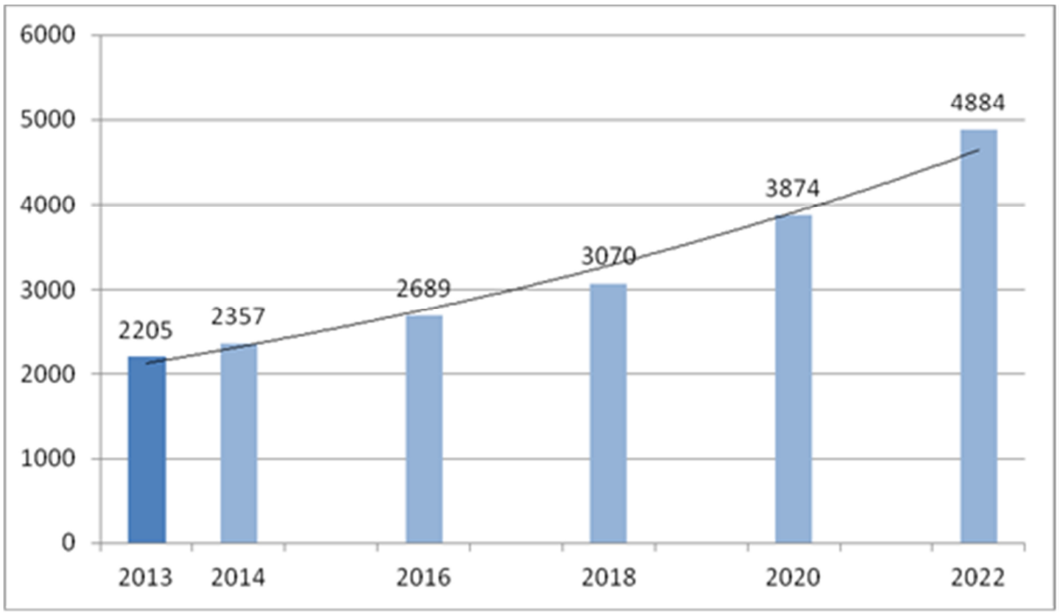

Fig. 17: Development of carbon composite revenues in US$ million in the market segment Automotive. [2]

Sport/Leisure

The market segment sport/leisure has always been one of the strongholds of the carbon fibre and carbon composite industries. Due to strong pricing pressure, revenues are expected to grow only slightly (4% annually) over the coming years. From 2018, the annual growth rate will be around 7.5%, i.e. below the growth rates in the aircraft, automotive and wind turbine markets. Carbon composite revenues should reach US$2.4 billion by 2022. The segment will therefore fall behind the automotive sector.

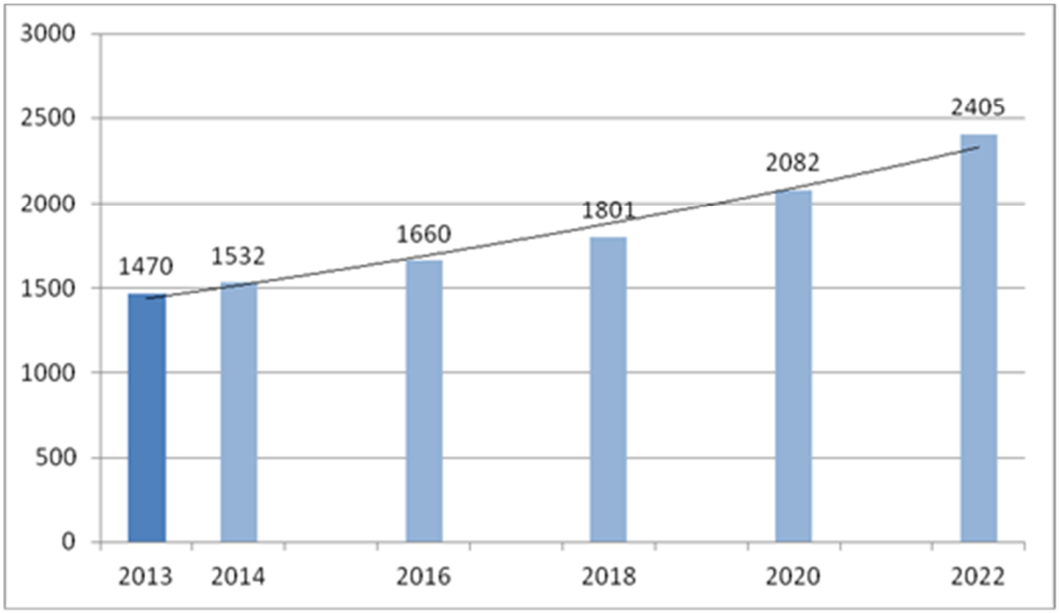

Fig. 18: Development of carbon composite revenues in US$ million in the market segment Sport/Leisure. [2]

Construction

Analysts believe there is excellent potential for the use of carbon fibre in the construction industry. As well as new, filigree architectural structures, concrete reinforced with carbon fibre ("carbon concrete") is increasingly being used to repair bridges and other ageing structures. Although the cost of the material is higher than that of steel reinforced concrete, this is counterbalanced to some extent through faster and lower costs of installation, lighter transportation and the ability to stabilise buildings and structures over the long-term.

The construction sector offers enormous opportunities if the cost of carbon concrete can be brought down still further. In the USA, nearly half of the country's approx. 600,000 bridges are in an unsatisfactory condition. In Europe, too, many bridges are reaching the age at which they require restoration or replacement. According to one study, Germany alone will have to invest €16 - €17 billion in such projects by 2030 [16]. In 2013, demand for carbon fibre in this sector was estimated at 2300 t. Carbon composite revenues (Fig. 19) totalled around US$590 million. An annual growth rate of 6% has been forecast for the next five years with a long-term growth rate of 9%.

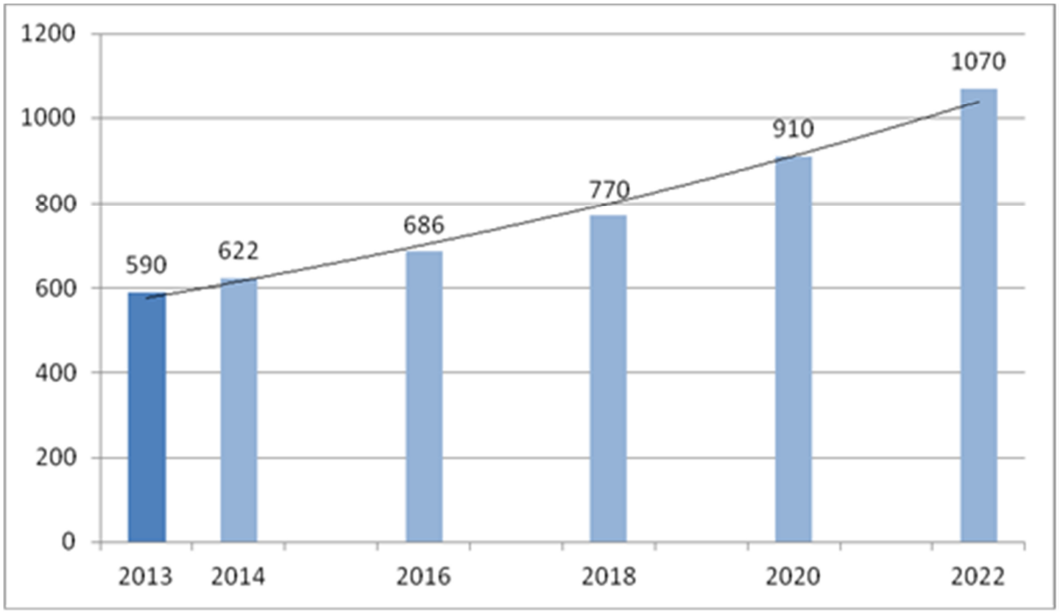

Fig. 19: Development of carbon composite revenues in US$ million in the market segment Construction. [2]

Final observations

After exceptional growth in the early years and in the wake of the global economic and financial crisis in 2009, the carbon fibre market has now stabilised at a healthy and steady growth rate of around 10% (average 2010 - 2013). Likewise, the CRP market has grown at an annual rate of 10.5% over the past three years. In 2014, carbon fibre consumption is expected to exceed 50,000 t for the first time and generate revenues of approx. US$1.77 billion. For the carbon composites market, total annual revenues are estimated to be in the region of US$15 billion in 2014.

Continuous growth of around 10% is forecast for the coming years with stability guaranteed by the sectors *aerospace & defence*, *wind turbines* and *sport/leisure*. There is also exceptional, but less certain, growth potential in the *automotive* and *construction* market segments. In both these sectors, the large scale use of carbon fibre and carbon composites depends heavily on the industry's ability to reduce the prices of these materials. This uncertainty is reflected in the revenue forecasts for the overall carbon fibre and carbon composite markets.

The generally positive outlook is also reflected in recent results of the Composites Germany market survey, which is conducted twice annually among the business association's members. Composites Germany was founded in 2013 by the four major organisations representing the composites industry in Germany – AVK, CCeV, CFK Valley Stade and VDMA Forum Composite Technology. Overwhelmingly, the association's members described the growth of their companies as positive or very positive.

Even conservative estimates predict an extremely vibrant future market. However, the industry must also overcome a number of hurdles, for example in automation, cost-cutting and the development of manufacturing processes suitable for mass production. The price-performance ratio will decide which materials or combinations of materials will be adopted in which application areas. Ecological aspects – if these are demanded by lawmakers or not economically disadvantageous – are likely to assume greater relative importance than pure business considerations.

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