2017
Global Carbon Fiber Composites Market Report

WeChat: ATA-ACIH

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1. Preface

2017 is a memorable year for Chinese carbon fiber industry. Each carbon fiber company in operation have sold out their current produced products and even the in-stock products. The polyacrylonitrile fiber has been running at a high price, the carbon fiber manufacturers have also announced a rise in price, which shows a prosperous year in both production and sales. From the statistical data, we can see that the import volume is the same as that in 2016, so the contribution of high-speed growth in the domestic market comes from domestic manufacturers. The domestic fiber sales volume in 2017 is more than twice of 2016’s 3,600 tons, that is 7,400 tons, reaching a historical peak.

2017 also is a milestone year for Chinese carbon fiber industry. This is not only due to the prosperous production and sales brought by the growth of the market, but also due to the reason that through the arduous efforts of Chinese carbon fiber companies, their products are increasingly recognized by the market. All kinds of information show that by 2020, Chinese market demand will be strong, and full-load production will greatly improve the stability of quality. We may expect that by 2020, domestic fiber will have the same market share as import fiber, and we can expect to get rid of the embarrassing situation that theoretical production capacities is far more than actual sales.

Strong market demand can solve some of the problems in the industry. However, there also exist lots of underlying problems such as technological innovation abilities, technical support to users, quality stability, high corporate debt, profitability and global competitive advantage, etc. With the help of the good market conditions, we shall work hard to build internal strength, to ensure that we can withstand the trend though there are ebbs and flows.

In 2017, there are several important events in global carbon fiber industry. First, Toray developed a low-cost, small-tow carbon fiber Z600 by integrating Zoltek's low-cost advantage with its local high performance advantages. From some experts' analysis: Toray intends to fight against their competitors with the cheaper Z600, and protect the traditional market of T700. Second, SGL launched a large-tow intermediate modulus fiber model, which aims to the aerospace industry market. "Small tow not necessarily means high cost, while large tow not always means low performance." These market innovations will keep changing our traditional ideas.

Besides, it is also worth mentioning the news happened in carbon fiber car industry: BMW Germany and SGL had jointly promoted the extensive and deep application of carbon fiber in automobile industry (especially in new energy vehicles I3), which has caused both auto giants and steel giants to be restless. At the same time, international information is also widely publicized about the arrival of "carbon vehicle era". In 2017, SGL acquired BMW's joint venture share for carbon fiber. Regarding this share change, the market has different interpretations: Maybe BMW is shortening the supply chain and they prefer to using the carbon fibers instead of producing them; SGL would like to integrate valve chain and pay more attention on carbon fiber production; It is difficult for BMW to bear the high cost of carbon fiber composite and they want to go back into mental body; BMW
expect to seek for cheaper carbon fibers from more suppliers... The automobile industry is a highly industrial and civilized industry, with its inherent and powerful operating laws. Only when we extremely familiar with this industry, can we have a more objective view of some events.

A respected teacher from the industry and academia had provided some pertinent guidance for our 2016 report: Maintaining independence, making less mention of company names, enhancing analysis of insights and farsights, improving written skills, and aiming to turn the paper into an authoritative white paper of industrial development. As a small, privately-owned company in the industry, despite the choices between "individuality" and "social collaboration," we will keep in mind his teaching and go forward.

As the previous "Global Carbon Fiber Composites Market Report", this report will also be issued in both Chinese and English versions worldwide. We hope the world can know more about Chinese industries, and also hope to do some promotional work for Chinese companies to "go abroad" and "incorporate deep into the international composite material industry chain". The report adopts some information and data from Internet and from some companies. We will mark the sources as much as possible in the report. If anything is missing, please point it out to us. We has also received great attention and support from the domestic carbon fiber composite industry. They have made extraordinary contributions to our data and conclusions. In particular, we would like to thank Mr. Xueyun Bai and Mr. Yuhang Chen from Hantrong investment Co., Ltd for their untiring support over the years. We also want to thank Mr. Dingjin Zhang, Chairman of China Composite Materials Group, and other colleagues in the industry for selflessly sharing industry information and ideas.
2. The Global Carbon Fiber Market

2.1. The Global Demand for CF - by year

![Global demand for carbon fiber (Kilo-ton)](chart)

The global carbon fiber demand data for 2017 is calculated based on the internationally recognized data of the growth rate of 10%. Throughout the annual data of major international carbon fiber manufacturers and international market research organizations, our data are slightly higher at the middle level, and the main deviation lies in the statistics of demand data for sports equipment. Since this industry is highly concentrated in China, there are a large number of business enterprises, and it is difficult for Western statistical agencies to get the data. Therefore, with our local advantages, we have a relatively good understanding of the application market and have more confidence in these data.

In the 2016 report, we cited the industry scale comparison of JEC's four typical light-weight structural materials: "plastic, aluminum alloy, glass fiber and carbon fiber" and concluded that carbon fiber will inevitably lead to a low-cost technical revolution to the whole industry. This year, we do not want to give the reader repeat information, but we still insist on this point of view. The 50-year-old “Kondo Watt Process” (see the detailed interpretation in the last chapter) may be ended within 10 years (or even shorter time), let us look forward to the arrival of this new generation of carbon fiber technology, which will make a difference.
2.2. The Global Demand for CF - by application (in Kilo-ton)

Total amount: 84,200 tons

We have made some adjustments to the 2017 data. We will explain it in details as below:

Aerospace (including military): The data for this year is 10% more than that of last year. We focus on the changes in the production capacities of the Boeing 787 and Airbus 350. The Airbus 350 made a significant contribution to growth throughout the year. Later we will introduce it detailedly in the sub-application of aerospace.

Wind Turbines: The demand for carbon fiber from the wind power industry, among the large suppliers, the data of ZOLTEK is not very bright, while the data of VESTAS is very optimistic. So we take a middle growth rate of 10%.

Automobiles: In 2016, the figure is 9,100 tons. The barometer of the market is BMW I3. Its sales in 2017 is good, exceeding 30,000 units. Besides, “Carbon Core” in the 7-series car makes up part of the demand. We cautiously and optimistically assume a 9,800 ton demand in 2017.

For Molding Compound, we significantly reduce the demand, based on the information that in this segment, chopped reinforced plastics grows slowly, but CF SMC has not yet been widely use.

We add statistics and descriptions of carbon-carbon composite materials, electronic and cable core sub-applications.
2.3. The Global Demand for CF - by application (in US$)

Total amount: 2,344.2 Million US$

<table>
<thead>
<tr>
<th>Application</th>
<th>Total amount (Million US$)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace &amp; Defence</td>
<td>303.60</td>
<td>13.0%</td>
</tr>
<tr>
<td>Sports &amp; Leisure</td>
<td>277.20</td>
<td>11.8%</td>
</tr>
<tr>
<td>Wind Turbines</td>
<td>1,152.00</td>
<td>49.1%</td>
</tr>
<tr>
<td>Pressure Vessels</td>
<td>112.00</td>
<td>4.8%</td>
</tr>
<tr>
<td>Civil Engineering</td>
<td>64.00</td>
<td>2.7%</td>
</tr>
<tr>
<td>Electronics</td>
<td>27.60</td>
<td>1.2%</td>
</tr>
<tr>
<td>C/C Composite</td>
<td>50.40</td>
<td>2%</td>
</tr>
<tr>
<td>Automotive</td>
<td>176.40</td>
<td>7.5%</td>
</tr>
<tr>
<td>Sport &amp; Leisure</td>
<td>277.20</td>
<td>11.8%</td>
</tr>
<tr>
<td>Others</td>
<td>28.00</td>
<td>1.2%</td>
</tr>
</tbody>
</table>

2017 Global demand for carbon fiber by application (Million US$)

<table>
<thead>
<tr>
<th>Application</th>
<th>2017 Global demand for carbon fiber by application (Million US$)</th>
</tr>
</thead>
</table>

USD/kg: 60.0, 23.0, 14.0, 18.0, 18.0, 20.0, 20.0, 18.0, 23.0, 23.0, 23.0, 20.0

Million USD: 1,152.00, 303.60, 277.20, 176.40, 124.2, 112.0, 64.0, 37.8, 27.6, 20.7, 20.7, 28.0
2.4. The Global Demand for CF - by product (in Kilo-ton)

Total amount: 84,200 tons

In 2017, we add separated statistics on the different tow sizes of standard modular fibers. The rules are as below:

**Modulus definition:**
- **Standard modulus:** tensile modulus within 230-265GPa
- **Intermediate modulus:** tensile modulus within 270-315GPa
- **High modulus:** tensile modulus over 315GPa

**Small tow (or regular tow):** 1-24K (included 24k)
**Large tow:** more than 24k

The above mentioned market share is a rough estimation based on the consumption situation of the various applications, so it’s a just a qualitative share.

These definitions are flexible and they should be changing with times. For example, developing large-tow into intermediate modulus is a technically feasible solution and it is beneficial for applications mainly on the main bearing structures. Intermediate modulus fiber not only can be used in the cross beam of the aircraft, the spar cap of the wind power and the body structure of the car, as long as the cost is feasible, it can bring lightweight to more applications.
3. The Global Carbon Fiber Supply

3.1. The Global CF Theoretical Capacity - by manufacturer

In 2017, the global theoretical production capacities of carbon fiber is 147,100 tons. According to Toray official website, the production capacity of ZOLTEK has been reduced by 600 tons to 14,900 tons. Companies that have fulfilled their production capacity expansion plan are: Mitsubishi with a 2,200-ton expansion and Toho with a 2,400-ton expansion. Other major global companies have not significant capacity expansion. Some companies that announced expansion plans (such as the large expansion plan of ZOLTEK) will continue to finish the construction in 2018.

In September 2017, the largest carbon fiber company in India, Reliance announced the acquisition of all the assets of Kemrock India. Kemrock have two production lines. The lab line was produced independently in India, but the 3m wide line was imported from Europe and the United States. Unfortunately they have never produced qualified carbon fiber after these two lines were established. Hope that the lines can run smoothly this time with the great support from Reliance.

In China, the total theoretical production capacity is 26,000 tons. CCGC built a 1,000-ton line, Jilin Jinggong built a 1,500-ton carbon fiber production line in 2017; Jilin Chemical Fiber Group is increasing the precursor production capacity, their sales is also good. In 2017, we do not count zombie companies (stop running for more than one year, and their equipment is not stable).
3.2. The Global CF Theoretical Capacity - by region (in Kilo-ton)

Total amount: 139,000 tons

There is no essential change in the global carbon fiber map in 2017. The previous world pattern is: European and American companies are focusing on large tow and emerging markets, while Japanese companies are focusing on small tow and traditional markets. The new setup of the world for 2017 is a mixed operation of large and small tow as well as the new and old markets. Hungary and Mexican bases of Toray are expected to surpass Taiwan and South Korea and become important international carbon fiber production bases.

Japan: All three companies have stepped up international mergers and acquisitions and accumulation of resources in emerging markets represented by wind power and automobiles. In particular, after Toray completed the effective integration of ZOLTEK, with the help of low-cost carbon fiber and its market foundation in ultra-luxury cars, they gradually enter the luxury cars market with greater demands, their competitive advantage has become more and more apparent. I believe that Toho and Mitsubishi Rayon will follow up quickly.

The advantages of applying and manufacturing cost in the United States will attract more and more carbon fiber companies to build factories there. In the United States, HEXCEL and CYTEC (of Solvay Group) have not significant expansion during these years. Both companies want to take a share of pie in the automobile and wind power industry markets, but the shortage of their fibers will certainly seriously hamper this strategic intent. Although CYTEC had acquired German DOLAN (European Carbon Fiber Company) in the past, it is a big challenge for them to take advantage of this acrylic companies given up by Europe and to make cost-effective precursors.
In Europe, after several rounds of purchasing and selling shareholding, SGL focused its capital and energy on carbon fiber and intermediate products in 2017. The precursor issue is a pain in their heart. In the past they ever acquired DOLAN, a German acrylic fiber company, but later abandoned it. They once cooperated with Mitsubishi Rayon on precursor, but were hard to bear the cost. They also acquired FISIPE, an acrylic fiber factory in Portugal, and invested a precursor production line. FISIPE is not necessarily the end. SGL has a hard way to go to integrate strategic resources.
4. Chinese Carbon Fiber Market

4.1. Chinese Demand for CF - by year

In 2017, we begin to add the contribution of domestic fibers to the statistics of Chinese market demand. In the past, domestic fibers had a small share and contribution in meeting Chinese market demand. In 2017, we achieved a huge increase. If pushing this momentum forward, we can expect that by 2020, domestic carbon fiber could achieve the same market share as import carbon fiber.

 Readers should pay special attention to the premise of this forecast: According to the growth momentum in 2017, there are two major hidden information here, one is the momentum of market demand, and the other is the market performance of domestic CF. Though optimistic information exists, but there are no major changes to the long-standing problems in the industry. Therefore, the above forecast can be more understood as a good wish for Chinese carbon fiber industry.

In 2017, domestic carbon fiber sales has increased by 3,800 tons compared to 2016. Where is this 3800 tons new demand from? Since 2014, domestic carbon fiber demand has increased at a growth rate of 13-20%, and it has been increasing year by year: 2015 was up 13.4% compared to 2014, 2016 was 16.5% compared to 2015, and 2017 was 20% compared to 2016. Judging from the current market situation, 2018 will have at least a 20% increase over 2017. Based on 20% increase in 2017, there was a natural increase of about 3,800 tons for the traditional market.

We are very confident in the objectivity of the demand data for Chinese market. There are detailed customs data to support it, and we have repeatedly checked it with domestic suppliers and large demand users. Since 2014, the growth rate of China's market has been increasing. A growth rate of more than 10% for international demand is already a very optimistic and high growth. But our growth rate was 13.4% in 2015, 16.5% in 2016 and 20% in 2017, the figure in 2018 will be also very bright. In virtue of wind, send me into the sky. Wish the Chinese carbon fiber industry could thrive.
4.2. Chinese Demand for CF - by application

Total amount: 23,487 tons

Sports segment still occupies half of the market share. This is not only the traditional market for carbon fiber, but also the market foundation for the development of Chinese carbon fiber industry. This market will be highlighted in the individual introductions that follow.

The carbon fiber consumption in wind turbine segment is basically the same as 2016. The demand of VESTAS is strong, with a rapider and rapider momentum, and its supply setup is changed significantly. Another unidirectional fabric infusion process also witnesses a great development in 2017. Throughout the year, 113 tons of fabrics has been imported from SAERTEX, Germany, providing domestic wind blade companies with high-permeability unidirectional fabrics.

We have made major adjustments to Aerospace industry this year. Before, our estimation was only based on domestic carbon fiber supply to aerospace industry and HEXCEL’s prepreg exported to China. In recent years, Cytec (Shanghai) has sold around 200 tons of prepreg every year. Considering also the demand for carbon fiber in General Aviation and UAV industry, the estimated amount changes to 900 tons in 2017 from 400 tons in 2016.

For the demand of the automobile industry, the amount of 300 tons in 2016 was from the calculation of total estimated consumption of many automobile (including new energy vehicles) manufacturers. In 2017, manufacturers of automobile refitting parts and auto parts for luxury cars are added into the calculation, therefore the figure changes to 600 tons.
4.3. Chinese Demand for CF - by province

Total amount: 19,563 tons

![Pie chart showing carbon fiber demand by province]

- Guangdong: 5,563 MT (23.7%)
- Shandong: 5,306 MT (22.6%)
- Jiangsu: 3,095 MT (13.2%)
- Shanghai: 3,194 MT (13.6%)
- Shandong: 5,306 MT (22.6%)
- Fujian: 2,261 MT (9.6%)
- Other: 688 MT (2.9%)
- Zhejiang: 830 MT (3.5%)
- Beijing: 1,272 MT (5.4%)
- Tianjin: 1,277 MT (5.4%)

The composite industry is still concentrated in six provinces that requires thousands of tons of carbon fiber. Beijing raises its ranking because Hantrong Investment has imported lots of fibers from Turkey, but its CF industry is not big. Due to the pulling force of Weihai city, Shandong Province enters the 5,000-ton club. In 2018, Weihai and Wujiang cities have a rapid increasing momentum.
From the perspective of consumption amount, Guangdong Province still maintains the first place. Although Shandong Province has far more carbon fiber consumption quantity than Shanghai, it is mainly low-cost wind blade fibers. Therefore, their consumption amount has not yet entered the billion-US-dollar clubs, including Guangdong and Shanghai.
4.4. Chinese Demand for CF - by origin

Total amount: 23,487 tons

Only judged from country of original, China has become the largest carbon fiber supplier to meet domestic demand for the first time. But the real situation is that the fibers exported from South Korea to China are mainly produced by Toray (South Korea) company. Therefore, they should be considered as Japanese products. Because Toray acquired ZOLTEK, part of fibers from Mexico, Hungary and the US are also considered Japanese products. In total, Japan still has 9,085 tons of sales and it is still the largest supplier in the Chinese market.

Taiwan’s sales have increased significantly, from 3,094 tons in 2016 to 4,203 tons in 2017;

The ZOLTEK (Mexico, Hungary, and the US) fibers exported to China have seen a sharp decline: Compared with 2016, the US has reduced 624 tons, Hungary has reduced 863 tons, and Mexico has reduced 50 tons, totaling 1,537 tons. The reason is that VESTAS has made major adjustments to their suppliers: Importers have been changed from Yancheng TPI and Tianjin VESTAS to Guangwei Composites and Jiangsu Aosheng, carbon fiber brand has been changed from ZOLTEK to mainly Formosa Plastics and partly domestic. We still have no idea whether the reasons for this adjustment is on VESTAS side or on ZOLTEK side.

Import volume of Turkey fibers declines by a certain extent last year, with a decrease of 288 tons. The main reason is that there are some stocks in domestic dealerships from 2016. The actual sales in China in 2017 increases to 1,100 tons.

Attention should also be paid to UMATEX, Russia, which exported 263 tons of fibers to China last year. Throughout the global market perspective, there are few countries that use carbon fiber in civil application. China undoubtedly have an extremely inclusive big market.
The main market for Japan and South Korea is traditional small tow carbon fiber. Currently this is also the main market for most of carbon fiber enterprises in China. The reason why Korea is included is that Toray have 4,700 tons carbon fiber line and downstream process in Korea. We can see a trend that despite the fierce competition from China Taiwan, Turkey and China mainland for these years, on the whole the sales of Japanese carbon fiber in China has been increasing steadily. Among them, Toray Korea is seeing a steady grow on export volume.

Total amount: 568,179 thousand US$
The sales amount of carbon fibers and intermediate materials in China has reached 568 million US$, and these years it has been growing sustainedly and rapidly. Although China sell more tons of fibers than Japan, there is still a large gap between sales amounts. We still calculate the domestic carbon fiber price at 18 US$/KG (about 115 RMB/KG), which not only considers the high price of small volume fibers in military application, but also considers the low price of B, C grade fibers.

In 2017, we make a comparison of fibers prices for the past three years among major suppliers. The price of domestic fiber is increasing, Japanese fiber is fluctuating, Taiwanese fiber is decreasing, and Russian fiber is the lowest.

It should pay attention that in 2017, only the prices of Japanese and American fibers are higher than domestic fibers, the prices of fibers from other countries are lower than domestic fibers. I hope everyone could soberly aware that the high price is not due to high quality, and the government’s protection policy can not last forever.
5. China Carbon Fiber Industry

5.1. China CF Theoretical Capacities

In 2017, we do not count zombie companies (stop running for more than one year, and their equipment is not stable). The overall national theoretical production capacity is 26,000 tons.

A. The production capacity of over 1,000 tons: 7 companies. CCGC have built an expansion 1,000-ton-line. Jilin Jinggong (joint venture enterprise of Zhejiang Jinggong and Jilin Chemical) have built an expansion 1,500-ton-line. TISCO have built an expansion 1,000-ton-line.

B. The production capacity of 500-1,000 tons: 4 companies

C. The production capacity of 100-500 tons: 7 companies

D. The production capacity of below 100 tons: 2 companies

The sales volume is approximately 7400 tons within 26,000 tons capacity, the sales/capacity ratio is 28.5%. The international sales/capacity ratio is 57.2%. Beside China, the sales/capacity ratio in other countries is 63.4%. Therefore, it is an important task for domestic carbon fiber companies to improve the sales/capacity ratio.

The industry concentration is accelerating in 2017. The total theoretical production capacity of the seven 1’000-ton-line companies has accounted for 84.8% of the national theoretical production capacity. We believe that the industry concentration will keep accelerating in the coming years.
5.2. Chinese CF project Effectiveness Analysis

Let's view the factors that will influence the carbon fiber manufacturer's economic benefit from the project construction and finance perspectives.

<table>
<thead>
<tr>
<th>Product</th>
<th>Designation</th>
<th>Linear density</th>
<th>12K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work width</td>
<td>3000</td>
<td>0.8</td>
<td>T700</td>
</tr>
<tr>
<td>Tow number</td>
<td>420</td>
<td>330</td>
<td>G/M</td>
</tr>
<tr>
<td>Production speed</td>
<td>10</td>
<td>133</td>
<td>Days</td>
</tr>
<tr>
<td>Desired capacity</td>
<td>133</td>
<td>330</td>
<td>Continuous production</td>
</tr>
<tr>
<td>Power consumption</td>
<td>3,991,680</td>
<td>1,995,840</td>
<td>Power price</td>
</tr>
<tr>
<td>Natural gas consumption</td>
<td>39,600</td>
<td>99,000</td>
<td>Natural gas price</td>
</tr>
<tr>
<td>Nitrogen consumption</td>
<td>198,000</td>
<td>158,400</td>
<td>Nitrogen price</td>
</tr>
<tr>
<td>Wage &amp; welfare /Y</td>
<td>100,000</td>
<td>333,333</td>
<td>Operators</td>
</tr>
<tr>
<td>Sales management</td>
<td>200,000</td>
<td>200,000</td>
<td>Sales management</td>
</tr>
<tr>
<td>Depreciation period</td>
<td>10</td>
<td>2,083,333</td>
<td>Fixed assets</td>
</tr>
<tr>
<td>Loan interest</td>
<td>6%</td>
<td>1,250,000</td>
<td>Loan amount</td>
</tr>
<tr>
<td>Yield</td>
<td>2</td>
<td>7,451,136</td>
<td>PAN price</td>
</tr>
<tr>
<td>Maintenance cost /M</td>
<td>400,000</td>
<td>5%</td>
<td>RMB/KG</td>
</tr>
</tbody>
</table>

2. Construction and production stages
<table>
<thead>
<tr>
<th>Stage</th>
<th>Designation</th>
<th>Description</th>
<th>Period</th>
<th>Cost</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Stage A: construction</td>
<td>Installation and commissioning</td>
<td>5-15</td>
<td>Depreciation+lab or</td>
<td>None</td>
</tr>
<tr>
<td>B</td>
<td>Stage B: trial</td>
<td>Feed fiber, process adjustment</td>
<td>3-6</td>
<td>Full cost</td>
<td>90-200</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>90-200 ton of off-grade product</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Stage C: stable</td>
<td>Normal production, target property, unstable</td>
<td>6-24</td>
<td>Full cost</td>
<td>B/C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>product</td>
</tr>
<tr>
<td>D</td>
<td>Stage D: standard</td>
<td>Subsequent process improvement</td>
<td>24-36</td>
<td>Full cost</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>product</td>
</tr>
<tr>
<td>E</td>
<td>Stage E: perfect</td>
<td>Customer satisfied product, good price</td>
<td></td>
<td>Long term</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td>Full cost</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Best revenue</td>
<td></td>
</tr>
</tbody>
</table>

### Production cost (per month)

<table>
<thead>
<tr>
<th>Stage</th>
<th>A-Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>1,995,840</td>
</tr>
<tr>
<td>Natural gas</td>
<td>99,000</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>158,400</td>
</tr>
<tr>
<td>Wage &amp; welfare</td>
<td>533,333</td>
</tr>
<tr>
<td>Depreciation</td>
<td>2,083,333</td>
</tr>
<tr>
<td>Financial expense</td>
<td>1,250,000</td>
</tr>
<tr>
<td>Maintenance cost</td>
<td>400,000</td>
</tr>
<tr>
<td>Operation cost (10% sales)</td>
<td>798,336</td>
</tr>
<tr>
<td>PAN</td>
<td>7,451,136</td>
</tr>
<tr>
<td>Size &amp; packaging</td>
<td>665,280</td>
</tr>
<tr>
<td>Period (M)</td>
<td>5-15</td>
</tr>
<tr>
<td>-----------</td>
<td>------</td>
</tr>
<tr>
<td>Monthly sales</td>
<td>0</td>
</tr>
<tr>
<td>Min period (M)</td>
<td>5</td>
</tr>
<tr>
<td>Max period (M)</td>
<td>15</td>
</tr>
<tr>
<td>Total sales (short term)</td>
<td>0</td>
</tr>
<tr>
<td>Total sales (long term)</td>
<td>0</td>
</tr>
<tr>
<td>Overall profit (short term)</td>
<td>-19,333,333</td>
</tr>
<tr>
<td>Overall profit (long term)</td>
<td>-58,000,000</td>
</tr>
<tr>
<td>Overall loss (short term)</td>
<td>38 Months</td>
</tr>
</tbody>
</table>
Through the above analysis, we can come to the conclusion that:

I. Carbon fiber companies have to go through five major stages: Stage A - Construction, Stage B - Trial, Stage C - Stable, Stage D - Standard, Phase E - Perfect. There are slight differences between the standard and perfect stages. There are also price differences for the fibers during these two stages.

II. Carbon fiber is indeed a "Costly" industry. Each manufacturer has a Construction Stage and a Trial Stage, but the period varies among different manufacturers, mainly dependent on their system engineering competences. There are problems on rationalization of the whole line process set-up, stabilisation of equipment, times spent on modification of process or equipment, and especially the adaptability between process and equipment. The real costly periods are the Stable Stage and the Standard Stage. Almost all the production costs are invested during these periods, but the products come out are B, C grade or even off-grade, which can not be sold at a good price in the market, or even can not be sold. This is the “suffering” period that most of the carbon fiber manufacturers have to go through. The suffering comes from the shortage on process optimization and quality stabilisation, which relate the quality stabilisation and process optimization of the PAN fiber, but more relate to the carbonation level. If the period (including the Construction Stage plus Trial Stage) is longer than 81 months, that is 6.75 years, the capital investment on the production line is basically burned out.

III. How long it is from Stage A: Construction to Stage D: Standard is an important criterion for verifying whether the investment on a carbon fiber project is successful or not. Currently, for international level this period is basically 12-14 months. The Standard Stage: does not only mean grade A products produced on this line meet the proportion (should be more than 90%), but also means the estimated production cost (including capital investment, energy consumption, PAN fiber yield, manpower cost) has reach the target. This "Standard
Period" can be an indicator for evaluating a company's engineering capabilities and benefits. When judging industrial companies, entrepreneurs and the media should turn their attention from when the performance of a certain carbon fiber will surpass that of XX company in a trial production to how long the "Standard Period" is. Only when a company survives, can they have the opportunity to improve their technical capabilities.

IV. For those who are planning to invest on carbon fiber industry, nowadays if you still plan the project according to the above "Costly Period", you will certainly become one of the many "victims" in this industry. Of course, in any industry, as long as the technology does not reach the ceiling, there are opportunities for us to take advantage of important innovation in technology and "go faster to catch up with others". It is impossible for a few people in the investment department to get these insights to make decisions by studying some network data. Complex technology industry is much more difficult to make decisions than simple manufacturing industry. Complex technology industry is likely to be doomed to failure before they finish the construction. There is limited space to make adjustment and modification during the implementation of the project, so before you invest on a project, it is important to raise enough money and do enough industry "actuarial study", rather than aimlessly start the project and then burn off the money soon.
5.3. China CF Industry Development

First of all, let's congratulate Jilin Chemical Fiber Group (Jilin Tangu) for the implementation and effectiveness of their PAN fiber strategy. Their sales volume has exceed 5,000 tons in 2017, and it is expected to increase in 2018. For international carbon fiber industry, the previous operating rule is being strictly confidential to the PAN fiber technology, and basically there is no external sales. Currently only Mitsubishi Rayon and the SGL Germany shave strategic cooperation on PAN fiber. Jilin Chemical Fiber has changed this rule. They turn PAN fiber into commercialized product and sell it worldwide. This will have an impact on the global industry pattern.

As another important PAN fiber company, Sinopec Shanghai is one of the few companies in China that have proprietary technology of acrylic fiber and fully localized equipment. They have the technical ability to produce PAN fiber on the existing acrylic fiber equipment (partially modified). The small batch of 48K PAN fibers produced by them have achieved high performance after carbonization processing.

We sincerely hope that these two world-class acrylic companies will produce large-scale, low-cost, differentiated, industrial PAN fiber commodities. They should supply the global carbon fiber manufacturers with PAN fiber and make contribution to expanding the global industry scale; Meanwhile, they should take up the responsibility and mission of rejuvenating the national carbon fiber industry, and fully support Chinese carbon fiber manufacturers with good-quality and low-cost PAN fiber to free them from worries, so that they can concentrate on improving the carbonization technology and engineering.

CCGC is producing high performance, small tow fiber under free market competition. Compared with other similar companies, the localization of their equipment is very high, so they have advantages on production cost.

Jiangsu Hengshen and Kangdexin Group (including ZAX, Kangde Composite, Kangde Tangu) have a whole industry chain with wide applications. Hengshen made significant progress in developing rail transit application last year. Kangde Composites made substantial progress in automobile application. Both Kangde Tangu and Kangde Composites have big construction targets and are under bustling construction.

Guangwei composite, Sinofibers Technology and TISCO all focus on aerospace industry for profit and now are striving to enter industrial applications. Guangwei Composite is not only carbon fiber manufacturer, but also the largest carbon fiber users in China. Strong demand from internal applications will help to improve their production level on producing industrial grade carbon fibers.

Zhejiang Jinggong Group is a young company specialized in carbonization and composite materials. Last year their production capacity reached 3,500 tons had made good sales. By the end of 2018, they will increase 3,000 tons of production capacity. Jinggong Technology under the group
cooperated with Europe in building carbonization equipment. They have done a lot of effective work in the localization of equipment, and this has been proved by the production line running rate.

Ningbo Institute of Material has been working on developing high-modulus carbon fiber. With the improvement of their production technology, the modulus has been increasing. By now it has basically reached M60J level. Compared with the performance of M60J fiber, the fiber strength of Ningbo Institute of Material is higher. It is a new type fiber with “high modulus high toughness”.
6. Global Carbon Fiber Composites Market

6.1. Global Demand for CFRP - by year

The demand for CFRP is based on 65% carbon fiber in the composite. It is a scale concept.

6.2. Global Demand for CFRP - by application (in Kilo-ton)

Total amount: 129.5 thousand tons
6.3. Global Demand for CFRP - by application (in US$ billion)

**Total amount: 12.65 Billion US$**

In 2017, the main revenue of CFRP still comes from Aerospace. Boeing, Airbus and US military aerospace, accounts for the most of the market. This is a typical high investment, high technology, high barrier, long term, high profit market segment. One side, we are expecting the Chinese industries of Aerospace, military, nuclear, marine could become a big market for Chinese advanced composite material, on the other side, we also clearly realize that this is a long-term accumulation and collaborative achievements for these technology-developed countries. It could not happen in short period of time and we should not hurry in such investment decisions.

Winder turbine market, although the consumption of carbon fiber has exceeded aerospace market, the revenue from this market is far below Aerospace, even lower than Sports equipment. This is easy to understand, since we use low-cost big-tow CF, and most economic pultrusion and uni-directional RTM process. Regarding the pultrusion process, the unit cost of pultrusion parts is nearly the same as unit carbon fiber price. Pultrusion could maximize the carbon fiber strength in axial direction, that is what we should learn for other industries.

Compared with wind power industry, automobile composite not only require low-cost, but also require high-rhythm, automatic manufacturing processes, and economic maintenance cost etc. The difficulty in application is imaginable.
6.4. Global Demand for CFRP - by region (in US$ billion)

Total amount: 12.65 Billion US$

From the application market analysis above, we can find that the United States has become the largest composite market because of Boeing and military aerospace applications. In Europe, there are Airbus, automobile, and wind power industries. Although the sales amount of carbon fiber is less than that of the United States, their consumption amount is bigger.

Although Japan is a world leader in carbon fiber industry, its disadvantages in composites and applications is still obvious when compare with Europe and the United States. If Mitsubishi Heavy Industries, Kawasaki Heavy Industries and other companies do not undertake the production of Boeing's large composite parts, Japanese local composite market will be even smaller. Therefore, Japanese carbon fiber giants have expanded their production layout in Europe and the United States by acquiring international companies specializing in intermediate products and composite.

The Asia-Pacific region mainly refer to Mainland China, Taiwan China and South Korea. The most popular application in this region is sports equipment. But it is also expected to make considerable breakthroughs in industrial applications such as wind power and automobiles.
6.5. Global Demand for CFRP - by process

Total amount: 129.5 thousand tons

<table>
<thead>
<tr>
<th>Process</th>
<th>Amount (thousand tons)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepreg layup process</td>
<td>52.3</td>
<td>41%</td>
</tr>
<tr>
<td>Pultrusion and winding</td>
<td>34.1</td>
<td>26%</td>
</tr>
<tr>
<td>Wet lamination &amp; infusion process</td>
<td>9.0</td>
<td>7%</td>
</tr>
<tr>
<td>RTM</td>
<td>12.8</td>
<td>10%</td>
</tr>
<tr>
<td>Molding &amp; Compound</td>
<td>15.4</td>
<td>12%</td>
</tr>
<tr>
<td>Perform</td>
<td>3.2</td>
<td>2%</td>
</tr>
<tr>
<td>Others</td>
<td>2.7</td>
<td>2%</td>
</tr>
<tr>
<td>Others</td>
<td>2.7</td>
<td>2%</td>
</tr>
</tbody>
</table>

There are lots of innovations occurred for resin matrix composite forming process. Innovations may come from resin formulation, fiber form, pre-forming, layup and curing method. Generally speaking, composite forming process is a process of turning one dimensional fiber to three dimensional shape. It is an innovation borrowing ideas widely from other industries such as traditional textile, metal, construction materials, plastic industries etc. The difficulty of composite forming process lies in the maturation and cost efficiency.

In Aerospace, Sports Equipment, Super Luxury Cars applications, the main process is still “prepreg layup plus autoclave” process. Each year, over 50% of the carbon fiber is made into composite through this process. It is an “expensive” process, so sports equipment adopts “molding” process instead of “autoclave” process. However, the features of “even impregnation” and “low void” of this process can best ensure the structural performance.

As the process for VESTAS spar cap, pultrusion process is widely applied. Similar to UD prepreg, pultrusion process can release the best UD properties of fiber. Pieces of UD panels bond into a curved spar, together with the top and bottom spars and the web beam, a rigid spar cap can be formed. This is really a cost effective technical idea, which deserves more promotion.

Currently there are various popular processes in automobile industry, no matter molding & compound, HP RTM and its variation or wet layup, none can meet its requirements of maturation and cost efficiency. We should also make objective evaluation on the light weight of different parts using different energy type. Based on the cost by replacing metal parts with composite parts, it is impossible to use carbon fiber in automobile industry.
6.6. Global Demand for CFRP - by matrix (in US$ billion)

Total amount: 17.15 Billion US$

![Pie chart showing 2017 Global demand for composites-Matrix (Bilion US$)](chart)

The global consumption on CFRP in 2017 shows little change, so we still estimate the amount of other composites based on the data of 2016. Thereinto we separate the C/C composite out from the resin matrix composites. Since there is few of producers of ceramic and metal matrix composites in China, we can do nothing but make reference to data of CCEV Germany.

Regarding the ratio between thermoset and thermoplastic composites in resin matrix composites, after Toray acquired the TENCATE Netherlands, we have to review whether we are objective in assuming the thermoplastic composites. From the information on Toray's official website, international commercial aircraft used 10 million US$ of thermoplastic composites last year. From the above data, aerospace segment totally consume 8.86 billion US$ of resin matrix composites. Toray pointed out, besides commercial aircraft, thermoplastic composites are also applied in laptop cover, sports shoe sole and medical equipment, even in cars by year 2020. Considered there are also chopped carbon fiber reinforced plastics, and continuous carbon fiber thermoplastic prepreg reinforced by continuous glass fiber, we adjust the ratio between thermoset and thermoplastic to 75% and 25%.
7. Trends of Composites Applications and Prospect

7.1. Aerospace

Market development trend is shown as below: CF demand quantity is 19,200 tons in 2017.

Aviation and Aerospace Market share (by Ton) is shown as below:

- Utility aircraft: 300 (1.6%)
- Military aircraft: 1,950 (10.2%)
- Corporate aircraft: 2,100 (10.9%)
- Commercial aircraft: 13,400 (69.8%)
- UAV: 350 (1.8%)
- Helicopter: 1,000 (5.2%)

Aerospace

- 2017 Carbon fiber demand in Aerospace-Segement

Utility aircraft: 300
1.6%

Military aircraft: 1,950
10.2%

Corporate aircraft: 2,100
10.9%

Commercial aircraft: 13,400
69.8%

Aerospace

- 2017 Carbon fiber demand in Aerospace-Segement
Commercial aircraft has a big drive to carbon fiber demand. According to the information on Boeing and Airbus official websites, in 2017 Boeing has delivered 136 sets of composites aircraft B787, consistent with 2016, while Airbus has delivered 78 sets of composites aircraft A350XWB, increased by 60% compared with 2016. Therefore, the increased carbon fiber consumption on commercial aircraft mainly comes from Airbus.

The above commercial aircraft development plan cited from Toray’s official website gives several messages: The trend of international commercial aircraft development shows more focus on mid to small airplanes; By September 2017, Boeing had 4633 sets order (including 1471 sets of B787) in hand and Airbus had 4325 sets order (including 1056 sets of A350XWB) in hand.
7.2. Sports & Leisure

Sports & Leisure market and demand development in the past 10 years is shown as below, the demand in 2017 is 13,200 tons.
Carbon Fiber and Sports Power

In 1971, Toray Japan started the industrial carbon fiber production (output 1ton/month); In 1972, Japanese company Olympic exhibited the fishing rod "Seiki" produced with Toray carbon fiber; In the same year, Gay Brewers won the champion of Pacific Golf Masters by using carbon fiber golf shaft, which inspired people’s enthusiasm for purchasing and using “black shaft golf shaft”. At the very beginning of carbon fiber development, it started an indissoluble bond with sports equipment.

Talking about the sports equipment industry, we have to mention the article “Reviews on Taiwan tennis racket industry development - Establishing its leadership in composites production” written by Mr. Quanyuan Wu of Taiwan Tsinghua University. It wrote "In 1978, Guangnan Company introduced CF composites from abroad and started the production of CF tennis racket. Only after several years, Taiwan weeded out the wooden racket, they changed the global tennis racket production and sales structure and became the leader. By then, Taiwan had established its important position in global composites processing industry. At the end of the article, Mr. Wu wrote with passion " This is an work-class technology history. The history route of Taiwan’s struggle on tennis racket industry is till the benchmark for the many other industries to follow." Began with CF tennis racket, Taiwan continued to make outstanding achievements in CF golf shaft, fishing rod, hockey stick, bicycle etc. Taiwanese invested plants in Mainland, which boost the CF sport equipment industry in Mainland. We could not forget this history.

Most of the global CF sports equipment production is located in Greater China. European and Japanese companies mainly focus on brands management. Chinese companies has limited profit room and technological innovation ability. Currently the main process relies heavily on labors, low automation lead to high production cost, finally it result in expensive products, which common civilians can not afford. Sports equipment has quite different "lightweight value" from industrial products. Automobile engineer will calculate every cent on the parts. But common people will be generous to pay extra money for sport equipment with less weigh and good feeling.

Advanced sports equipment and scientific training methods make it possible to make better sports achievements which will bring good reputation to advanced sports equipment. In return it make for easy promotion and brand effects to increase industrial profit, which help to achieve better performance in competitive sports allow more career options for retired sportsman. Carbon fiber can make best use of its advantages in sports equipment used in air, sea, land, ice, water or snow conditions. Sports legends of “faster, higher, stronger” can be found everywhere after natural material or metal is replaced by CF. Material replacement also lead to many brilliant industrial technological innovations. China (including Taiwan area) is a big global CF sports equipment manufacturing country, however, due to the lack of industrial equipment design technique and brand management experiences, though with the biggest potential market in hand, we have to face the brutal reality of "popular foreign brands, sweat domestic factories". “Strengthening technical production capability, adopting international design experience, national support on domestic brand management, mutual improvement for competitive sports” is the advanced carbon fiber sports equipment power plan demanded by the epoch and the whole nation!
7.3. Wind Blade

In 2017, both the low speed wind field and offshore wind power boost development of large-size wind blades. Wind turbine segment have a increasing demand on carbon fiber. After VESTAS signed a long term supplying contract with FPC, in June 2017, they signed another 4 year contract with AKSA, for supplying 0.3 million US$ pultruded panel of spar cap. At end of last year and early this year, ZOLTEK successively announced their expansion in Mexico and Hungary, increased the production capacity from 14,900 tons to 25,000 tons.

The CF composite supplies for Chinese wind blades industry have changed a lot from 2016 to 2017: TPI (wind blades supplier for VESTES) and VESTES subsidiaries totally imported 2,465 tons of CF in 2016. This group only imported 240 tons of CF this year. But the total market demand is the same. The gap is made up by Guangwei composites and Jiangsu Aosheng. We think this suppliers change is mainly cased by the process change of VESTAS. It determines the process route of producing spar cap with pultruded panels.

The main manufacturers producing carbon fiber wind blades are: Vestas, Gemesa-Siemens, Senvion, Nordex and GE (acquired LM last year), as well as TPI (wind blades supplier for VESTAS and Senvion) and Tessis Brazil (wind blades supplier for GE). Last year, TPI announced they would use RodPack of SENVION to produce wind blades.

The main domestic wind blades manufacturers: Luoyang SunRui, Sinoma, ChongTong, MingYang, CCGC, TMT are actively promoting the applications of carbon fiber. In June of last year, SunRui delivered the 5MW 83.6-meter-long wind blade, the longest offshore wind blade in China, using the spar cap produced by carbon fiber fabric infusion process.
7.4. automobile

For automobile composites segment, we have to mention the i3 of BMW; According to the annual report of BMW, they sold out 31,482 pieces of i3 cars, with a 23.3% year-on-year increase; BMW staff has complained about the high cost of CF composites for several times, there is rumors that they intend to go back into aluminum alloy car boy; SGL bought back BMW's joint venture share for carbon fiber car last year. From last year, people are cooling the hot “hybrid composites” thoughts adopted by BMW "Carbon Core7“ series car.

Besides the electrical car, fuel cell car is also getting hot from last year, most of the car producers has increased their investment on it. Fuel cell stack is popular to use carbon fiber paper. Toray starts to expend their carbon fiber paper plants to achieve 5 times of output. Although many innovations on hydrogen storage, high pressure CF cylinder is still the best option. 35&70MPA hydrogen cylinder is getting hot in the market.

Japanese CF producers led by Toray are actively promoting the application of automobile composites. After purchased the low cost CF producer ZOLTEK, Toray swift quickly from research to industry setup. They have acquired quite some automobile composites companies these years.

There are several points for the automobile composites market:
A. Parts must use CF, such as fuel cell with diffusion CF paper, hydrogen cylinder, are crucial.  
B. Must follow the rule of CF car applications: From F1 racing car, to super luxurious limited edition car, to luxury car. If start from common family car, no matter new energy car or not, the high cost problem can not be solved within short time.  
C. Automobile producers must make “light weight value” evaluation for whole product cycle. If this value is less than the cost of expensive carbon fiber composites itself, don’t waste the money on research.
7.5. Pressure Vessel

Regarding pressure vessel segment, there are mainly three points:

A. Traditional market of respirator cylinder and CNG cylinder develop slowly and stably.

The main market drive for carbon fiber demand are as below:

B. Composites CNG trailer: Hexagon Lincoln’s latest version TITAN XL 40 feet container, 15000 SCM trialed in Latin America in 2015 and got the road permit from USDOT in July 2016. In China Sinoma Chengdu also promoted this product and have make some process.

C. Hydrogen cylinder: hydrogen fuel vehicle mainly use type 3 cylinder (full wrapped with composite cylinder with metal inner) and type 4 cylinder (full wrapped composite cylinder with plastic inner). Whereas, type 3 cylinder mainly used in public transportation, bus and logistics with working pressure 35Mpa, type 4 cylinder mainly used in passenger car with working pressure of 70Mpa.

The main cylinder producers in developed countries, such as Hexagon, Dynetek, Toyoto are far ahead in the market share and technical capacity of high pressure composites vessels. Dynetek occupies the major part of global market type 3 cylinders, and Hexagon is the now the leader of type 4 cylinder, Toyoto has used lots of its own developed 70Mpa type 4 cylinder in its Mirai fuel cell commercial cars.

The main domestic companies that develop and produce type 3 cylinders are: Sinoma Chengdu, Beijing Tianhai Industry, Shenyang Gas Cylinder Safety Technology, Beijing Ketek Technology, Zhangjiagang Furui Special Equipment, CIMC etc. But the type 4 cylinder is still under development stage.

Pressure vessel is the an application which best displays the tensile strength and coefficient of variation of carbon fiber. The release ratio of carbon fiber tensile strength calculated from bursting strength of the cylinder is an important process index. Precise design, precise graticule shaping and automatic production are important directions for the development.
7.6. Molding & Compound

Strictly speaking, the molding & compound is not an application but a description of process. But because it covers a wide range of applications, we summarize it as an application in order to articulate it more clearly.

Compound mainly refers to discontinuous carbon fiber reinforced plastics including chopped fiber and long fiber thermoplastic (LFT). Glass fiber D-LFT applied in automobile field exclusively proves the advantage of this type of composites. However, it only can be used in non structural parts. It's difficult for auto industry to stand the high cost of carbon fiber. Therefore, it requires CF-LFT to achieve better mechanical performance (especially modulus) and high cost efficiency; , CF-DLFT is a necessary way to shorten the process and reduce the cost. The technology is critical in sizing, dispensing and remaining length. Besides mechanical performance, this application also makes use of anti-static resistance and electromagnetic shielding features of carbon fiber.

Molding mainly refers to Sheet Molding Compound-SMC and Bulk Molding Compound-BMC. This is also a promising low cost process way for auto industry. Its problem is similar to that of chopped fiber and LFT mentioned above. Compared with similar GF products, it is less cost effective. But it has different technical issue, mainly in improving the impregnation and evenness of fibrillating.

Usually we will use the thermoplastic composites in compound. It is critical make innovations in screw extruder technology, to ensure both even dispersion of fiber and longer remaining length, but there is conflict between this two features. Molding mainly uses thermoset resin, it requests full impregnation but less cost than prepreg material. It is a big technical challenge to achieve not only better evenness of fiber distribution but also high fiber content.
Carbon fiber composite can play an important role in construction application, mainly in reinforcement for old constructions. It mainly adopts carbon fabric hand layup and on-site bonding process. A good adhesion with construction is critical for high quality construction operation.

Europe, US and Japan focus on the research of making use of carbon fiber composite to prevent and against earthquake. Their experiences prove that houses after carbon fiber composite reinforcement can better prevent and against earthquake. The quality of construction in China cannot compare with that of western contraries. We still have a lot to do in making relevant national policy and building reinforcement research, especially reinforcement for the dangerous buildings in the earthquake region.

Except in common building reinforcement, carbon the bridges composite also has also a big potential in reinforcement for bridge, tunnels and various industrial pipes. With the development of domestic carbon fiber and composites, it is also compromising in these applications.

Japan focus on the research of replacing bridge cable materials with composites material. China has also done some research. There are technical difficulties in solving problems such as carbon fiber radial shearing strength from transverse wind and connection with metal parts. General speaking, there is a lack of process in this research.

Compared with other developed countries., China has the unparalleled market advantages in the above mentioned applications. The top international designers are designing the airport, benchmarking building and bridges in China. Afraidly China also have the most poor quality constructions that require reinforcement. Why we can not improve the technology with the drive from such a good application market ? It seems that we get lost without the technical guidance from the developed countries. Getting used to copy from others, we will lose the thinking abilities.
7.8. C/C Composite

![Carbon fiber demand in C/C-Trend (MT)](image)

The main market and situation of carbon carbon composites is as below:

Airplane brake disk: From 2009 US Honeywell began to replaced the powder metallurgy brake disks in B737 with carbon brake disks, it means that after a few years, all of the Boeing and Airbus aircraft will install carbon brake disks. The main international carbon brake disk producers are: Messier-Bugatti in France, Honeywell, B.F.Goodrich, Goodyer in US and Dunlop in UK. The main domestic airplane brake disk producers are: Avic Xi'an brake branch, Boyun new material, Xi'an Chaoma etc. Each commercial airplane will consume 234kgs of carbon fiber. (Source: Jiangsu Tianniao high technology)

Aero parts: C/C composite becomes the priority material option for throat lining, nozzle and diffusion section of motor, end cap of the giant solid rocket due to its high performance.

Thermal field parts: All the high temperature thermal equipment, represented by solar silicon wafer production equipment, such as single crystal growing furnace and multicrystal casting furnace, require C/C composite materials. Most of the C/C composite materials used in big diameter industrial furnace are provided by foreign suppliers, mainly including SGL Germany, Tokai Carbon Japan etc. The domestic C/C composite material suppliers includes Xi'an Chaoma technology, Aerospace Long March Arimt Technology, Boyun New materials, Central South University, South Boyun etc.

Preforming is an important production step for C/C composites. Performing parts made from pre-oxidized fiber, discontinuous carbon fiber by quasi-three-dimensional needling, braiding stich and orthogonal three-dimensional fabric etc. Outstanding producers represented by Sinoma Nanjing glass fiber institute, Jiangsu Tianniao technology, Institute of composite materials of Tianjin Polytechnic University, Jiangsu Feizhou High Technology Materials.
7.9. Electronics

3C products consume the most carbon fiber in Electronics application. Lightweight laptop, Lenovo X1 display cover, HP SPECTRE baseboard are all made from carbon fiber composites.

Every year 50~60 million pieces of lightweight laptops are sold, currently most of them are made from aluminum alloy and magnesium, only small part of them, about 6~7 million pieces are made from carbon fiber composite.

There is always competition between thermoset and thermoplastic in this application. Lenovo uses thermoset fabric prepreg, while HP uses thermoplastic fabric prepreg.

The popular process is: prepreg laminating and molding process to form the main structural board, then feed it into the injection molding machine to inject other precise parts (such as screw holes etc), finished parts after painting.

The sleeve of high speed permanent magnet motor rotor is usually made by filament winding process, which requires high tension during the winding process and maintain the tension after cure.

The above applications mainly make use of carbon fiber structural performance. Quite some of office electronic equipment and electrical components adopt carbon fiber reinforced plastics for its functional performance such anti-static resistance and electromagnetic shielding. Thanks for its stiffness and rigidity, more and more carbon fiber composites are being used as diaphragm material in speakers.
7.10. Marine

Currently, carbon fiber demand in marine mainly comes from: racing ships, luxury yachts, high speed passenger craft and military vessel.

From 70s of last century, many vessels began to use composite materials and become an important application for glass fiber composites. It's quite difficult for carbon fiber composites to take a share of pie from low cost glass fiber composites.

In 2017, there are some important news: In September, China - Norway carbon fiber construction project was settled in Guangzhou Nansha and a successful signing ceremony was held pearl river shipping and New Shipbuilding Heavy Industry under Shipping Group and BRAA, a famous shipyard in Norway. A joint-venture plant, ZhongWei composite Materials co., LTD is built in Nansha. They cooperated with shipbuilding base in Nansha little tiger island to introduce advanced technology represented by carbon fiber composite materials manufacturing to build neotype high-speed passenger carbon fiber passenger ships. In October, two Norwegian carbon fiber high-speed passenger ships hull were smoothly lifted and transported by sea to a new hull workshop of Guangdong New Shipbuilding Heavy Industry. It started a new journey in carbon fiber shipbuilding for New Shipbuilding Heavy Industry.
7.11. Cable Core

In 2017, we calculate the global demand as 900 tons, the base for this data is:

The main global producer is US CTC company and its international authorized business partners. This company started the research work in 2001, and promoted the commercial application of ACCC in 2005. Currently they have four main global strategic business partners: General Cable in North America, Midal in Middle East, Bahrain, Lamifil in Belgium, Europe and Far East Cable in China. (Source: CTC official website)

Though Japanese companies are the earliest in developing composites cable core, due to the local mature power network, they have few chance to set up new power network, so there is no market to support their research.

Except for the CTC subsidiary in China, the main Chinese producers are: China Electric Power Research Institute, Zhongfu Carbon Core Cable technology Co., LTD, North China electric power institute cooperated with Heibeii Silicon Valley, Liaoning Electric Power company cooperated with Harbin FRP Institute.

CTC used to make an optimistic estimation on carbon fiber cable core application. However, the commercialism situation is not so good as their expectation over these years. On the contrary, China consumes about 400 tons of carbon fiber in this application, taking up half of the total international demand.