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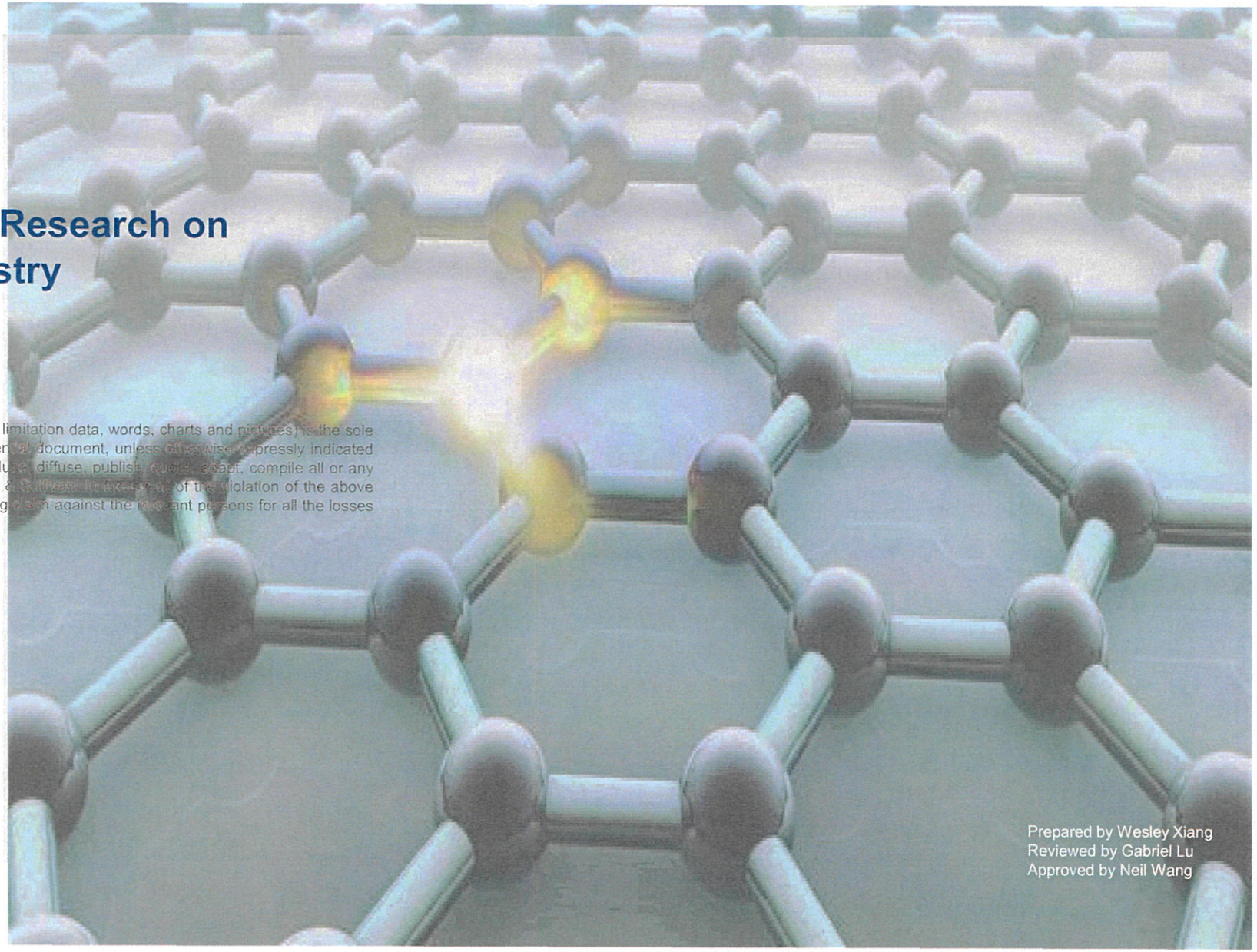
Independent Market Research on China Graphite Industry

_____2022

Signature:

FROST & SULLIVAN
沙利文



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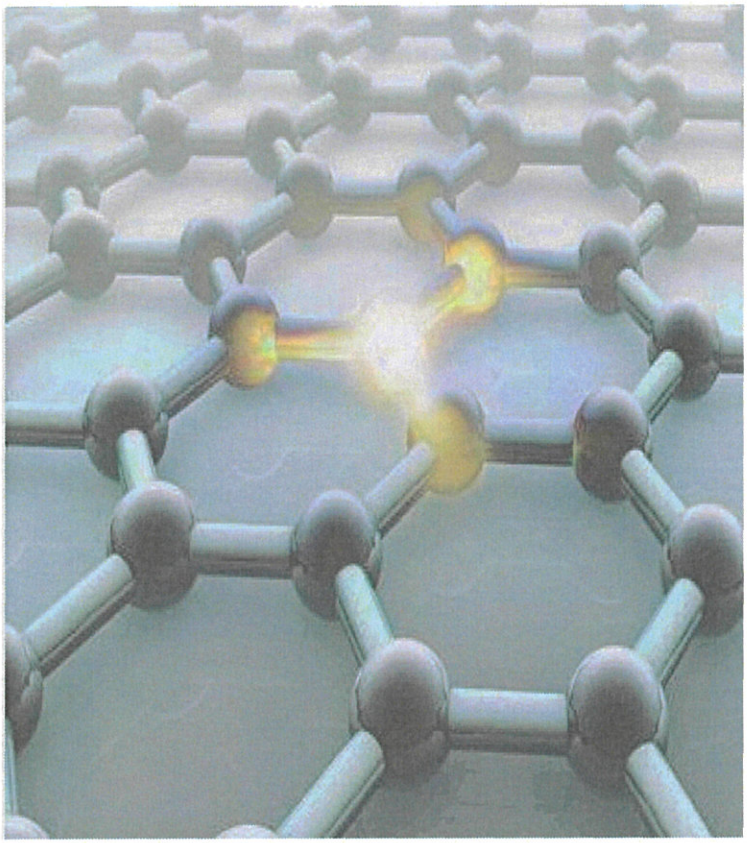
Agenda



China Macro Economic Overview

Nominal GDP

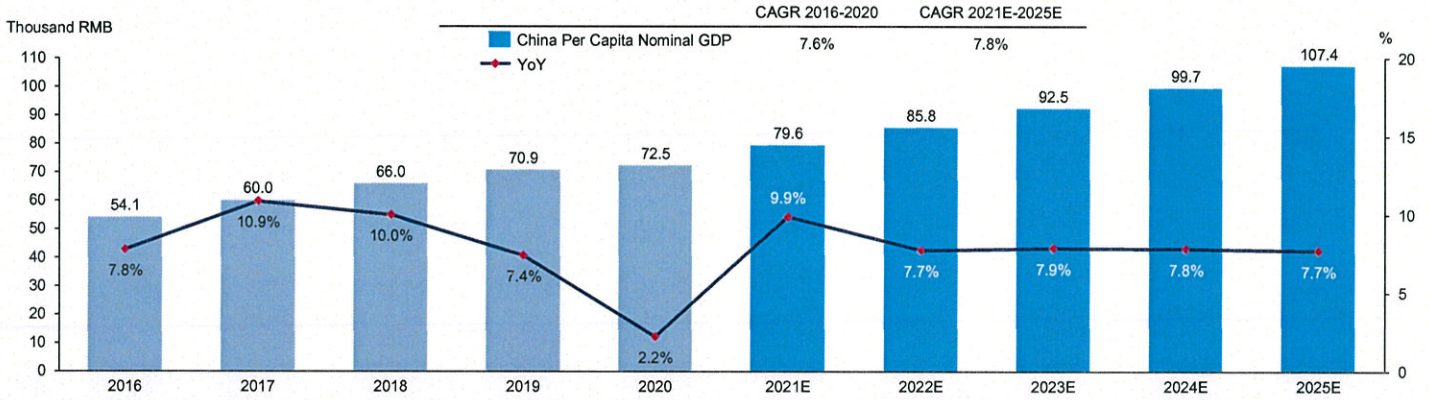
- Due to a series of economic stimulus policies adopted by the Chinese government, including the "Four Trillion Plan" ("四万亿计划") and the "Ten Industry Revitalization Plan" ("十大产业振兴规划"), China's GDP has maintained a relatively rapid growth in the past few years. The nominal GDP increased from RMB74.6 trillion in 2016 to RMB101.6 trillion in 2020 at a CAGR of 8.0%. The outbreak of COVID-19 in January 2020 has significantly impacted China's overall economy. The GDP in the first quarter of 2020 had a decrease of 6.8% compared to last year. However, with the great efforts made across the country, the Chinese government's anti-epidemic measures were quickly implemented and the epidemic was effectively controlled within a short period of time. China's economic growth has turned from negative to positive since the second quarter in 2020. Driven by a series of proactive fiscal and monetary policies by the Chinese government, the economy has gradually returned to normal. The year-on-year growth rate of the nominal GDP showed 4.9% in the third quarter and 6.5% in the fourth quarter in 2020. According to the latest World Economy Outlook released by IMF, China's nominal GDP growth rate is expected to be around 3.0% in 2020, making it one of the few countries in the world to achieve positive economic growth. In the post-epidemic era, China will further enhance its innovation capabilities, create a large domestic market, promote higher levels of reform and opening up, and achieve high-quality economic growth. From 2021 to 2025, China's nominal GDP is expected to maintain a CAGR of approximately 7.9%, reaching approximately RMB151.9 trillion by 2025.

Source: National Bureau of Statistics of China, IMF, Frost & Sullivan

China Macro Economic Overview

Per Capita Nominal GDP

Per Capita Nominal GDP (China), 2016-2025E



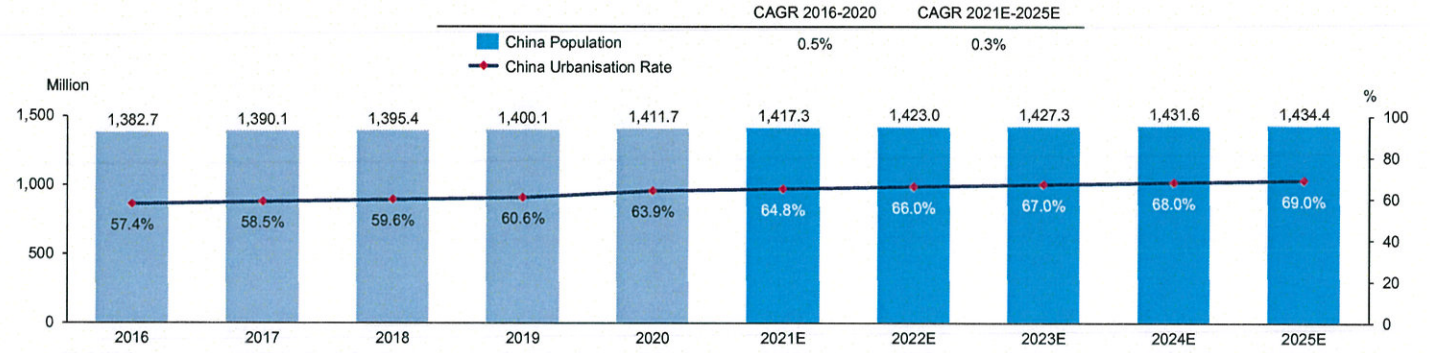
- In line with China's overall economic growth, China's per capita nominal GDP has maintained a rapid growth in the past few years, from approximately RMB54.1 thousand in 2016 to approximately RMB72.5 thousand in 2020, representing a CAGR of approximately 7.6%. Based on the annual average exchange rate, per capita nominal GDP in China reached over USD10,000 for the first time. It took less than 20 years for a large country with a population of 1.4 billion to achieve a per capita GDP from USD1,000 in 2000 to USD10,000 in 2019, demonstrating China's strong economic development momentum. The growth rate of China's per capita nominal GDP in 2020 has dropped to 2.2% affected by COVID-19. Looking forward, driven by factors such as technological innovation and consumption upgrading, China's per capita GDP will maintain steady growth from 2021 to 2025, which is expected to reach RMB107.4 thousand by 2025, representing a CAGR of about 7.8%.

Source: National Bureau of Statistics of China, IMF, Frost & Sullivan

China Macro Economic Overview

Population and Urbanisation

Population and Urbanisation (China), 2016-2025E



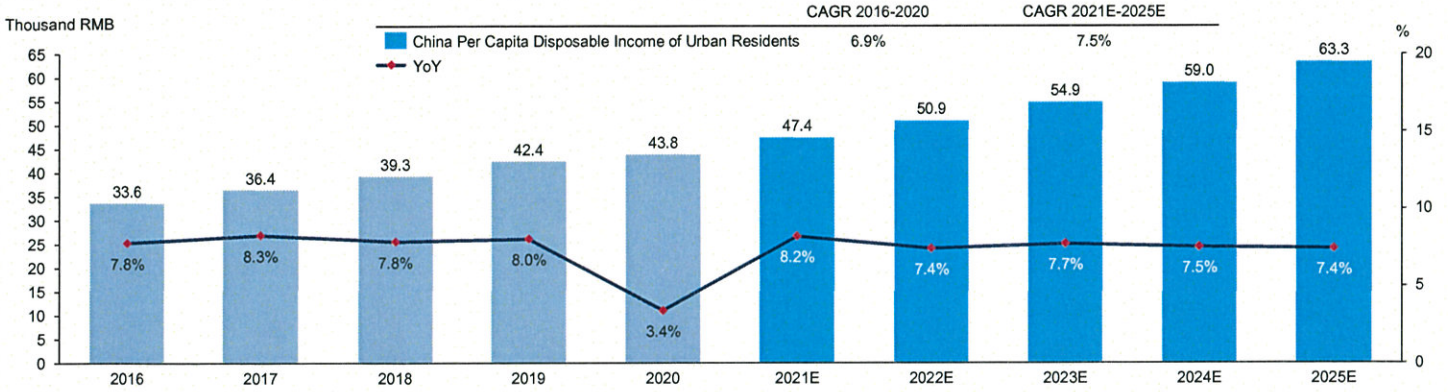
- China has the world's largest population in the world. With the Chinese government investing a tremendous effort into controlling the enormous population, the population growth rate has been stable over the past few years. In 2020, China's total population was around 1,411.7million. According to the "National Population and Development Planning" (国家人口发展规划(2016-2030)), the Chinese population is expected to keep an increasing tendency. It is estimated that the total population will reach 1,434.4 million by 2025, representing a Five-Year CAGR of 0.3%.
- Due to the rapid economic development of China and the influx of migrants from rural areas to urban areas, the Chinese urban population has been increasing steadily. The rapid economic growth has fueled the unprecedented urbanisation of its population since the 1990s. The urbanisation rate in China increased from 57.4% in 2016 to 63.9% in 2020. With the continuous growth of urbanisation, the urban population of China is expected to grow further. Under the "National Plan for Promoting Healthy Urbanisation" (全国促进城镇化健康发展规划) raised in 2013, new-style urbanisation is expected to promote the urban-rural coordination and reasonable distribution. Accordingly, the urbanisation rate is likely to increase gradually from 2021 to 2025, reaching 69.0% by 2025.

Source: National Bureau of Statistics of China, IMF, Frost & Sullivan

China Macro Economic Overview

Per Capita Annual Disposable Income of Urban Residents

Per Capita Annual Disposable Income of Urban Residents (China), 2016-2025E



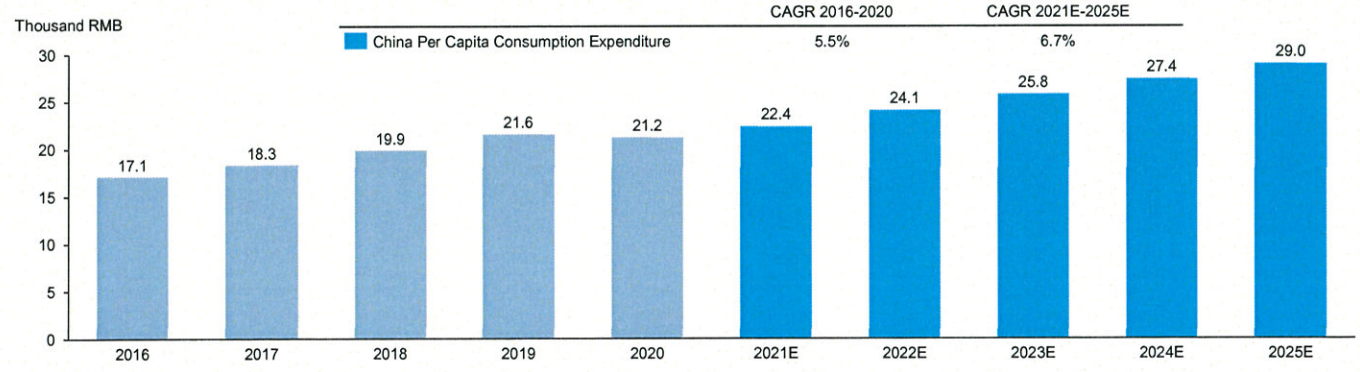
- China's robust economic growth has made a huge impact on improving people's living standards. The per capita disposable income of urban residents grew rapidly from RMB33,600.0 in 2016 to RMB43,800.0 in 2020 at a CAGR of 6.9%. In the face of the epidemic, the country has taken a series of measures to boost people's income. In the upcoming 14th Five-Year Plan period, with sustained and healthy economic growth, further improvement of the income distribution system and the increasing domestic demand, the income level of the Chinese people will continue to rise, the size of the middle-income group will continue to expand, and China is expected to rise from a middle-high income country to a high-income country.
- Looking forward, as the Chinese economy and urbanisation rate continues to grow, the per capita disposable income of urban residents is projected to reach approximately RMB63,700.0 by 2025 from RMB47,700.0 in 2021 at a CAGR of 7.5%.

Source: National Bureau of Statistics of China, Frost & Sullivan

China Macro Economic Overview

Per Capita Consumption Expenditure

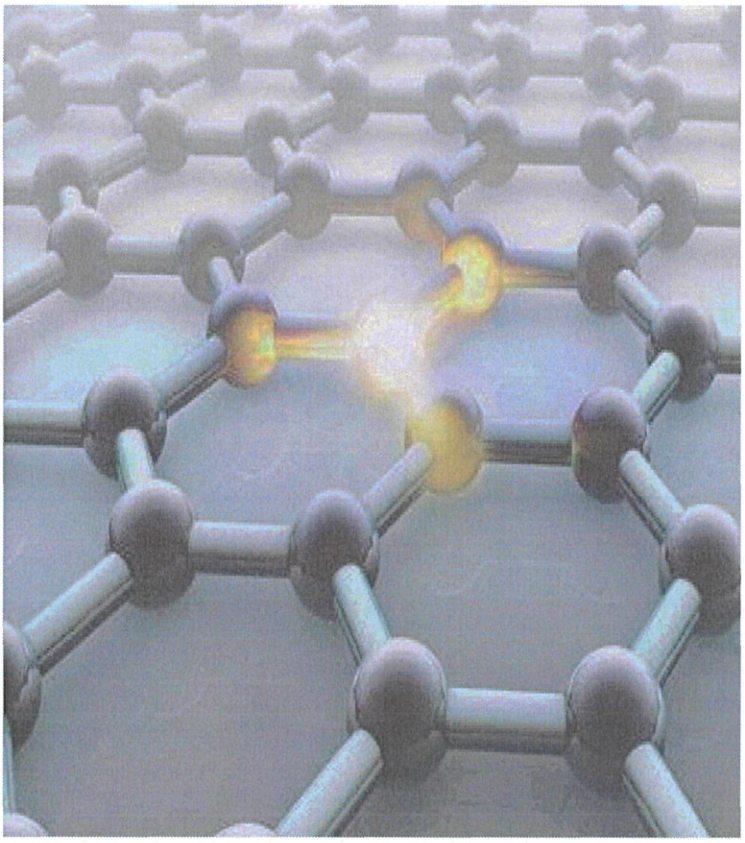
Per Capita Consumption Expenditure (China), 2016-2025E



- With the steady growth of China's per capita nominal GDP and the increase in disposable income of Chinese urban residents, per capita consumption expenditure has also increased rapidly in the past years. With the steady growth of China's per capita nominal GDP and the increase in disposable income of Chinese urban residents, per capita consumption expenditure has also increased rapidly in the past years. In the upcoming 14th Five-Year Plan period, with sustained and healthy economic growth, further improvement of the income distribution system and the increasing domestic demand, the income level of the Chinese people will continue to rise. The continuous improvement of residents' income promotes the increase of residents' purchasing power, and the per capita consumption expenditure maintains an upward trend.
- Looking forward, as the Chinese economy and living standard of people continues to grow, the per capita consumption expenditure is projected to reach approximately RMB29,000.0 by 2025 from RMB22,400.0 in 2021 at a CAGR of 6.7%.

Source: National Bureau of Statistics of China, Frost & Sullivan

Agenda

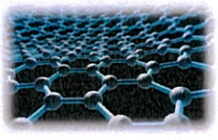


China Graphite Industry Overview

Introduction and Classification (1/2)

Graphite

- *Graphite is a mineral composed of stacked sheets of carbon atoms with a hexagonal crystal structure. It is gray to black, opaque, and has a metallic luster.*
- *Natural graphite is mined from deposits in metamorphic rocks, such as marble, schist, and gneiss, and from accumulations in vein deposits. Natural graphite typically forms as a result of metamorphism of accumulations of organic matter in sedimentary rocks.*
- *Synthetic graphite is manufactured by high-temperature heat treatment (graphitization) of, or chemical deposition from, hydrocarbon materials. Synthetic graphite is more than 99.9% graphite, but it has slightly higher porosity, lower density, lower electrical conductivity, and a much higher price than natural graphite.*
- *Graphite is considered as a critical and strategic mineral because of its essential applications in the aerospace and energy sectors, especially the emerging noncarbon energy sector.*



Characteristics

- Graphite has physical and chemical characteristics of high temperature resistance, high thermal and electrical conductivity, chemical inertness, thermal shock resistance, high radiation emissivity, flame retardance, high compressive strength, flexibility, high resistance to erosion, good machinability, low friction and self-lubrication and many other special properties.

Applications

- Natural graphite is suitable for coatings, pencils, powder metallurgy, steelmaking, refractories, lubricants and batteries. For some of these uses, no suitable substitutes are available. Steelmaking and refractory applications in metallurgy use the largest amount of produced graphite; however, emerging technology uses in large-scale fuel cell, battery, and lightweight high-strength composite applications could substantially increase world demand for graphite.

Production

- Natural graphite is mined from more than 20 nations, but world production is dominated by China, Mozambique, Brazil, Madagascar and India, which export graphite worldwide. In 2019, China produced more than 60% of the world's graphite, of which approximately 40% was amorphous graphite, approximately 60% of which was flake graphite. North America produced only 4% of the world's graphite supply with production in Canada and Mexico and no production of natural graphite was reported in the United States.

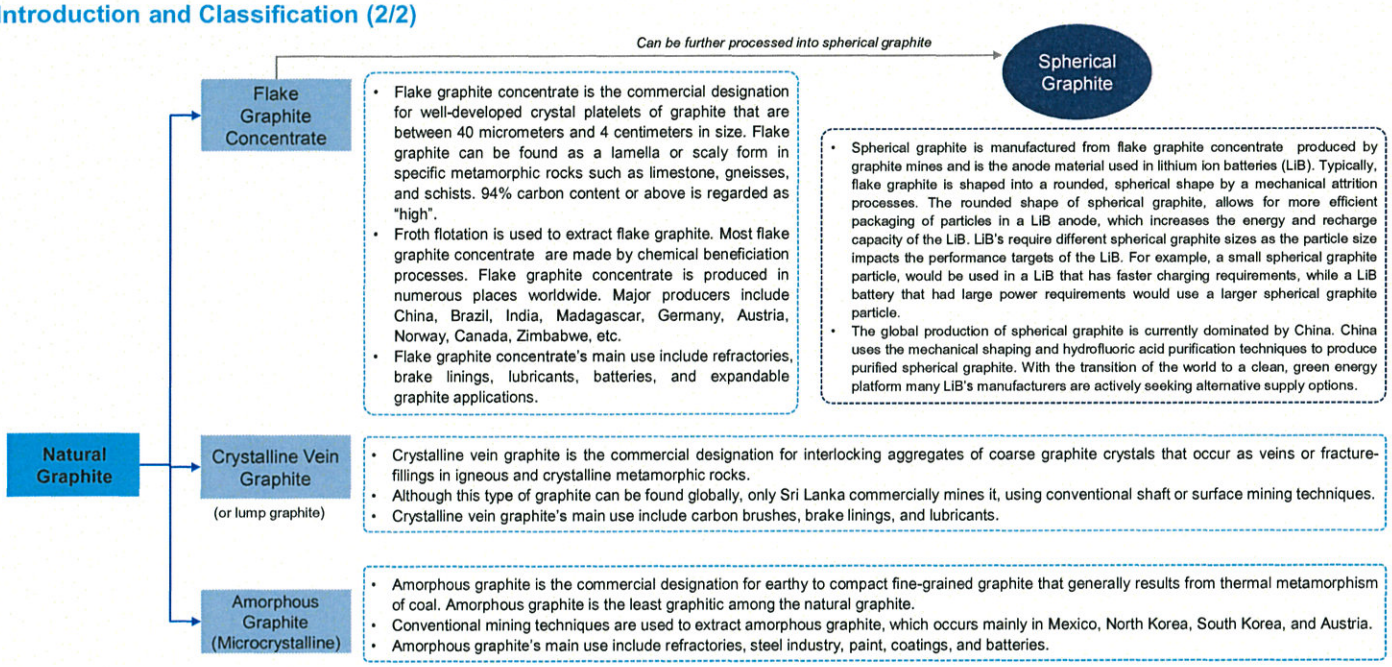
Classification

- For commercial purposes, natural graphite is classified into the following three categories based on its crystallinity, grain size, and morphology: (i) Flake graphite concentrate; (ii) crystalline vein (or lump) graphite; (iii) amorphous (microcrystalline) graphite. Flake graphite concentrate and crystalline vein graphite belong to scaly graphite. Well-crystallized graphite flakes have a black metallic luster, whereas microcrystalline material is black and earthy with an amorphous appearance. They each have unique properties that make them well-suited for certain applications.

Source: United States Geological Survey, Frost & Sullivan

China Graphite Industry Overview

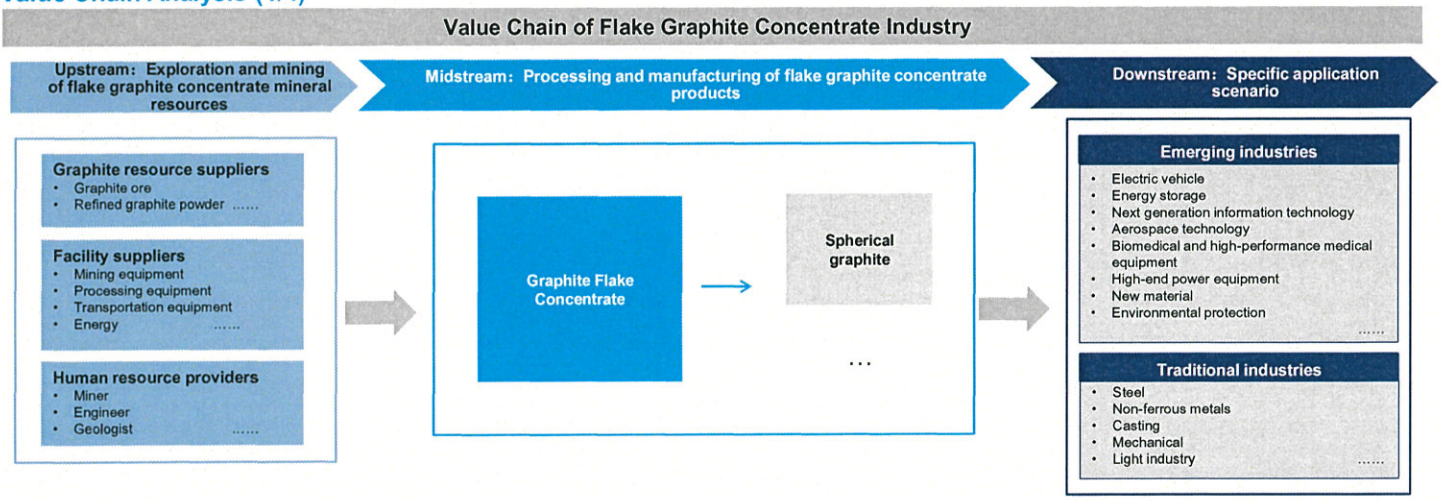
Introduction and Classification (2/2)



Source: United States Geological Survey, Frost & Sullivan

China Graphite Industry Overview

Value Chain Analysis (1/4)



- The industry players in the value chain of the flake graphite concentrate industry mainly consist of mine owners, flake graphite concentrate distributors, flake graphite concentrate product manufacturers and end consumers.
- The upstream of flake graphite concentrate industry mainly consists of graphite resource suppliers including graphite ore and refined graphite powder suppliers, facility suppliers such as miming equipment, processing equipment, transportation equipment suppliers and energy suppliers, and human resource providers.
- After ore mining and primary processing, flake graphite concentrates are sold to the midstream graphite product manufacturers, to be further processed into material grade graphite products. Flake graphite concentrate may also be sold to graphite distributors by mine owners and then sold to graphite manufacturers. Certain manufacturers in midstream are capable of processing mining resources. Micro graphite powder and high purity graphite powder are the by-products of processing spherical graphite. Unprocessed marble is the by-product of mining operations. Costs incurred in relation to transporting raw materials from the mine to the beneficiation and processing plants may constitute a sizeable cost component in any mining operation. The competition in the PRC mining industry for experienced personnel in the area of exploration and development is intense.
- The downstream of flake graphite concentrate industry are broad application scenarios of various graphite products. Driven by continuous technology upgrading and policy stimulus, the application scope of graphite products has expanded to many emerging fields, such as electric vehicles, consumer electronics, energy storage, information technology, aerospace, etc.

Source: Frost & Sullivan

China Graphite Industry Overview

Value Chain Analysis (2/4)

Major Application Fields of Natural Graphite-Traditional Industry

Refractory materials & steelmaking

- One of the main uses of graphite is to produce refractory materials, including refractory bricks, crucibles, continuous casting powder, mold cores, mold detergents and high-resistant materials. In the past 20 years, refractory materials such as magnesia-carbon bricks and aluminum-carbon bricks have been widely used in steelmaking furnace linings and continuous casting, making the demand for graphite closely connected with refractory materials and the steel industry. Graphite and other impurity materials can be used as recarburizers when used in the steelmaking industry. The range of carbonaceous materials used in carburizing is very wide, including natural graphite, artificial graphite, petroleum coke, metallurgical coke and natural graphite. Steelmaking recarburizers is still one of the main uses of earthy graphite in the world. Although the graphite industry has made considerable progress in other new application areas in recent years and the proportion of graphite used in the steel and refractory industries has been decreasing over the past few years, but it is still the largest application sector of graphite.

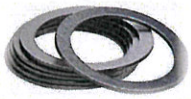
Lubricant

- Graphite is often used as a lubricant in the machinery industry. The main products include dry powder graphite lubricant, water-based graphite lubricant, and oil graphite lubricant. The good lubricity of graphite material comes from the graphite crystal structure. It can not only form a strong lubricating film when contacting the metal surface, but also improve the wettability of the metal surface to other lubricants, thereby maintaining long-term lubrication. Lubricating oil often cannot be used under high-speed, high-temperature, and high-pressure conditions, while graphite wear-resistant materials can work at very high temperatures and at high sliding speeds (100m/s) without lubricating oil. Therefore, equipment that transports corrosive media widely use graphite materials to make piston rings, sealing rings and bearings. Graphite emulsion is also a good lubricant for many metal processing (wire drawing, pipe drawing).

Corrosion resistant materials

- Graphite has good chemical stability. Specially processed graphite has the characteristics of corrosion resistance, good thermal conductivity, and low permeability, which is widely used in the production of heat exchangers, reaction tanks, condensers, combustion towers, absorption towers, coolers, heaters, filters, pumps and other equipment. The equipment have been used in petrochemical, hydrometallurgy, acid-base production, synthetic fiber, papermaking and other industrial sectors, which can save a lot of metal materials.

Sealing materials



- Flexible graphite pressed from expanded graphite after high temperature expansion is a very excellent sealing material. Various graphite gaskets are made to seal various parts. The high-quality flexible graphite sealing material can withstand high temperature and corrosion, and can be used for high temperature fluid sealing in chemical, petroleum, electric power and other industries. In addition, due to the advantages in performance of graphite material, it has played an irreplaceable role in the aviation and aerospace fields as a sealing material, which can be used for static and dynamic sealing of pipes, valves, boxes and other components of aerospace vehicle propulsion, hydraulic and pneumatic systems, as well as the sealing of structural and heat proof system components. With the development of China's automobile, petroleum, chemical, electric power and aerospace industries, the graphite sealing industry will have broad development prospects.

Note: Flake graphite can be used in all the above applications.

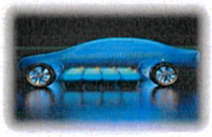
Source: Frost & Sullivan

China Graphite Industry Overview

Value Chain Analysis (3/4)

Major Application Fields of Natural Graphite-Emerging Industry

Anode Material of Lithium Batteries



Electric Vehicle

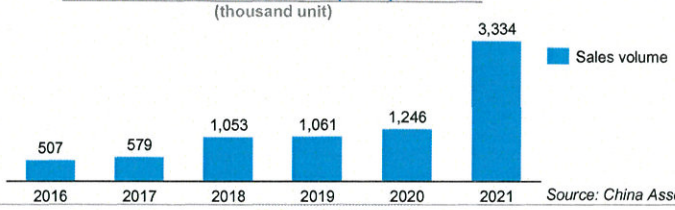
Overview

- Lithium batteries are mainly composed of four parts: cathode material, anode material, electrolyte and cell separator. Anode material mainly affects the initial efficiency and cycle performance of lithium batteries. The conductivity of graphite is significantly better than other non-metals, and it is currently the most widely used anode material for lithium-ion batteries. Flake graphite concentrate does not only extend battery life, promote voltage stability, enhance conductivity, but also reduce battery costs, which has been mainly used in consumer electronics and power battery markets. In particular, the spherical graphite through spherical treatment of flake graphite concentrate has better specific heat capacity, cycle performance, good conductivity, higher crystallinity and low discharge point, which has become an important part of lithium battery anode material.
- Driven by the rapid growth of lithium-ion battery market with demand stemmed from the fast growth of consumer electronics, transportation and energy storage industries, the battery industry has become the fastest growing application sector of graphite and will further stimulate the demand for natural graphite.

- The electric vehicle industry in China has achieved rapid development in the past few years. Since 2015, the sales of EV in China have ranked first in the world for five consecutive years. According to data released by China Association of Automobile Manufacturers, the total sales volume of EV in China increased from 507 thousand units in 2016 to 3,334 thousand units in 2021, representing a CAGR of 45.7%. The shipment of electric vehicle lithium-ion battery in the PRC has grown from approximately 32.1 GWh in 2016 to 154.5 GWh in 2021, representing a CAGR of 36.9%.
- Currently, the EV industry in China has entered a new stage of superimposed convergence and integrated development. The Chinese government has also attached great importance on the high-quality development of EV industry as well as continuous innovations of relevant technology. According to "Electric Vehicle Industry Development Plan (2021-2035)"(新能源汽车产业发展规划（2021—2035年）) published in November 2020, major breakthroughs in key technologies such as power batteries, drive motors and vehicle operating systems are expected to be made by 2025. Driven by policy stimulus and technology progress, the application market space of graphite in the field of electric vehicle will be further released.

Sales Volume of Electric Vehicles (China), 2016-2020

(thousand unit)



Source: China Association of Automobile Manufacturers, Frost & Sullivan

China Graphite Industry Overview

Value Chain Analysis (4/4)

Major Application Fields of Natural Graphite-Emerging Industry

Consumer Electronics/3C

- With the continuous development of the world economy and improvement in people's purchasing ability, consumers have increasing needs of communication, entertainment and work efficiency, which leads to the rising consumer demand of and penetration of 3C products. According to the report released by CNNIC (China Internet Network Information Center), as of March 2020, the number of mobile internet users in China had reached 897 million, and the proportion of internet users using mobile phones had reached 99.3%. In addition, the breakthrough and application of 5G technology will bring new increments to the smartphone market. Furthermore, with the rapid development of emerging technologies such as mobile internet and artificial intelligence, wearable products represented by smart watches have gained more and more popularity. The downstream increasing demand of 3C products will keep driving the application of graphite as anode materials. With the iteration of key technologies of sensors and AI, smart wearables are gradually integrating richer functions, and technologies such as folding screen technology and wireless charging are bringing new growth momentum to consumer electronics products.

Energy Storage

- Energy storage is an important solution to improve the flexibility and economy of the traditional power systems as well as ensure stable electricity supply. Energy storage can also increase the consumption of renewable energy such as wind and solar energy. In the past few years, the Chinese government has issued a series of policies to support the development of the energy storage industry.
- Lithium batteries have become one of the world's major energy storage systems due to the high energy density, high power density and high efficiency. It has been widely used in various energy storage fields such as grid energy storage, household energy storage, and communication energy storage. In the future, the Chinese government will further accelerate the sustainable transformation of the energy structure. According to "Strategy for a Revolution in Energy Production and Consumption 2016-2030" (能源生产和消费革命战略2016-2030) , during the period of 2021 to 2030, the non-fossil fuel energy consumption will account for about 20% of total energy consumption. With the continuous development of clean energy, distributed power grids, micro grids, electric vehicle charging piles and other industries, the market demand for lithium batteries will further increase, promoting the application of graphite as well.
- With the increasing policy support for new energy storage, standardized business model of energy storage, and the continuous decline in the cost of lithium batteries, the shipments of energy storage lithium batteries continued to rise. The shipment volume of lithium-ion battery energy storage has increased from approximately 0.1 GW in 2016 to approximately 5.8 GW in 2021 with a CAGR of approximately 125.3%.

Major Policies Of Energy Storage in China

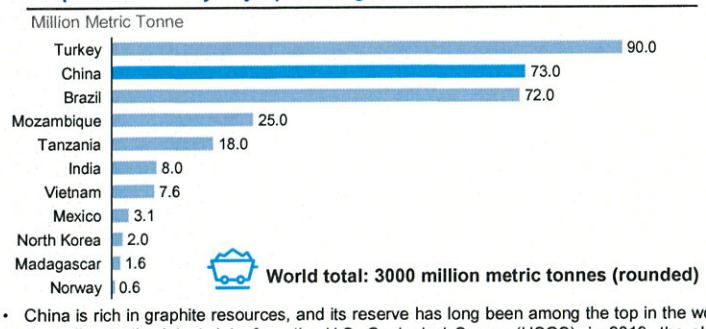
Regulations	Issuing year & body	Description
Notice on matters related to the compilation of the 14th Five-Year Plan for the Development of Renewable Energy《关于做好可再生能源发展"十四五"规划编制工作有关事项的通知》	2020 National Energy Administration	The document points out that priority should be given to the development of distributed and distributed renewable energy, promoting the direct and nearby utilization of distributed renewable electricity, heat, gas and other users, and combining with emerging technologies such as energy storage to increase the proportion of renewable energy.
Implementation Plan On Strengthening Standardization Of Energy Storage《关于加强储能标准化工作的实施方案》	2020 National Energy Administration	The implementation plan encourages the formulation of key energy storage standards and research on standards for emerging energy storage technologies and applications.

Source: CNNIC, Frost & Sullivan

China Graphite Industry Overview

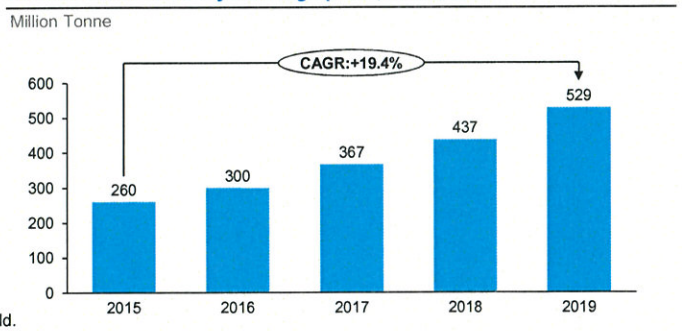
China Graphite Reserves

Graphite reserves by major producing countries, 2019



- China is rich in graphite resources, and its reserve has long been among the top in the world. According to the latest data from the U.S. Geological Survey (USGS), in 2019, the global graphite reserves reached about 300 million metric tonnes, of which Turkey ranks first in graphite reserves, reaching about 90 million metric tonnes, followed by China of around 73 million metric tonnes. In addition, Brazil, Mozambique and Tanzania have rich graphite reserves, which are 72 million tonnes, 25 million tonnes and 18 million metric tonnes respectively.
- Crystalline graphite[1] ore is mainly distributed in China, Ukraine and Brazil. Amorphous graphite ore is mainly distributed in countries such as India, South Korea, Mexico and Austria. According to the report published by USGS, most countries only produce one type of graphite. China is one of the few countries that produce both crystalline and amorphous graphite, in addition to Mexico, North Korea, Republic of Korea, Russia, with Ukraine and United States.

Identified reserves of crystalline graphite[1], China, 2019



- With the advancement of exploration technology and the increase of investment, the identified reserves of crystalline graphite[1] in China had increased from 260 million tonnes in 2015 to approximately 529 million tonnes in 2019, representing a CAGR of 19.4%, according to data released in China Mineral Resource Reports. China's crystalline graphite[1] mines are mostly large and medium-sized mines, accounting for 70% of the total mineral deposits. About 88% of the country's crystalline graphite[1] mineral reserves are concentrated in large mines.

Note: 1: "crystalline graphite" is a name used by China natural resources administration, which mainly refers to flake graphite.
According to the definitions of USGS, "reserves" is part of the "reserve base" which could be economically extracted or produced at the time of determination. "Identified resources" means reserves whose location, grade, quality, and quantity are known or estimated from specific geologic evidence. Identified resources include economic, marginally economic, and subeconomic components.

Source: United States Geological Survey, Frost & Sullivan

China Graphite Industry Overview

China Graphite Reserves

Regional distribution of graphite reserves in China

- In most cases, producers of the graphite products may directly purchase graphite ores from upstream suppliers or explore the graphite from the mining resources owned by themselves. According to the China Graphite Resources Survey Report published by Chinese Academy of Geological Sciences, graphite resources is widely distributed throughout China, and there are more graphite resources in the east than in the west. At present, graphite mines have been discovered in around 25 provinces (municipalities, autonomous regions), with a total of 91 mining areas. Specially, in terms of the reserves of crystalline graphite ores, Heilongjiang, Inner Mongolia, Sichuan, Shanxi and Shandong account for more than 85% of China crystalline graphite reserves. China's graphite mining areas have superior geological conditions, which are mainly regional metamorphism and contact metamorphism. According to graphite metallogenic conditions and metallogenic rules, there are 15 key metallogenic regions, which are presented in the table.
- In terms of different types of graphite, at present, China has developed six major graphite production and processing bases, which account for more than 80% of the country's output. Among them, crystalline graphite[1] (including flake graphite concentrate) is mainly deposited and produced in Heilongjiang (Jixi, Luobei), Shandong (Pingdu) and Inner Mongolia (Xinghe); amorphous graphite is mainly deposited and produced in Hunan (Chenzhou), Jilin (Panshi), etc.
- Heilongjiang Province is a large province of graphite mineral resources and rich in graphite resources. The reserve of graphite in Heilongjiang Province is mainly deposited and produced in Jixi City and Luobei County. As of Apr 2021, there were only 14 graphite extraction and processing companies with mining rights in Heilongjiang. Many of the mines with mining rights acquired by leading players had already been in operations for many years. It might push the average selling price of graphite products higher during the cold climate seasons due to the overall drop in supply in the market. The suspension of the supply of unprocessed graphite would lead to the suspension of the benefication and processing plants, which would generally also suspend operations during those winter months. In 2020, the production volume of flake graphite concentrate in Heilongjiang accounted for over 60% of the total production volume of flake graphte concentrate in China.
- It is the market move that much of Heilongjiang's graphite were actually processed in Shandong.

NO.	Names of key metallogenic regions in China	Deposits	Type of deposits	Stratigraphic age
1	Jiamusi block metallogenic area 佳木斯地块	Liumao 柳毛	▲	Middle Archaic
2	Erguna block metallogenic area 额尔古纳地块	Menduli 门都里	▲	Paleoproterozoic
3	Jihei Metallogenic Area 吉黑	Xianrendong 仙人洞	●	Mesozoic
4	Liao-Ji Rift Metallogenic Belt 辽吉裂谷	Sanbanjiang 三半江	▲	Paleoproterozoic
5	Metallogenic belt on the northern margin of the North China Block华北陆块北缘	Xinghe 兴和	▲	Middle Archaic
6	Alashan Road land block mineralization area阿拉善路陆块	Chahanmuhulu 查汗木胡鲁	▲	Middle Archaic
7	Metallogenic area on the northeastern margin of the Tarim ancient land block塔里木古陆块东北缘	Sujiquan 苏吉泉	■	Mesozoic
8	Altai metallogenic belt阿尔泰	Huangyangshan黄羊山	■	Mesozoic
9	Metallogenic belt on the southern margin of the North China Block华北陆块南缘	Beizi背孜	▲	Archaic
10	Jiaodong Block Metallogenic Area胶东地块	Nanshu 南墅	▲	Paleoproterozoic
11	Metallogenic belt in the northern margin of the Yangtze block扬子陆块北缘	Pinghe 坪河	▲	Proterozoic
12	Kangding Earth Axis Mineralization Area康定地轴	Zhongba 中坝	▲	Cambrian
13	Metallogenic belt in the northern part of Cathaysia Block华夏陆块北部	Sanchaya 三岔垭	▲	New Archaean-Paleoproterozoic
14	Metallogenic area in the Southeast东南地区	Lutang 鲁塘	●	Permian
15	Metallogenic belt in southern Cathaysia block华夏陆块南部	Wuyuan 伍园	▲	Cambrian

Regional metamorphism mineral deposit: ▲
Contact metamorphism mineral deposit: ●
Magma hydrothermal mineral deposit: ■

Source: Frost & Sullivan

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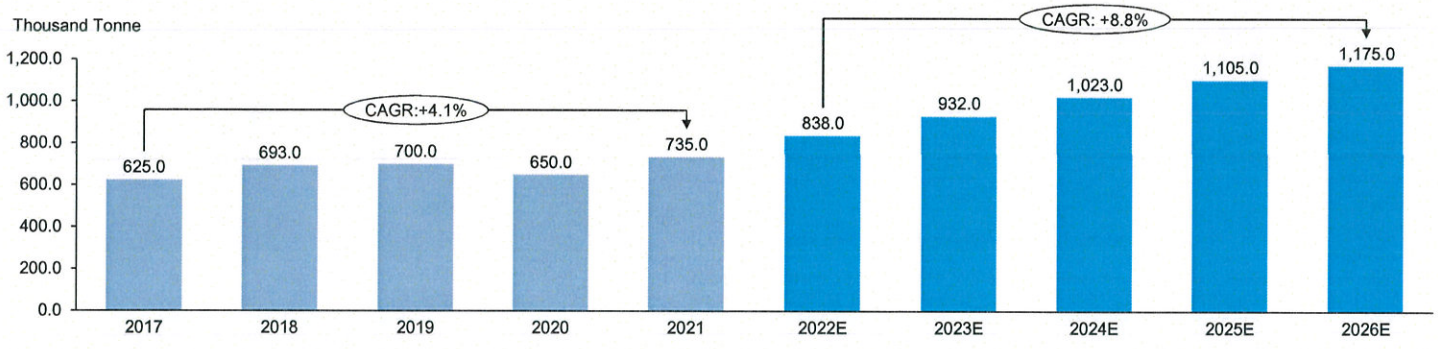
Note: 1: "crystalline graphite" is a name used by China natural resources administration, which mainly refers to flake graphite.
definitions of types of mineral deposits are included in the glossary page in the appendix

China Graphite Industry Overview

China Production Volume of Natural Graphite

Production Volume of Natural Graphite (China), 2017-2026E



- Driven by the growth in lithium-iron batteries and EAF (Electric Arc Furnace) steel sector in China, domestic production of natural graphite increased steadily to approximately 700.0 thousand tonnes in 2019 from approximately 625.0 thousand tonnes in 2017. The decrease of the production of natural graphite in 2020 was mainly due to the outbreak of COVID-19. With the recovery of economy and the resumption of production, the production volume in 2021 increased to 735.0 thousand tonnes. Going forward, with increasing demand from downstream sectors including refractory materials, lubricant and lithium-ion batteries, the production volume of natural graphite in China is expected to increase continuously at a CAGR of approximately 8.8% from approximately 838.0 thousand tonnes in 2022 to approximately 1,175.0 thousand tonnes in 2026.
- China is a major producer of natural graphite in the world. In 2021, China produced more than 60% of the world's graphite. In terms of the production volume of natural graphite, flake graphite accounted for more than 60% in 2021.

Note: The natural graphite refers to the natural graphite that has been primarily processed.

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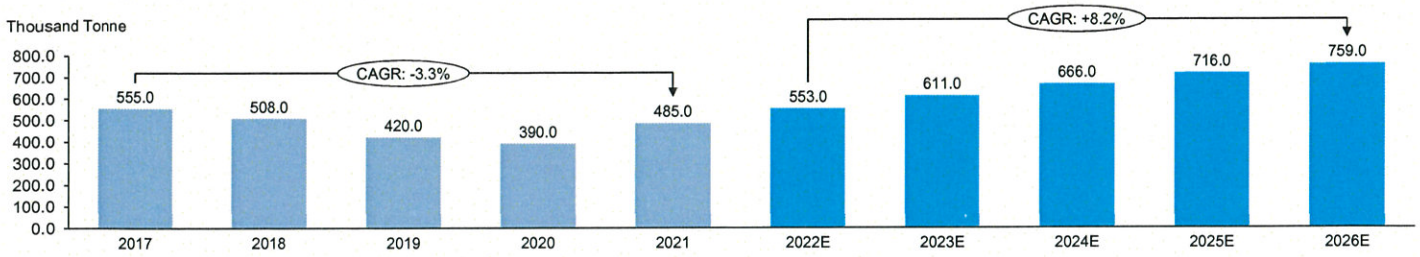
Source: United States Geological Survey, Frost & Sullivan

China Graphite Industry Overview

China Production Volume of Flake Graphite Concentrate

Production Volume of Flake Graphite Concentrate (China), 2017-2026E



- The China production volume of flake graphite concentrate dropped from approximately 555.0 thousand tonnes in 2017 to approximately 390.0 thousand tonnes in 2020. The shutting down of enterprises affected by environmental inspections is the main reason behind the shrinkage in domestic flake graphite concentrate production over the past few years. Additionally, many of the deposits being exploited were getting deeper and more expensive to mine which raised the cost of domestic graphite mining. In 2021, the production volume has reached 485.0 thousand tonne.
- Whereas, leading companies in the flake graphite concentrate industry with rich graphite resources and mature techniques on the production of the graphite are likely to achieve economy of scale and reduce costs. Rapid advances in technological innovation, including through automation, digitization, and electrification, are having a fundamental impact on the graphite mining sector. Automated technologies allow companies to remove staff from dangerous working conditions, which offer companies further opportunities to reduce and manage their operating costs. The cost of deeper graphite mining could be relatively reduced. Moreover, crystalline graphite (including flake graphite concentrate) has been declared as a strategic mineral due to its potential strategic applications in "National Mineral Resources Planning (2016-2020)" (全国矿产资源规划(2016-2020年)) issued by Ministry of Land and Resources, National Development and Reform Commission, Ministry of Industry and Information Technology, Ministry of Finance, Ministry of Environmental Protection and Ministry of Commerce, which reinforced the inspections of companies towards unlicensed exploration, waste of resources and environmental damage. The Graphite Industry Specific Conditions has also strengthened the strategic position of graphite. Especially flake graphite concentrate has growing importance in high technology applications and green energy sector due to its unique physical and chemical properties. The production volume of flake graphite concentrate is forecasted to experience an increase from approximately 553.0 thousand tonnes in 2022 to approximately 759.0 thousand tonnes in 2026, representing a CAGR of approximately 8.2%.

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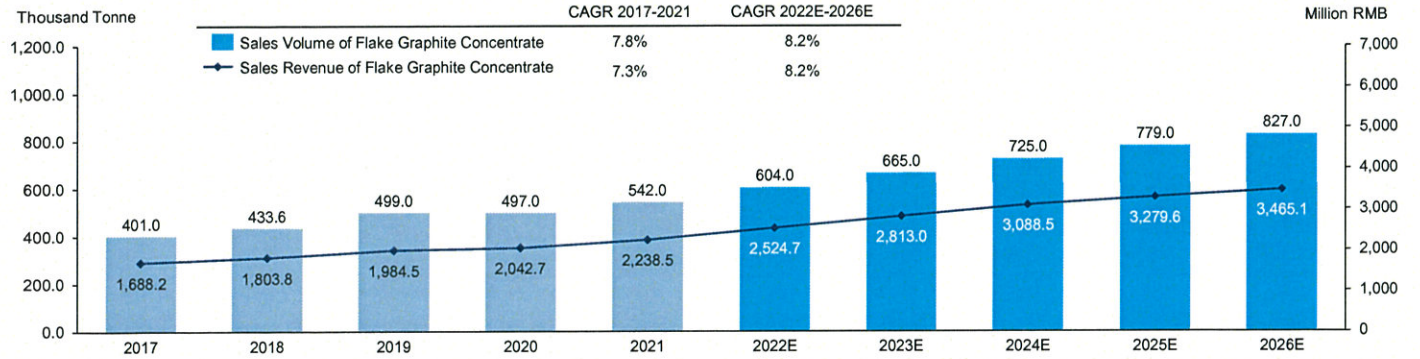
Source: United States Geological Survey, Frost & Sullivan

China Graphite Industry Overview

China Sales Volume and Sales Revenue of Flake Graphite Concentrate

Sales Volume and Sales Revenue of Flake Graphite Concentrate (China), 2017-2026E



- In 2021, the sales volume and revenue has continually increased and reach 542.0 thousand tonne and RMB2,238.5 million, respectively.
- The graphite mining technology has constantly been upgraded and improved as emerging technology such as IoT (internet of things), drones and automation has been adopted. As graphite is the core materials of EV batteries, the graphite industry is expected to witness a growth in the next few years driven by the positive EV-related policies such as "14th Five-Year Plan (2021–2025) for National Economic and Social Development and Long-Range Objectives for 2035" which disclose the strategic position of electric vehicles for national development. Driven by the opportunities including benefits from industry-favoured policies, advancement on graphite manufacturing technology and increasing demand of downstream industries, the sales volume of flake graphite concentrate is expected to increase to approximately 827.0 thousand tonnes in 2026, representing a CAGR of approximately 8.2% from 2022.The sales revenue of flake graphite concentrate is expected to further increase to approximately RMB3,465.1 million in 2026, illustrating a CAGR of approximately 8.2% from 2021.

Source: Frost & Sullivan

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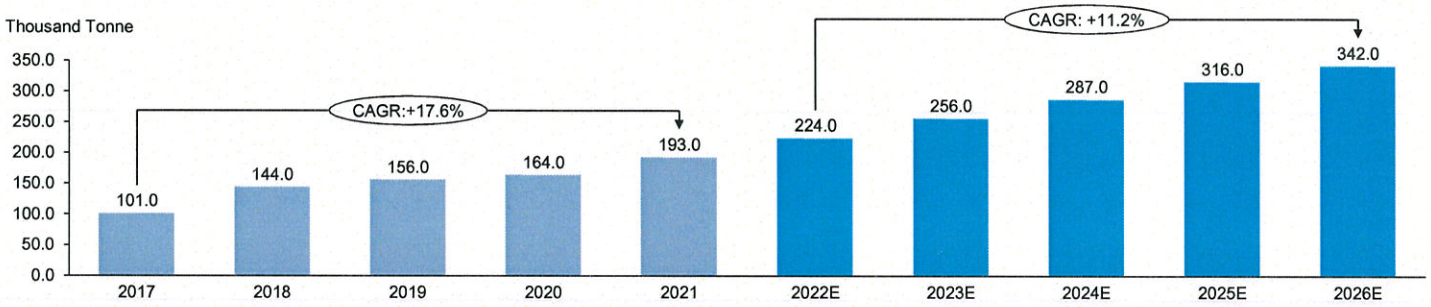
China Graphite Industry Overview

China Production Volume of Spherical Graphite

Production Volume of Spherical Graphite (China), 2017-2026E



- Spherical graphite is manufactured from flake graphite concentrate and can be used in the production of lithium-ion batteries (being one of the key raw materials). Influenced by the continuous policy incentives in electronic vehicle manufacturing and electronic information industry, the sales volume of electronic vehicle increased from approximately 0.5 million units in 2016 to approximately 3.3 million units in 2021, with a CAGR of approximately 45.7%. The electronic vehicle market in the PRC is expected to grow in next few years driven the proposal of carbon neutral and green energy. The sales volume is expected to reach 9.6 million in 2026. The booming development of electronic vehicle industry promoted the growing demand of lithium-ion batteries in previous years, which paves the way for the market growth of spherical graphite.
- The domestic production volume of spherical graphite witnessed a steady increase at a CAGR of approximately 17.6% from approximately 101.0 thousand tonnes in 2017 to 193.0 thousand tonnes in 2021. Affected by the outbreak of COVID-19, the growth rate of spheric graphite production volume slowed downed a little bit in 2020. Looking forward, the growing downstream markets are projected to offer opportunities for the spherical graphite providers over the next five years. Along with potential technology improvement, domestic production will increase steadily from approximately 224.0 thousand tonnes in 2022 to approximately 342.0 thousand tonnes in 2026, illustrating a CAGR of approximately 11.2%.

Source: Frost & Sullivan

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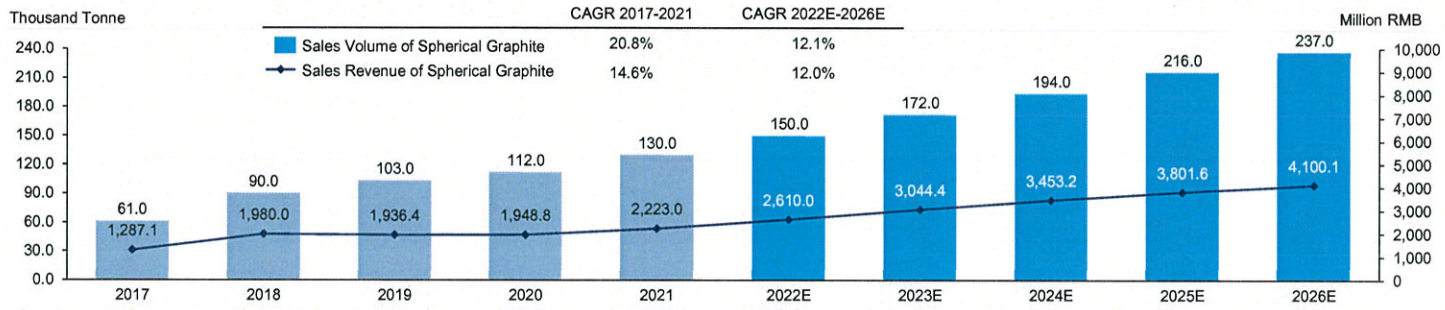
China Graphite Industry Overview

China Sales Volume and Sales Revenue of Spherical Graphite

Sales Volume and Sales Revenue of Spherical Graphite (China), 2017-2026E



- The sales volume of spherical graphite in China went through a significant increase in previous five years, growing from approximately 61.0 thousand tonnes in 2017 to approximately 130.0 thousand tonnes in 2021, illustrating a fast CAGR of approximately 20.8%. Likewise, the sales revenue also benefited from the huge market demand, which increased from approximately RMB1,287.1 million in 2017 to approximately RMB2,223.0 million in 2021 at a CAGR of approximately 14.6% during the same period. Similarly, COVID-19 has caused a negative impact on the year-on-year growth rate of sales volume and sales revenue of spherical graphite in 2020.
- China possess the vast majority of processing and consumption of battery-grade spherical graphite in the world. The fining and processing technology of spherical graphite are expected to improve continuously in the near future in response to huge demand from downstream market. The incentives of new electronic vehicles (NEVs) especially the "Notice on Further Improving the Policy for the Promotion and Application of Financial Subsidy for New Energy Vehicles" (关于进一步完善新能源汽车推广应用财政补贴政策的通知) issued by Ministry of Finance, Ministry of Industry and Information Technology, Ministry of Science and Technology and National Development and Reform Commission in Dec 2020, will further promote the production of NEVs as well as the demand for lithium-ion batteries. On January 21, 2022, seven departments including the National Development and Reform Commission issued the "Implementation Plan for Promoting Green Consumption"(促进绿色消费实施方案）, proposing to vigorously develop green transportation consumption.
- Moving forward, the sales volume of spherical graphite in China is estimated to surge from approximately 150.0 thousand tonnes in 2022 to approximately 237.0 thousand tonnes in 2026, representing a CAGR of approximately 12.1%. The sales revenue is expected to grow from approximately RMB2,610.0 million in 2022 to approximately RMB4,100.1 million in 2026 at a CAGR of approximately 12.0%.
- Since specifications of spherical graphite products have been constantly evolving, such as those requiring longer shelf-life for battery in electric vehicles, resulting in new graphite products being launched in the market every year.

China Graphite Industry Overview

Challenges

Environmental issue

- China's graphite mining and beneficiation technology is still backward, resulting in a relatively low recovery rate. Years of open-pit mining has caused tremendous damage to resources and the environment. Currently, the country has formulated strict access standards, technical and environmental requirements for enterprises, which will strengthen the protection of graphite resources and the environment. In July 2020, the "Graphite Industry Specification Conditions" (《石墨行业规范条件》) issued by the Ministry of Industry and Information Technology of the PRC put forward higher requirements of the resources and environmental protection for the graphite industry. For example, the document set relevant standards for the comprehensive energy consumption of graphite product production, the emission level of pollutants, and the treatment methods of production waste. In addition, the document encourages graphite companies to use energy-saving and environmentally friendly process technologies and develop circular economy. Therefore, graphite companies need to pay more attention to environmental issues in the process of mining, production, processing and R&D, reduce the impact on the geological environment, water, soil, vegetation, air, biodiversity, as well as improve overall energy efficiency.

Intensifying competition

- Recently, driven by the policy stimulus on electric vehicles and new materials, the downstream application of graphite such as lithium battery has a good development prospect. As a result, the number of companies participating in the graphite production and processing industry has further increased, and industry competition has become more intense. However, with the exception of a few industry leaders, most of China's graphite industry companies are small in scale, and most of the companies only focus on rough processing of graphite raw materials, which lacks precision and deep processing. Most of the products produced by newly invested graphite companies are similar to those of the original companies, resulting in low-level repeated construction of production lines, aggravating the overcapacity of primary processed products, and causing vicious competition among companies. As a result, competition in the graphite manufacturing industry is concentrated in the low-end market, and the price war is fierce, which restricts the sustainable development of the graphite industry. Furthermore, as the government subsidy on electric vehicle gradually faded, the midstream graphite manufacturers will face challenge under the pressure from the downstream companies to further reduce costs.

Lack of high value-added products

- Due to insufficient investment in technological development, the added value of graphite products in China is relatively low, making the large resource advantages difficult to transform into economic and technological advantages. In addition to the relatively complete graphite industry chains in Heilongjiang and Shandong that have deep processing enterprises producing relatively high added value graphite products, the other major graphite production areas are basically focus on mining and the added value is extremely low. After recent years of development and competition, some large companies have made significant progress in the purification technology and quality management of graphite products, but the processing technology of high-purity fine graphite is still lagging behind developed countries in Europe, America, Japan and South Korea. For example, high value-added products such as flexible graphite, colloidal graphite, high-purity ultra-fine graphite and other products are still mainly rely on imports. Furthermore, most of the Chinese graphite companies previously only pursued the expansion of production scale to maximize profits, ignoring the importance of R&D and talent development, which restricted the innovation of graphite technology. Therefore, China's graphite industry needs to actively introduce high-end production lines while increasing investment in R&D to increase the number of independently developed products and the high added value of products.

Source: Frost & Sullivan

China Graphite Industry Overview

Entry Barriers

Technology barrier

- Due to the limited upstream graphite resources and supply, the graphite market is very competitive. When selecting graphite materials or products, downstream application companies will take technology as a key factor into account. At the same time, driven by the upgrading of terminal electronic products as well as the further penetration of electric vehicles, the downstream manufacturers will have higher requirements on the technology and performance indicators of graphite materials and products. For example, anode materials will develop towards high specific capacity, high charge-discharge efficiency, high cycle performance and lower cost. As a result, anode material suppliers have been promoted to increase R&D investment, speeding up technological innovation and continuously developing high-performance products, which usually requires strong technology and talent accumulation as well as time and capital investment. Therefore, technology become one of the major barriers of graphite industry.

Customer barrier

- The customers of graphite providers are mainly industrial manufacturers. These customers tend to have strict requirement and screening process to do business with new suppliers. Track record in production with downstream customers are vital for the graphite companies to secure orders. New entrants are likely to face greater difficulties in satisfying customer's requirements and in maintaining stable raw material supplies. New entrants would have to compete against experienced players who have mature setup and networks, and would not able to build up close relationship and networks with customers in a short time.

Channel barrier

- Driven by technology and policies, the application of graphite has penetrated into a variety of fields, and the demand for graphite products is rising rapidly among enterprise-level users in different regions and industries, especially in the fields of electric vehicles and consumer electronics. Whether the sales channels of graphite manufacturing companies are complete and whether the coverage of the marketing network is extensive determines the company's market competitiveness. Leading companies have gradually established a stable and extensive distribution system and marketing network in the long-term business process. At the same time, major graphite providers continue to deepen their communication and integration with upstream and downstream market participants as the scarcity of upstream raw materials becomes more and more evident. Graphite manufacturers consolidate their leading positions in the industry through partnerships with or direct acquisitions of upstream graphite miners and raw material suppliers or with a variety of downstream companies. It is difficult for new entrants to establish a competitive channel system in the short term.

Capital barrier

- The graphite industry is a capital-intensive industry, which requires a lot of investment in infrastructure and production equipment in the early stage. This is mainly because the graphite manufacturing needs a large amount of initial capital for the procurement of upstream primary graphite, the construction of manufacturing factories as well as the purchase or installation of machineries in order to produce various graphite materials and products. With the rapid changes of the market, the need to expand production and upgrade manufacturing techniques in time poses a challenge to the capital of the enterprise. If the new entrants do not have enough capital reserves to cope with the changes and follow up the trends of the market, it is difficult for them to keep a leading position in the competition.

Source: Frost & Sullivan

China Graphite Industry Overview

Drivers and Trends (1/3)

1 Wider Application and Rising Downstream Demand

Steelmaking and refractory applications in metallurgy use the largest amount of produced graphite; however, emerging technology uses in battery, large-scale fuel cell, and lightweight high-strength composite applications could substantially increase world demand for graphite.

- ***High demand from refractories manufacturing***
  The development of refractory manufacturing has led to an increase in demand for graphite. One of the main uses of natural graphite is to produce refractory materials (such as magnesia-carbon refractory bricks, crucibles, ladles and molds containing molten metal), making the demand for graphite closely linked with metallurgy and steelmaking, chemical engineering, petroleum, machinery manufacturing, silicate, power and other industrial fields. According to World Steel Association, the production of crude steel in China grew from approximately 870.7 million tonnes in 2017 to approximately 1,032.8 million tonnes in 2021, at a CAGR of approximately 4.4% and expect to increase to around 1,200.0 million tonnes in 2025. Although the graphite industry has made considerable progress in other new application fields in recent years, the refractory manufacturing industry remains as the largest consumption field of graphite. As the metallurgical and steelmaking industries will still maintain a fundamental position in economic development, the demand for graphite will remain robust in the future.
- ***Increasing demand for lithium-ion batteries***
  The structure of graphite consumption growth is gradually shifting from traditional industries to strategic emerging industries such as new energy vehicles, energy storage, nuclear energy, and electronics is increasing rapidly. The conductivity of graphite is significantly better than other non-metals, making it the most widely used anode material for lithium-ion batteries at present. Lithium-ion batteries are smaller, lighter and more powerful than traditional batteries and have a flat voltage profile meaning they provide almost full power until discharged, whose production volume in China increased rapidly from approximately 7.84 billion in 2016 to approximately 17.56 billion in 2020, illustrating a CAGR of approximately 22.3%. As the world transforms to a clean energy base across the electric vehicles and energy storage, the global demand for cost effective energy storage solutions continues to drive the growth of the lithium-ion batteries market and graphite market as well. Specifically, The electric vehicle industry in China has achieved rapid development in the past few years, with the sales volume of electric vehicles representing a CAGR of approximately 45.7% from approximately 507 thousand units in 2016 to approximately 3,334 thousand units in 2021. Driven by policy stimulus and technology progress, the market space for the application of graphite in the field of electric vehicle will be further released. Moreover, lithium-ion batteries have become one of the world's major energy storage systems due to the high energy density, high power density and high efficiency. It has been widely used in various energy storage fields such as grid energy storage, household energy storage, and communication energy storage. With the continuous development of clean energy, distributed power grids, micro grids, electric vehicle charging piles and other industries, the market demand for lithium-ion batteries will further increase, promoting the application of graphite as well. Hence, under the energy conservation and environmental protection trend globally, the driving force for the demand in the lithium-ion battery market in the future will mainly come from transportation and industrial energy storage, thus boosting the fast and continuous growth of graphite industry.
- ***Emerging demand for expandable graphite***
  Expandable graphite is one of the fastest growing markets along with Lithium-ion batteries though its market size is quite small at present. It is produced by treating flake graphite with a dilute acid solution and heating it to cause the flakes to split apart, expand and increase hundreds of time in volume. This material is pressed into sheets which can be used in many applications including thermal management in consumer electronics, advanced building materials, heat and corrosion resistant gaskets, flow batteries and fuel cells which have the potential to consume as much graphite as all other uses combined in the future according to the USGS. In addition, expandable graphite is the only segment of graphite market to experience rising prices in recent years. The emerging commercial applications and unexpectable potential of expandable graphite is a new significant force to promote the development of graphite industry.

Source: Frost & Sullivan

China Graphite Industry Overview

Drivers and Trends (2/3)

2 Upgrading and Innovations of Mining and Producing Techniques

- ***Development of deep processing technologies for high-end products***
  With the constantly breakthroughs of deep processing technologies including chemical & thermal purification technology, coating technology, carbonization technology, etc., the mass-production and wide application of high-end graphite products including spherical graphite, expandable graphite, high-purity graphite, flexible graphite and graphene achievable in nearly future. For example, the chemical purification technology is applied to further purify the graphite concentrate to TGC (total graphitic carbon) 99.99%, used for producing high-tech products such as fuel cells which require higher purity than typically upgraded by flotation. In order to get ultra-high purity graphite, the fine intergrown minerals residing between the graphite layers have to be removed, which can be achieved by one or multi-stage acid washing with different acids or combinations. An alternative to acid treatment is thermal purification by heating the graphite above 2,000° C. High-end graphite products has become indispensable key materials in the fields of aerospace, nuclear, new energy cars, energy storage, nuclear, environmental protection, new materials and other strategic emerging industries. The industrialization and successful applications of graphene is once again pushing up the strategic position of the graphite. The modern high-end deep processing of graphite will be of significance in promoting the upgrading of China graphite industry, as well as one of the most important means of China graphite manufacturers into the global market.

- ***Improvement of graphite mining technology***
  During the graphite mining process, the use of automation, IoT and underground-drones for 3D mapping are gaining popularity, which brings higher levels of safety, improvements in performance and productivity, and reducing costs of mining. The application of equipment with high degree of autonomy and efficiency for the roughening and flotation of graphite facilitates the beneficiation of high carbon content graphite flakes without severe damage to graphite crystals. Moreover, IoT allows machineries to become smarter and more productive through the use of sensors, and also facilitates time savings, safer mining, predictive maintenance, and other benefits related to automation, energy and costs. In addition, 3D maps of graphite mines enable engineers and designers to plan the layout and action plan before setting foot on the mine, resulting in short gestation periods. 3D maps of graphite mines are obtained by deploying underground-mapping drones with onboard sensors that scan the surroundings of the mines and build a schematic 3D map. In addition to 3D mapping, sensors on underground-mapping drones can also be used to monitor fluid levels, temperatures and vibrations at mines, resulting in timely maintenance based on the evidence rather than waiting for planned routine operations.

Source: Frost & Sullivan

China Graphite Industry Overview

Drivers and Trends (3/3)

3 Favourable Policy Environment

- ***More scientific and comprehensive regulation system of graphite industry***
  Recently, China has been making efforts on improving and upgrading graphite industry by establishing a regulation basis. The "Graphite Industry Specification Conditions"《石墨行业规范条件》 issued by the Ministry of Industry and Information Technology in July 2020 put forward higher requirements for graphite industry in terms of processing technology, product quality, and resource protection. With the improvement of the strategic position of graphite resources, the graphite industry chain is facing a trend of integration and upgrading. At present, the domestic graphite industry is still in a state of low-end and disorderly development, and the supply of low-end products exceeds demand. The introduction of new regulations is expected to drive the industry to shift to high value-added products and technological innovation-driven transformation. In addition, the project of "the Key Technology and Demonstration of Reduction of Graphite Resources from the Mining and Processing Source" 《石墨资源开采加工源头减量关键技术与示范》was successfully approved by Ministry of Science and Technology. The project focuses on conquering bottlenecks of deep processing technologies, puts forward the solutions and technical routes to produce high-end graphite products, and is expected to improve the technology ability of utlising and recycling graphite solid waste.

- ***Supportive initiatives for graphite downstream industries***
  Graphite and cutting-edge graphene materials are widely used in many fields such as the new generation of information technology, energy-saving and new energy vehicles, power equipment, new materials, etc., which are the key development fields promoted by "Made in China 2025"《中国制造2025》. According to the newly issued "Electric Vehicle Industry Development Plan (2021-2035)"(新能源汽车产业发展规划（2021—2035年）) in November 2020, major breakthroughs in key technologies such as power batteries, drive motors and vehicle operating systems are expected to be made by 2025. Driven by policy stimulus and technology progress, the market space for the application of graphite in the field of electric vehicle will be further released. In addition, China also promogulated a series of policies supporting the development of graphene industry, including "Several Opinions on Accelerating the Innovation and Development of the Graphene Industry"《关于加快石墨烯产业创新发展的若干意见》, "Guide to the Development of New Materials Industry"《新材料产业发展指南》 "Guiding Catalogue for the First Batch Application Demonstration of Key New Materials (2019 Edition)" 《重点新材料首批次应用示范指导目录(2019年版)》, etc. These policies have established the important strategic position of graphene in the fields of electrochemical energy storage, marine engineering, flexible electronic devices, major environmental protection technology and equipment, automobiles, and aerospace industries.

Source: Frost & Sullivan

China Graphite Industry Overview

Policies and Regulations

Regulations	Issuing year	Description
Graphite Industry Code Conditions 《石墨行业规范条件》	2020	The government encourages the use of energy saving and environmental protection technology such as more crushing and less grinding, short flow grinding and floating, and encourages the use of advanced equipment such as large crushing and grinding equipment, large vertical mill, aerated mixing flotation machine, automatic plate and frame filter press, calendar with desulfurization function, so as to improve the level of automation and intelligence.
Guiding Opinions on Coordinating the Reform of the Property Rights System of Natural Resource Assets 《关于统筹推进自然资源资产产权制度改革的指导意见》	2019	In the Opinions, it is proposed to improve the property right system of natural resources, and set the validity period and extension period of mining rights according to the size of mineral resources reserves. The mortgage rights of mining rights shall be clarified in accordance with the law, and the mechanism for linking the right of exploration and mining with the right to use land and sea areas shall be improved.
Heilongjiang Provincial Government Work Report 2018 《黑龙江政府工作报告》	2018	Promote the development of emerging industries such as biomedicine, cloud computing, robotics and clean energy equipment. Promote the construction of graphite production bases in Jixi, Qitaihe and Hegang.
About the Issuance of Mineral Resources Rights and Interests Fund System Notice of the Reform Plan 《关于印发矿产资源权益金制度改革方案的通知》	2017	The notice proposed to organize and implement resource tax reform in the mining sector. The notice required that mineral resource compensation fees should be included in the resource tax. And all kinds of illegally established fees and fee funds should be banned in the future. In the link of mine environmental governance and restoration, the deposit for mine environmental governance and restoration shall be adjusted into the fund for mine environmental governance and restoration.
Guiding Opinions on Promoting Energy Storage Technology and Industrial Development 《关于促进储能技术与产业发展的指导意见》	2017	Focusing on a number of key core energy storage technologies and materials. Focusing on the overall goal of low cost, long life, high safety and high energy density, the research on energy storage principle and key materials, units, modules, systems and recycling technology will be carried out, and the test analysis and simulation of energy storage materials and devices will be developed.
Opinions of the People's Government of Heilongjiang Province on Promoting the Exploitation and Industrialisation of Mineral Resources 《黑龙江省人民政府关于推动矿产资源开发和产业化发展的意见》	2016	In the opinion, it is proposed to speed up the pace of intensive and deep processing of important advantageous resources for large and super large key mines with graphite, molybdenum, copper, iron, coal and other key advantageous resources and reserves. The mining right is determined through the integrated bidding of mineral resources and industrial deep processing project jointly organized by Heilongjiang Provincial Development and Reform Commission and Heilongjiang Provincial Department of Land and Resources.
Measures for the Administration of Registration of Mining of Mineral Resources 《矿产资源开采登记管理办法》	2014	To strengthen the management of mineral resources exploitation, protect the legitimate rights and interests of mining rights holders, maintain the order of mineral resources exploitation, and promote the mining industry's development, these measures are formulated under the Mineral Resources Law of the people's Republic of China.

Source: Frost & Sullivan

China Graphite Industry Overview

Average Selling Price of Major Products of Flake Graphite Concentrate and Spherical Graphite

Average Selling Price of Major Products of Flake Graphite Concentrate and Spherical Graphite (China), 2019-2021E

	2019 ASP (Thousand RMB/tonne)	2020 ASP (Thousand RMB/tonne)	2021 ASP (Thousand RMB/tonne)
flake graphite concentrate			
194	*3.7*	*3.6*	*3.8*
195	*4.1*	*4.0*	*4.1*
196	*4.4*	*4.4*	*4.5*
spherical graphite			
SG-10	*19.2*	*18.0*	*17.8*
SG-9	*15.4*	*13.4*	*14.3*

Note: The SG-9 products above refer to the spherical graphite products that have not been purified.

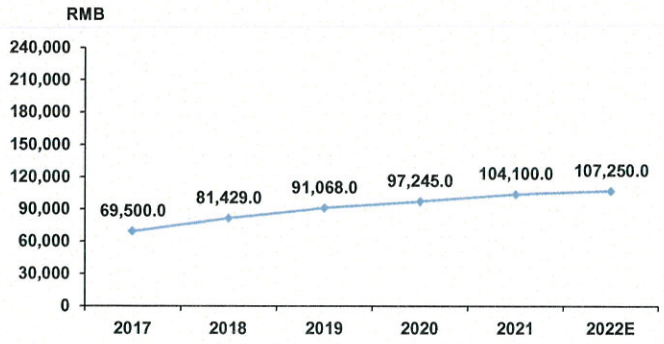
- Flake graphite concentrates are normally classified by different carbon content specification. Flake graphite concentrates with different carbon concentrations are applied in different areas. Spherical graphite is usually classified by different size. The average selling prices of flake graphite concentrate and spherical graphite may vary by different specification and generally influenced by factors such as production costs, market demands and macro economy. From 2018, many Chinese spherical graphite companies began to expand the spherical production capacity, which resulted in the decrease in the average selling price of spherical graphite in 2019 and 2020. Going forward, with the recovery of economy and continuously increasing demand from lithium-ion batteries industry, the demand of graphite would increase, which in turn would drive the average selling price of flake graphite concentrate and spherical graphite.

Source: Frost & Sullivan

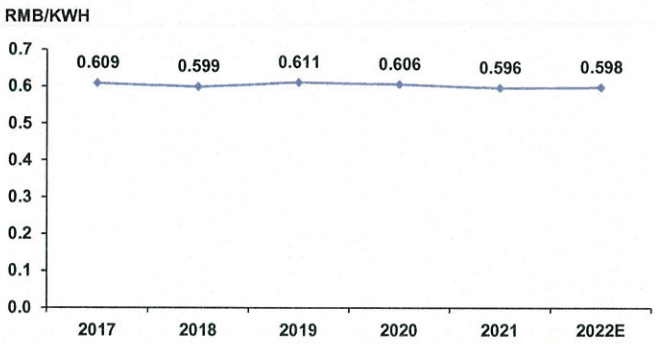
China Graphite Industry Overview

Average Annual Wage of Workers and Average Selling Price of Electricity in Graphite Industry

Average Annual Wage of Workers in Graphite Industry (China), 2017-2022E



Average Selling Price of Electricity in China, 2017-2022E



Labour

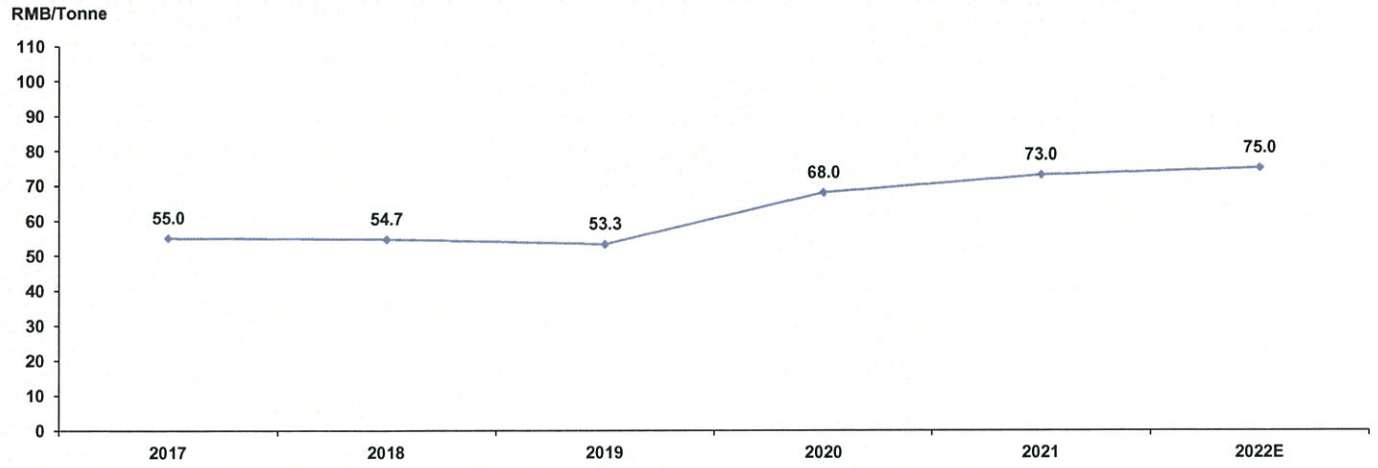
- Labour cost is considered as one of the key cost components comparing to other operational costs for graphite industry in China. The average annual wages of workers in graphite industry in China increased from approximately RMB69,500 in 2017 to approximately RMB104,100 in 2021, representing a CAGR of approximately 10.6%.
- From 2017 to 2021, the CAGR of average annual wage of workers in graphite industry was slightly higher than the average level in China, mainly due to the transformation in the mining and graphite industry. The promulgation of environmental protection policies and frequent inspections from government have accelerated the transformation of many graphite manufacturers and promoted the improvement of the graphite mining technology. The use of automation, IoT and underground-drones for 3D mapping are gaining popularity, which brings higher levels of safety, improvements in performance and productivity, and reducing costs of mining. Also, many graphite manufacturers have introduced sophisticated regulation to manage the environmental protection issue. This trend brought positive development for major graphite manufacturers and thus the average annual wage of workers in graphite industry is expected to continuously increase.
- The average selling price of electricity in China was approximately RMB0.596 per KWH in 2021. Going forward, the average selling price of electricity is expected to decrease as provincial governments are continuously improving business environments for companies and reducing electricity costs. The average selling price of electricity is expected to drop to approximately RMB0.598 per KWH in 2022.

Source: Frost & Sullivan

China Graphite Industry Overview

Average Price of Unprocessed Graphite in China

Average Price of Unprocessed Graphite (China), 2017-2022E



- The price of unprocessed graphite maintained stable from 2017 to 2019. In 2019, the average price of unprocessed graphite in China reached approximately RMB53.3 per tonne. Due to the impact of COVID-19 and increasing demand, the average price of unprocessed graphite increased to approximately RMB73.0 per tonne in 2021. Going forward, with the recovery of the economy, the average price of unprocessed graphite would maintain at a stable level.

Source: Frost & Sullivan

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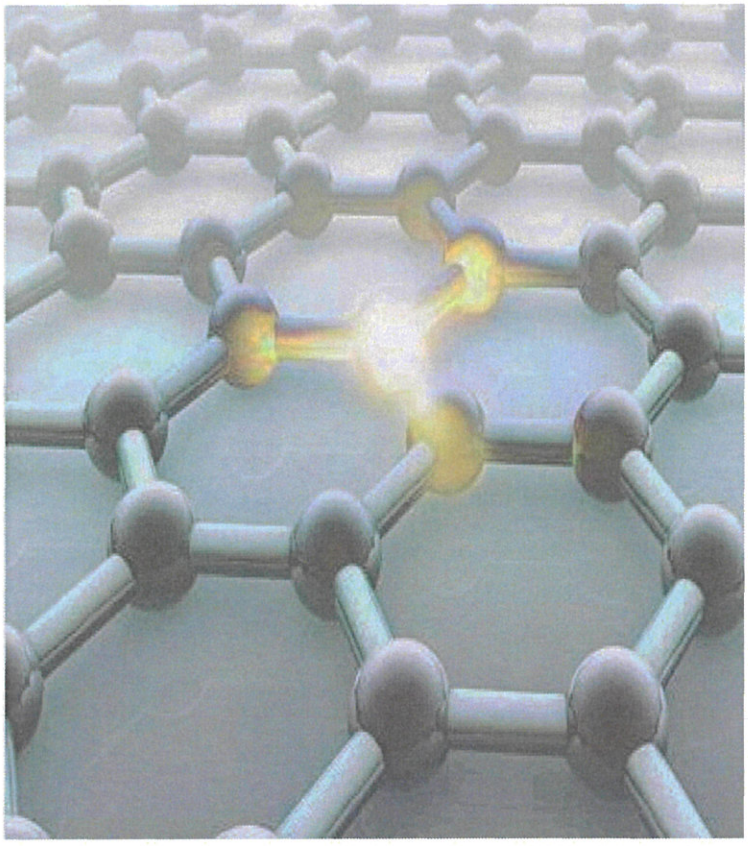
Agenda



Competitive Landscape Analysis

Ranking of Top Ten Companies by Sales Revenue in Flake Graphite Concentrate Industry

Top Ten Companies by Sales Revenue in Flake Graphite Concentrate Industry (China), 2021

Ranking	Company	Sales Revenue of Flake Graphite Concentrate (Million RMB)	Market Share
1	Qingdao Haida Graphite Co., Ltd.	228.0	10.2%
2	Jixi Northeast Asia Mineral Resources Co., Ltd	215.0	9.6%
3	Jixi Changyuan Mining Co., Ltd	165.0	7.4%
4	Ulanqab Darsen Graphite New Material Co., Ltd.	134.0	6.0%
5	China Graphite Group Limited	97.7	4.4%
6	Jixi Puchen Graphite Co., Ltd	72.0	3.2%
7	Jixi Jinhuafeng Graphite Manufacturing Co., Ltd	67.0	3.0%
8	Luobei Aoxing New Material Co., Ltd	51.0	2.3%
9	Jixi Fenglu Graphite Co., Ltd	45.0	2.0%
10	Luobei Xinlongyuan Graphite Products Co., Ltd	39.0	1.7%

- In 2021, the sales revenue of flake graphite concentrate in China reached RMB2,238.5 million. China flake graphite concentrate industry was concentrated with top ten companies accounting a total market share of 49.8% by sales revenue in 2021. There were over 120 participants in China's flake graphite concentrate industry in 2021. The flake graphite concentrate sales revenue of China Graphite Group Limited was approximately RMB97.7 million in 2021, ranking the fifth among such market participants and accounting for a market share of 4.4% of total flake graphite concentrate industry by sales revenue.
- Due to the advantages of graphite reserve in Heilongjiang Province, the graphite industry represented a promising prospect with over 50% of flake graphite concentrate market participants concentrated in Heilongjiang Province.

Source: Frost & Sullivan

Competitive Landscape Analysis

Ranking of Top Ten Companies by Sales Revenue in Flake Graphite Concentrate Industry

Top Ten Companies by Sales Revenue in Flake Graphite Concentrate Industry (China), 2021

Ranking	Company	Sales Revenue of Flake Graphite Concentrate (Million RMB)	Market Share
1	Company A	228.0	10.2%
2	Company B	215.0	9.6%
3	Company C	165.0	7.4%
4	Company D	134.0	6.0%
5	Our Group	97.7	4.4%
6	Company E	72.0	3.2%
7	Company F	67.0	3.0%
8	Company G	51.0	2.3%
9	Company H	45.0	2.0%
10	Company I	39.0	1.7%

- In 2021, the sales revenue of flake graphite concentrate in China reached RMB2,238.5 million. China flake graphite concentrate industry was concentrated with top ten companies accounting a total market share of 49.8% by sales revenue in 2021. The flake graphite concentrate sales revenue of China Graphite Group Limited was approximately RMB97.7 million in 2021, ranking the fifth among such market participants and accounting for a market share of 4.4% of total flake graphite concentrate industry by sales revenue.

Source: Frost & Sullivan

Competitive Landscape Analysis

Principal Business

Company	Company Name	Principal Business
Company A	Qingdao Haida Graphite Co., Ltd. 青岛海达石墨有限公司	The company is an unlisted Chinese company established in 1988, which primarily engages in the production of flake graphite concentrate, high-carbon graphite, high-purity graphite, and spherical graphite. The company has graphite production lines with innovative technological process.
Company B	Jixi Northeast Asia Mineral Resources Co., Ltd 鸡西东北亚矿产资源有限公司	The company is an unlisted Chinese company established in 2011, which primarily engages in the production of flake graphite concentrate, high-carbon graphite, and medium-carbon graphite.
Company C	Jixi Changyuan Mining Co., Ltd 鸡西长源矿业有限公司	The company is an unlisted Chinese company established in 2011, which mainly engages in the production of flake graphite concentrate and artificial graphite. It is indirectly owned by BTR New Material Group Co. Ltd.* (贝特瑞新材料集团股份有限公司). Headquartered in Shenzhen, China, BTR New Material Group Co., Ltd.* (贝特瑞新材料集团股份有限公司) has been listed on the National Equities Exchange and Quotations since 2015.
Company D	Ulanqab Darsen Graphite New Material Co., Ltd. 乌兰察布市大盛石墨新材料股份有限公司	The company is an unlisted Chinese company established in 2012, which mainly engages in the production of flake graphite concentrate and spherical graphite. Relying on its rich graphite mineral resources, strong technical advantages and superior production conditions, the company has established a unique development model of the entire industry chain of graphite deep processing.
Company E	Jixi Puchen Graphite Co., Ltd 鸡西市普晨石墨有限责任公司	The company is an unlisted Chinese company established in 2004, which primarily engages in the production of flake graphite concentrate. The company owns mining rights and is rich in graphite resources. It is one of the high-quality graphite production enterprises in Heilongjiang Province.
Company F	Jixi Jinhuafeng Graphite Manufacturing Co., Ltd 鸡西市金华丰石墨制造有限公司	The company is an unlisted Chinese company established in 2006, which primarily engages in the production of flake graphite concentrate and other graphite products.
Company G	Luobei Aoxing New Material Co., Ltd 萝北奥星新材料有限公司	The company is an unlisted Chinese company established in 2011, which primarily engages in the production of flake graphite concentrate and other graphite products. It is a Sino-foreign joint venture of graphite deep processing integrating R&D, production and sales.
Company H	Jixi Fenglu Graphite Co., Ltd 鸡西市丰禄石墨有限责任公司	The company is an unlisted Chinese company established in 1999, which mainly engages in the production of flake graphite concentrate.
Company I	Luobei Xinlongyuan Graphite Products Co., Ltd 萝北县鑫隆源石墨制品有限公司	The company an unlisted Chinese company established in 2008, which mainly engages in the production of flake graphite concentrate.

Source: Official Website, Frost & Sullivan

Competitive Landscape Analysis

Ranking of Top Ten Companies by Sales Revenue in Spherical Graphite Industry

Top Ten Companies by Sales Revenue in Spherical Graphite Industry (China), 2021

Ranking	Company	Sales Revenue of Spherical Graphite (Million RMB)	Market Share
1	Qingdao Haida Graphite Co., Ltd	400.0	18.0%
2	Qingdao Guangxing Electronic Materials Co., Ltd	315.0	14.2%
3	Qingdao GR-TAIDA Carbon Co., Ltd	240.0	10.8%
4	Zhanjiang Juxin New Energy Co., Ltd	155.0	7.0%
5	Graphex Group Limited	130.0	5.8%
6	China Graphite Group Limited	90.3	4.1%
7	Qingdao Qingbei Carbon Co., Ltd	75.0	3.4%
8	Qingdao Taihelong New Energy Co., Ltd	55.0	2.5%
9	Ulanqab Darsen Graphite New Material Co., Ltd.	50.0	2.2%
10	Qingdao Black Dragon Graphite Co., Ltd.	45.0	2.0%

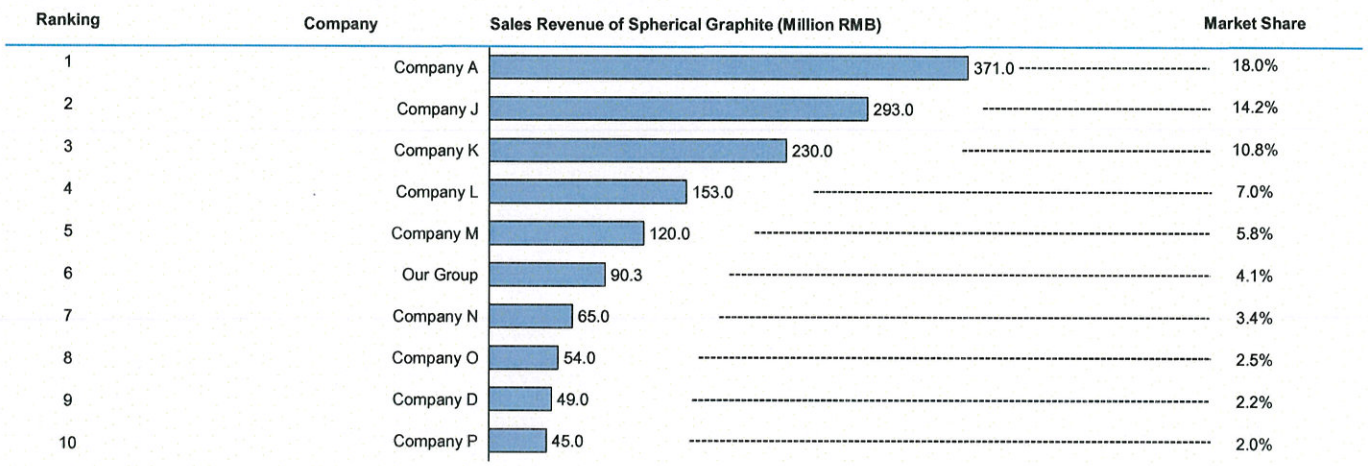
- In 2021, the sales revenue of spherical graphite in China reached RMB2,223.0 million. China spherical graphite industry was concentrated with top ten companies accounting a total market share of 70.0% by sales revenue in 2021. There were over 60 participants in China's spherical graphite industry in 2021.China Graphite Group Limited ranked as the No.6 in 2021 with a market share of 4.1% by sales revenue.

Source: Frost & Sullivan

Competitive Landscape Analysis

Ranking of Top Ten Companies by Sales Revenue in Spherical Graphite Industry

Top Ten Companies by Sales Revenue in Spherical Graphite Industry (China), 2021



- In 2021, the sales revenue of spherical graphite in China reached RMB2,223.0 million. China spherical graphite industry was concentrated with top ten companies accounting a total market share of 70.0% by sales revenue in 2021. Our group ranked as the No.6 in 2021 with a market share of 4.1% by sales revenue.

Source: Frost & Sullivan

Competitive Landscape Analysis

Principal Business

Company	Company Name	Principal Business
Company J	Qingdao Guangxing Electronic Materials Co., Ltd 青岛广星电子材料有限公司	The company is an unlisted Chinese company established in 2010, which primarily engages in the production of spherical graphite and flake graphite concentrate. It is a comprehensive graphite material supplier serving global customers. Its products are used in mercury-free alkaline batteries, power batteries, lithium-ion batteries, nickel-hydrogen batteries and nanomaterials.
Company K	Qingdao GR-TAIDA Carbon Co., Ltd 青岛泰达天润碳材料有限公司	The company is an unlisted Chinese company established in 2003, which primarily engages in the production of spherical graphite and other graphite products. Products have been exported to South Korea, Japan, the United States, Italy, Britain, Germany, India, South Africa and Southeast Asia.
Company L	Zhanjiang Juxin New Energy Co., Ltd 湛江市聚鑫新能源有限公司	The company is an unlisted Chinese company established in 2006, which mainly engages in the production of spherical graphite.
Company M	Graphex Group Limited 烯石电动汽车新材料控股有限公司	The company is a Hong Kong listed company HKEx Stock Code: 6128) established in 2013, which primarily engaged in the development, production and sale of graphene products. It also focuses on the research and development of renewable energy.
Company N	Qingdao Qingbei Carbon Co., Ltd 青岛青北碳素制品有限公司	The company is an unlisted Chinese company established in 2014, which mainly engages in the production of spherical graphite..
Company O	Qingdao Taihelong New Energy Co., Ltd 青岛泰和隆新能源材料有限公司	The Company is an unlisted Chinese company established in 2009, which mainly engages in the production of spherical graphite.
Company P	Qingdao Black Dragon Graphite Co., Ltd. 青岛黑龙石墨有限公司	The company is an unlisted Chinese company established in 1996, which mainly engages in the production of spherical graphite, high-carbon graphite, high purity graphite and micro-powder graphite. The company focuses on research and development and has established long-term cooperative relations with many leading research institutions at home and abroad.

Source: Official Website, Frost & Sullivan

Competitive Landscape Analysis

Company Profiles of Top Ten Companies in Flake Graphite Concentrate Industry (1/2)

No.	Company Name	Listed or Unlisted	Established Year	Business Introduction
1	Qingdao Haida Graphite Co., Ltd.	Unlisted	1988	Founded in 1988, the company covers an area of 160,000 square meters, has more than 300 employees, including more than 80 senior and intermediate technical personnel. The company has advanced graphite production process. At the same time, the company has domestic first-class production line of expansion graphite and flexible graphite sheet.
2	Jixi Northeast Asia Mineral Resources Co., Ltd	Unlisted	2011	The parent company is PRIDE, which is mainly engaged in natural graphite fine powder, spherical graphite and anode materials. It is a new material enterprise integrating deep processing of graphite, such as graphite mining and selection, anode materials for lithium-ion battery and graphene.
3	Jixi Changyuan Mining Co., Ltd	Unlisted	2011	The ore section owned by the company is a part of Liumao graphite deposit, the largest natural flake graphite deposit in Asia, with an area of 0.5765 square kilometers and a reserve of 21.74 million tons of graphite ore. It is a modern enterprise integrating graphite mining and selection.
4	Ulanqab Darsen Graphite New Material Co., Ltd.	Unlisted	2012	The company is a comprehensive new material high-tech enterprise integrating natural graphite mining, product R & D, production, sales and application technical services. At present, the company's products basically cover all fields of deep processing of natural graphite.
5	China Graphite Group Limited	Unlisted	2006	The company flake graphite concentrate product includes Models 194 (indicating a carbon content equal or above 94% and under 95%), 195 (indicating a carbon content equal or above 95% and under 96%) and196 (indicating a carbon content equal or above 96% and under 96.8%). The company is one of the largest graphite companies with vertically integrated supply chain in Luobei County, Heilongjiang Province, which is one of the largest graphite production centers in PRC. The main manufacturing and transport hubs for graphite products are located in the regions of Shandong, Dashiqiao, Jiangzhe, Henan and Liaoning.

Source: Frost & Sullivan

Competitive Landscape Analysis

Company Profiles of Top Ten Companies in Flake Graphite Concentrate Industry (2/2)

No.	Company Name	Listed or Unlisted	Established Year	Business Introduction
6	Jixi Jinhuafeng Graphite Manufacturing Co., Ltd	Unlisted	2006	The company was founded in 2006, mainly engaged in graphite products manufacturing, has a professional sales and technical team.
7	Jixi Puchen Graphite Co., Ltd	Unlisted	2004	The company has mining rights, rich in graphite resources, mainly engaged in the production and deep processing of natural flakes, with three graphite production lines, annual production of high carbon graphite 45,000 tonnes.
8	Luobei Aoxing New Material Co., Ltd	Unlisted	2011	The company's business includes manufacturing, selling graphite and carbon products. It has a lithium battery materials research and development laboratory, and has authorized 1 invention patent and 26 utility model patents.
9	Jixi Fenglu Graphite Co., Ltd	Unlisted	1999	The company is a large natural flake graphite concentrate mining enterprises. With an ore reserve of 350 million tonnes, it can produce high purity graphite, high carbon graphite, medium carbon graphite, expandable graphite, natural graphite electrode and other products, with an annual production capacity of 20,000 tonnes.
10	Luobei Xinlongyuan Graphite Products Co., Ltd	Unlisted	2008	The company was established in 2008, mainly engaged in graphite and carbon products manufacturing and machinery and equipment leasing.

Source: Frost & Sullivan

Competitive Landscape Analysis

Company Profiles of Top Ten Companies in Spherical Graphite Industry (1/2)

No.	Company Name	Listed or Unlisted	Established Year	Business Introduction
1	Qingdao Haida Graphite Co., Ltd.	Unlisted	1988	Founded in 1988, the company covers an area of 160,000 square meters, has more than 300 employees, including more than 80 senior and intermediate technical personnel. The company has advanced graphite production process. At the same time, the company has domestic first-class production line of expansion graphite and flexible graphite sheet.
2	Qingdao Guangxing Electronic Materials Co., Ltd.,	Unlisted	2010	The company is a comprehensive graphite material supplier integrating mining - flotation - spherical graphite, high purity graphite deep processing in one complete industrial chain. The products are widely used in mercury-free alkaline batteries, power batteries, lithium ion batteries, nickel metal hydride batteries and other fields.
3	Qingdao GR-TAIDA Carbon Co.,Ltd	Unlisted	2003	The company is a high-tech enterprise which integrates the research and development, production and sales of graphite conventional products and graphite application new carbon materials products, and has the import and export rights.
4	Zhanjiang Juxin New Energy Co., Ltd	Unlisted	2006	The company was founded in 2006, which is mainly engaged in the production of spherical graphite, lithium ion battery anode materials, power battery anode materials and carburizing agent.
5	Graphex Group Limited	Listed	2013	The company is engaged in the development, production and sale of graphene products. The Company offers spherical and micronized graphite for electric vehicle batteries.

Source: Frost & Sullivan

Competitive Landscape Analysis

Company Profiles of Top Ten Companies in Spherical Graphite Industry (2/2)

No.	Company Name	Listed or Unlisted	Established Year	Business Introduction
6	China Graphite Group Limited	Unlisted	2006	The company's products include graphite flakes concentrate, spherical graphite, modified natural graphite, high purity graphite and micro powder graphite. In 2018, company acquired the mining rights of graphite mine located at Yanjun Farm, approximately 28 km northwest of the county of Luobei in Heilongjiang Province (the "Beishan Mine"). The company is capable of producing spherical graphite with a size smaller than 10μm when the most available spherical graphite in the market ranged between 14 and 25μm.
7	Qingdao Qingbei Carbon Co., Ltd	Unlisted	2014	The company's business include Carbon products, lithium battery anode materials, graphite products processing and sales, graphite sales
8	Qingdao Taihelong New Energy Co, Ltd	Unlisted	2009	The company's business scope includes graphite and graphite products processing and sales (excluding mining); Import and export of goods.
9	Ulanqab Darsen Graphite New Material Co., Ltd.	Unlisted	2012	Darsen Graphite is a comprehensive new material high-tech enterprise engaging in natural graphite mining, developing, manufacturing, and marketing of graphite products and services.
10	Qingdao Black Dragon Graphite Co., Ltd.	Unlisted	1996	The company focuses mining and deep processing of products industry chain, and high carbon purification production that have built wastewater recycling technology system. After several years of equipment renewal and transformation, the number of employees has been successfully controlled at about 668.

Source: Frost & Sullivan

Competitive Landscape Analysis

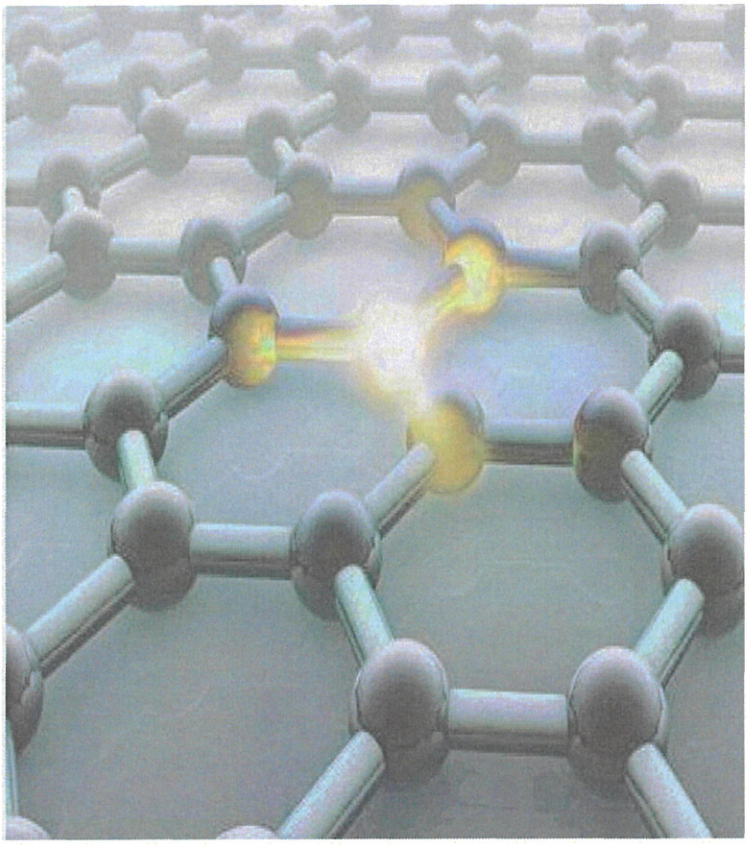
Key Success Factors of Graphite Industry

Key Success Factors of Graphite Industry in China

Advanced production techniques	• Advanced production techniques are one of the core competitive advantages for the graphite. With the rapid development of the electronic products and electric vehicles, the downstream manufacturers put forward higher requirements for the performance and technology of graphite materials and products. Therefore, it drives graphite suppliers to speed up technological innovation and continuously develop high-performance products.
Experienced and suitable human resources	• Experienced and suitable human resources is a key competitive advantage in the graphite market. Certain skills and expertise which can only be acquired through specific training are required for some business. Moreover, the high-calibre talents with extensive industry knowledge and rich experience play an important role in the successful operation of the graphite industry. The experts with extensive industry knowledge and professional management team with rich experience bring excellent competitive advantages to the leading enterprises. Being able to acquire and maintain talents is important for enterprises in graphite industry.
Sufficient capital	• In the graphite market in China, significant capital is necessary for the initial investment in land, machineries, vehicles and utilities, etc. The graphite manufacturing needs a large amount of initial capital for the procurement of upstream primary graphite, the construction of manufacturing factories as well as the purchase or installation of machineries in order to produce various graphite materials and products. Additionally, the maintenance of machineries and recruitment of experienced talents also require sufficient capital, so as to ensure a stable operation of business, thus forming a competitive edge to market participants. Therefore, company fulfilling above requirements are more likely to gain a sustained and continuous growth in the market competition.

Source: Frost & Sullivan

Agenda



Appendix 1

- Graphite has become an important strategic resource in the world as it is widely used in many industries and further promotes the development of national economy. However, graphite in nature contains many impurities, which makes it difficult to be used directly. Therefore, the graphite needs to be purified before used in the downstream markets. Graphite flakes with different carbon concentrations are applied in different areas. For instance, graphite flakes with carbon content mainly between 94% and 98% are used for the production of the heat resistant magnesia carbon brick and other heat resistant materials. Moreover, spherical graphite is mainly manufactured from high carbon content graphite flakes, which can be used for anode materials and batteries in computers, mobile devices and electric vehicles. The production of graphite flakes with high carbon concentrations normally requires advanced purification techniques and equipment, which poses a higher technique barrier to the new entrants.
- Spherical graphite is a niche technology contributing to the ongoing energy storage revolution by accelerating the performance of lithium-ion batteries.
- The seasonality plays an important role in the production volume. Despite the general shut down among industry players, market demand would not experience a severe drop, thus there would always be demand for graphite products during these winter months.
- A supply of unprocessed graphite with a lower carbon content, in general, may result in uncertain production costs, varying qualities, unstable delivery and more costly beneficiation processes. Such difficulties may faced by the leading players in graphite industry.
- There had been a drop in the overall market price for spherical graphite and flake graphite concentrate during the months of the COVID-19 outbreak.
- China Graphite Group Limited is one of the largest graphite companies in Luobei County, Heilongjiang Province, and one of the few companies in the PRC, with a vertically integrated supply chain linking a graphite processing operations to a graphite mine.
- China Graphite Group Limited is one of the largest graphite companies in Luobei County, and one of the largest graphite companies in the PRC, engaged in the sale of graphite products and with a vertically integrated supply chain linking a graphite processing operations to a graphite mine.
- It is not uncommon that the customers in the graphite industry will usually settle their debts with 3 to 6 months maturity bills receivables when their amount was due.

Appendix 2

- The insurance of graphite mining companies normally covers employer responsibility insurance, employee life insurance premium, safe production for mining production responsibility insurance and third party liability insurance, which are sufficient to insure against the operation hazards and environmental damages in mining business.
- The favorable government policies and rich graphite resources in Heilongjiang Province would further drive the expansion and booming development of the graphite industry in Heilongjiang Province.
- It is not uncommon that no long-term sales agreement is entered into between company engaged in the sales of flake graphite concentrate and spherical graphite and its major customers in the PRC.
- SG-10 and other models of spherical graphite are mainly varied by different particle size and carbon content. The application of SG-10 is various in the field of NEVs and electrics.
- Shelf life is not applicable on products in graphite industry.
- In terms of payment in the graphite industry, it is not uncommon that trade receivables were settled by bank transfer bills issued by financial institutions or telegraphic transfer. Such bills normally have a maturity period between 180 and 365 days after the receiving date.
- It is not uncommon that the credit period in the sale of graphite industry is 90 days and the turnover days of trade receivables range from 90 to 180 days. It is not uncommon that graphite companies extend credit terms to their customers in the PRC.
- The most available size of spherical graphite in the market ranged between 14 and 25μm, accounted for over 50% of the total market. Whereas, spherical graphite with smaller size (including SG-10) may achieve higher charging and energy density when used in lithium-ion batteries.
- The beneficiation yield is calculated by dividing the output amount of beneficiated flake graphite concentrate by the input amount of unprocessed graphite of the respective year. The beneficiation yield of China Graphite Group Limited is in line with the industry average.
- This calculation of processing yield of spherical graphite is different to the calculation of beneficiation yield, as the processing processes are different from beneficiation processes. The processing yield of China Graphite Group Limited is in line with the industry average.

Appendix 3

- Since March 2020, Coal prices have risen sharply. As a large percentage of coal is used for power, many enterprises had to reduce power generation to save costs. Many provinces releases relevant policies to adjust the market-based transaction prices of electricity. The "Key Points of Energy Supervision Work in 2022" issued by the National Energy Administration proposed that it is necessary to continuously improve the level of energy marketization system construction, and further promote the improvement of the marketization mechanism of coal power prices and expand the range of market transaction electricity price floating.

- TR New Material Group Co., Ltd. (貝特瑞新材料 集團股份有限公司) and its certain subsidiaries (the "BTR Group"), Qingdao Longdi Carbon Technology Co., Ltd.* (青島龍迪碳材料科技有限公司) and Dashiqiao Guancheng Refractory Co., Ltd. (大石橋市冠誠耐火材料有限公司) used the graphite products as such: (i) in the case of flake graphite concentrate, primarily in manufacturing refractory bulk materials, converter magnesia carbon bricks and other heat-resistant products; (ii) in the case of spherical graphite, primarily in manufacturing of anode materials for lithium-ion batteries for electronic devices and NEVs, the products of which are sold to the PRC and overseas markets; and (iii) in the case of micro-graphite poder and high-purity graphite power, in manufacturing of electric carbon products, fertilizer catalysts, pencil leads, plastic composites, battery cells, electrical glue and silicon carbide.

- The beneficiation yield of flake graphite concentrate of comparable carbon content specifications of type 194, 195 and 196 normally ranges from 5%–10% in the flake graphite concentrate industry.

- The processing yield of spherical graphite of comparable carbon content specification of SG-10 normally ranges from 35%–40% in the spherical graphite industry.

- In order to gain insights about the operating cash costs (per tonne) of extracting unprocessed graphite from open-pit graphite mine in the PRC, Frost & Sullivan has conducted both primary research and secondary research. Primary research involved in-depth interviews with market players among the value chain of the graphite industry and industry experts from Heilongjiang Graphite Industry Association (黑龙江石墨产业协会) and so on. Secondary research involved analysing data from Frost & Sullivan's internal database and various publicly available data sources, including public announcements and information from the government agencies such as the Department of Natural Resources. Based on the researches of Frost & Sullivan, the operating cash costs (per tonne) of extracting unprocessed graphite from open-pit graphite mine in the PRC mostly ranges from around RMB15 per tonne to around RMB40 per tonne.

- Due to the high reserve level of the Yunshan graphite mine and its close proximity to the processing plants of China Graphite Group Limited in Luobei County, Heilongjiang Province, the Yunshan graphite mine can continually offer stable supply of quality unprocessed graphite within reasonable costs and transportation time. Therefore, it is reasonable that the Yunshan graphite mine could enjoy the advantage and bargaining power in determining the selling price of unprocessed graphite.

Appendix 4

- Clean technology of spherical graphite is the continuous application of the integrated preventive environmental strategy to operate and manufacture in order to reduce risk to human beings and the workplace environment.

- Leading graphite providers are committed to adopt the sustainable and safe production procedure of spherical graphite for green energy and clean technologies.

- With the rapid development of Chinese economy and increasing downstream demand, especially the expansion of new material industries such as lithium-ion batteries, the use of lithium-ion batteries in vehicles and consumer electronic products will witness a rapid growth. Therefore, the demand for flake graphite concentrate as the main material of lithium-ion batteries will increase. Besides, the demand from steel industry would further drive the production volume of flake graphite concentrate.

Research Methodologies

- Frost & Sullivan is an independent global market research and consulting firm, which was founded in 1961 in New York and has over 40 global offices with more than 2,000 industry consultants, market research analysts, technology analysts and economists. It offers industry research and market strategies and provides growth consulting and corporate training. Its industry coverage includes automotive and transportation, chemicals, materials and food, commercial aviation, consumer products, energy and power systems, environment and building technologies, healthcare, industrial automation and electronics, industrial and machinery, and technology, media and telecom.
- The Frost & Sullivan's report includes information on China graphite industry.
- Frost & Sullivan has conducted detailed primary research which involved discussing the status of the industry with certain leading industry participants and conducting interviews with relevant parties to obtain objective and factual data and prospective predictions. Frost & Sullivan has also conducted secondary research which involved reviewing official government publications, company reports, independent research reports and data based on its own research database. Frost & Sullivan has obtained the figures for the estimated total market size from historical data analysis plotted against macroeconomic data as well as considered the above-mentioned industry key drivers.
- Frost & Sullivan's Market Engineering Forecasting Methodology integrates several forecasting techniques with the Market Engineering Measurement-based System. It relies on the expertise of the analyst team in integrating the critical market elements investigated during the research phase of the project. These elements include:
  - ✓ Expert-opinion forecasting methodology
  - ✓ Integration of market drivers and restraints
  - ✓ Integration with the market challenges
  - ✓ Integration of the Market Engineering Measurement trends
  - ✓ Integration of econometric variables
- In compiling and preparing the Report, Frost & Sullivan has adopted the following assumptions:
  - ✓ The social, economic and political environment of China is likely to remain stable in the forecast period
  - ✓ Industry drivers are likely to drive graphite industry in China in the forecast period.