

# Survey of Titanium Dioxide in China in 2023

The Twelfth Edition

December 2023

**Researched & Prepared by:**

**Kcomber Inc.**

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## Executive summary

Recent years, China's titanium dioxide (TiO<sub>2</sub>) industry has been developing steadily. The period of 2020–2022 saw consecutive growth of TiO<sub>2</sub> capacity and output. In 2022, domestic TiO<sub>2</sub> capacity grew to 5.36 million t/a and the output came to about 3.85 million tonnes. With increasing concentration of the industry and manufacturers to obtain better production technology, it is estimated that TiO<sub>2</sub> production capacity in China will reach about 7 million t/a by 2027 and the output will approach 5 million tonnes.

So far, chloride process TiO<sub>2</sub> is at the initial stage in China, and sulphate process still dominates. Although some major domestic manufacturers have already built or are building chloride process projects, technical barriers, product quality and high cost of related facilities make the process unreachable to most producers. The upgrading of China's TiO<sub>2</sub> production techniques still has a long way to go.

The domestic price curve of TiO<sub>2</sub> in 2020–H1 2023 showed a "down-up-fluctuation-down" pattern. TiO<sub>2</sub> prices hit the bottom in June or July 2020, then followed an upward trend till June 2021. After nearly yearlong fluctuations at a relatively high level, the prices dropped dramatically in H2 2022, and then in H1 2023, the prices slightly rebounded and turned relatively stable.

With high foreign demand and the continuous improvement in quality of domestic TiO<sub>2</sub>, the exports kept strong in 2020–2022, and China exported nearly 1.41 million tonnes of TiO<sub>2</sub> in 2022, the volume expanding at a CAGR of 8.1% during 2020–2022. The import volume of TiO<sub>2</sub> to China fluctuated in the same period; in 2022, it shrank to some 123,000 tonnes.

As one of the largest TiO<sub>2</sub> consumers worldwide, China sees its consumption fluctuate in recent years. In 2020–2022, domestic TiO<sub>2</sub> consumption increased from 2.41 million tonnes to 2.65 million tonnes and then declined to 2.51 million tonnes. Coating, plastics and papermaking industries remain the largest downstream markets for TiO<sub>2</sub>, accounting for 59%, 18% and 13% of the total in 2022. It is expected that in the next five years, these three industries will continue to lead the way in TiO<sub>2</sub> consumption.

## **Methodology**

*Survey of Titanium Dioxide in China* is CCM's twelfth edition report on China's titanium dioxide industry, finished in Dec. 2023.

The report is drafted by diverse methods as follows:

### **1) Desk research**

The sources of desk research are various, including published magazines, journals, government statistics, industrial statistics, customs statistics, association seminars as well as information from the Internet. A lot of work has gone into compilation and analysis of the obtained information. Where necessary, checks have been made with Chinese suppliers regarding market information such as key producers, key end users, production, export and demand and so on.

### **2) Telephone interview**

CCM has carried out extensive telephone interviews in order to survey the actual market situation of titanium dioxide industry in China.

Interviewees cover:

- Key producers
- Key end users
- Key traders
- Material suppliers
- Some associations
- Experts

### **3) Site visit**

CCM has visited some industry experts in order to obtain the experts' thorough views and investment suggestion.

### **4) Network**

CCM adopts network to contact with players in this industry by B2B website and software.

### **5) Questionnaire**

In order to confirm some information and obtain more experts' views for China's titanium dioxide industry development trend, CCM adopts questionnaire for some key producers, end users, traders and experts.

## **Data processing and presentation**

The data collected and compiled were sourced from:

- CCM's ValoTracer database
- Published articles from periodicals, magazines and journals, the third database
- Statistics from governments and international institutes
- Telephone interviews with domestic producers, joint ventures, service suppliers, government
- Questionnaire
- Third-party data providers
- Custom statistics
- Comments from industrial experts
- Professional database from other sources
- Information from the Internet

The data from various sources have been combined and cross-checked to make this report as precise and scientific as possible. Throughout the process, a series of internal discussions took place in order to analyse the data and draw conclusions from it.

## **Unit**

RMB: currency unit in China, also called Yuan

USD: currency unit in the US

tonne: ton, equals to metric ton in this report

/t: per tonne

t/a: tonne/annum or tonne/year

## Glossary

CAGR: Compound annual growth rate

GDP: Gross domestic product

TiO<sub>2</sub>: Titanium dioxide

MIIT: Ministry of Industry and Information Technology of the People's Republic of China

CNCIA: China National Coatings Industry Association

MOFCOM: Ministry of Commerce of the People's Republic of China

SAT: State Administration of Taxation

GACC: General Administration of Customs of the People's Republic of China

NDRC: National Development and Reform Commission

NBS: National Bureau of Statistics

IPO: Initial public offering

REACH: Registration, Evaluation, Authorization and Restriction of Chemicals

USGS: United States Geological Survey

Table Exchange rate USD/CNY, Jan. 2020–Dec. 2023

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
2020	6.9614	6.9249	6.9811	7.0771	7.0690	7.1315	7.0710	6.9980	6.8498	6.7796	6.7050	6.5921	<b>6.9284</b>
2021	6.5408	6.4623	6.4754	6.5584	6.4895	6.3572	6.4709	6.4660	6.4680	6.4604	6.4192	6.3693	<b>6.4615</b>
2022	6.3794	6.3580	6.3014	6.3509	6.5672	6.6651	6.6863	6.7467	6.8821	7.0992	7.2081	7.1225	<b>6.6972</b>
2023	6.9475	6.7492	6.9400	6.8805	6.9054	7.0965	7.2157	7.1283	7.1788	7.1789	7.1778	7.1104	<b>7.0424</b>

Source: The People's Bank of China

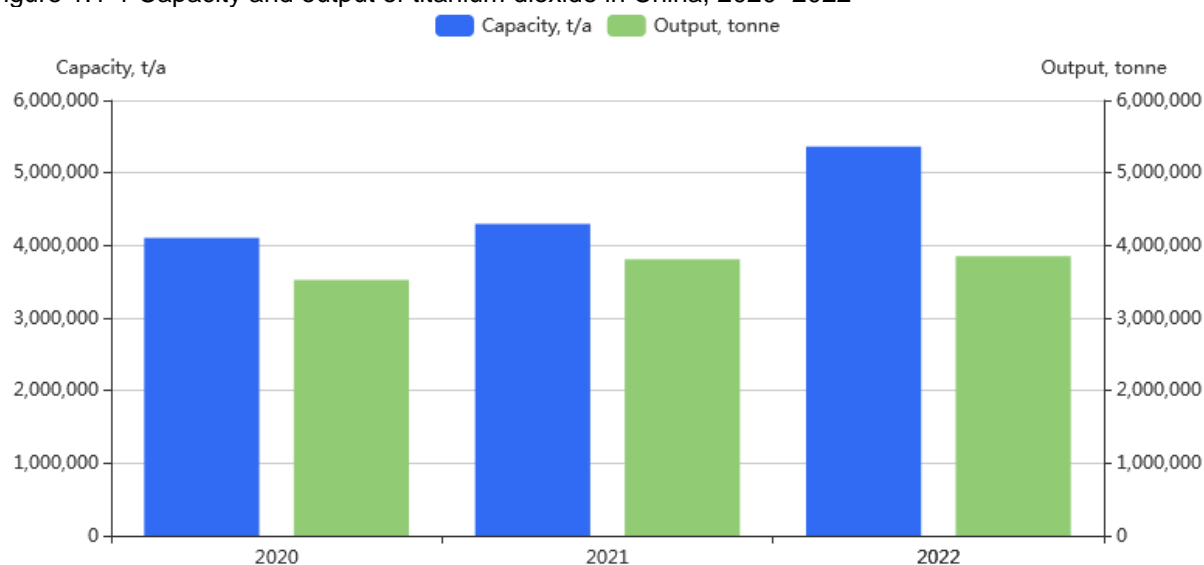


## 1 Titanium dioxide production in China

### 1.1 Titanium dioxide production information, 2020–2022

The period of 2020–2022 saw consecutive growths of TiO<sub>2</sub> capacity and output in China.

Figure 1.1-1 Capacity and output of titanium dioxide in China, 2020–2022



Source: CCM

In 2022, the capacity of TiO<sub>2</sub> in China increased to 5,360,000 t/a and the output reached 3,853,500 tonnes. The operating rate of the industry averaged 72%.

In 2020–2022, there were some new entrants and expansion projects of TiO<sub>2</sub>. LB Group Co., Ltd. (LB Group) and CNNC Hua Yuan Titanium Dioxide Co., Ltd. (CNNC Hua Yuan) expanded their capacity in 2020. In 2021, Guangdong Huiyun Titanium Industry Co., Ltd., Yibin Tianyuan Haifeng Hetai Co., Ltd. and Shandong Lubei Chemical Co., Ltd. (Lubei Chemical) expanded their capacity to 110,000 t/a, 100,000 t/a and 200,000 t/a, respectively. In 2022, several enterprises including LB Group, CNNC Hua Yuan, Lubei Chemical and CITIC Titanium Industry Co., Ltd. expanded their capacity.

The export volume of TiO<sub>2</sub> from China has expanded constantly these years and China's TiO<sub>2</sub> products have enjoyed greater recognition and popularity for their improved quality and advantageous prices. Growing export market has not only broadened business and sales destinations for Chinese producers, but also effectively consumed their inventories, which has driven up their productivity for more engagement in international trade.

### 1.2 Top 40 titanium dioxide suppliers, 2020–2022

In 2020, all the production activities worldwide were somehow affected by COVID-19. However, with China outperforming other countries in response to this public health incident, Chinese TiO<sub>2</sub> manufacturers were able to maintain normal production throughout the year in general, and managed to fulfil more orders from home and abroad. In 2020, of all the domestic TiO<sub>2</sub> suppliers, 12 suppliers crossed the 100,000-tonne-line in output; the output of these 12 suppliers totalled about 2.54 million tonnes, over 70% of the national total. LB Group alone achieved 817,200 tonnes, over 23% of the total, retaining the No.1 position in China.

In 2021, the output of TiO<sub>2</sub> in China surpassed 3.80 million tonnes, encouraged by improved demand at home and abroad. Overseas TiO<sub>2</sub> capacity has not been effectively increased for many years. Moreover, affected by the COVID-19, operating rates in foreign enterprises were at a low level. As a result, the volume of TiO<sub>2</sub> exported from China increased year by year. The increase in export volume stimulated China's TiO<sub>2</sub> manufacturers to up their operating rates. In 2021, the top 10 suppliers (by output) altogether produced about 2.54 million tonnes, accounting for more than 66% of the total output in China. In particular, the largest Chinese TiO<sub>2</sub> supplier LB Group produced 902,200 tonnes of TiO<sub>2</sub>.

In 2022, China's TiO<sub>2</sub> output continued to hit a new high thanks to the continuously growing overall export demand. The combined output of top 10 suppliers (by output) was almost 2.61 million tonnes, accounting for

over 67% of the nation total. LB Group remained the top supplier domestically; it registered the largest year-on-year output increase (in number) among the suppliers and its output reached 989,800 tonnes.

Table 1.2-1 Titanium dioxide production of top active 40 suppliers in China, 2020–2022

No.	Supplier	Location of production base	Capacity, t/a			Output, tonne		
			2022	2021	2020	2022	2021	2020
1	LB Group Co., Ltd.	Henan, Yunnan, Sichuan, Hubei, Gansu	1,510,000	1,010,000	1,010,000	989,800	902,200	817,200
2	CNNC Hua Yuan Titanium Dioxide Co., Ltd.	Anhui	400,000	300,000	300,000	334,300	324,200	317,600
3	GPRO Investment Holding Group Co., Ltd.	Jiangsu	260,000	260,000	260,000	190,000	204,000	187,600
4	Shandong Lubei Chemical Co., Ltd.	Shandong	260,000	200,000	100,000	191,400	153,400	133,500
5	Pangang Group Vanadium & Titanium Resources Co., Ltd.	Sichuan, Chongqing	235,000	235,000	235,000	243,500	244,400	235,500
6	Shandong Doguide Group Co., Ltd.	Shandong	220,000	220,000	220,000	170,000	189,100	170,000
7	China National Chemical Co., Ltd.	Shandong, Guangxi	200,000	170,000	170,000	170,000	174,500	135,400
8	Guangxi Jinmao Titanium Co., Ltd.	Guangxi	160,000	100,000	100,000	110,000	112,900	113,100
9	Shandong Dawn Titanium Industry Co., Ltd.	Shandong	140,000	100,000	100,000	105,000	123,600	113,500
10	Yunnan Dahutong Industrial & Trade Co., Ltd.	Yunnan, Sichuan	130,000	120,000	120,000	90,000	96,000	110,500
11	Ningbo Xinfu Titanium Dioxide Co., Ltd.	Zhejiang	120,000	120,000	120,000	83,200	99,700	100,000
12	CITIC Titanium Industry Co., Ltd.	Liaoning	120,000	60,000	60,000	70,500	68,300	68,700
13	Guangdong Huiyun Titanium Industry Co., Ltd.	Guangdong	110,000	110,000	65,000	93,700	82,300	69,200
14	Yibin Tianyuan Haifeng Hetai Co., Ltd.	Sichuan	100,000	100,000	50,000	45,000	35,100	24,400
15	Guizhou Sunward Fuquan Chemicals Co., Ltd.	Guizhou	100,000	50,000	50,000	65,000	51,000	30,000
16	Panzhuhua Taihai Technology Co., Ltd.	Sichuan	80,000	80,000	80,000	95,000	114,000	108,200
17	Anhui Annada Titanium Industry Co., Ltd.	Anhui	80,000	80,000	80,000	101,700	102,800	85,300
18	Panzhuhua Haifengxin Chemical Industry Co., Ltd.	Sichuan	60,000	60,000	60,000	84,000	96,300	64,200
19	Guangxi Shunfeng Titanium Industry Co., Ltd.	Guangxi	60,000	60,000	60,000	51,000	52,300	52,700
20	Jiangxi Tikon Titanium Co., Ltd.	Jiangxi	50,000	50,000	50,000	40,600	50,000	46,700
21	Panzhuhua Xingzhong Titanium Industry Co., Ltd.	Sichuan	50,000	50,000	50,000	49,000	47,500	52,000

No.	Supplier	Location of production base	Capacity, t/a			Output, tonne		
			2022	2021	2020	2022	2021	2020
22	Shanghai Pengbo Titanium Dioxide Co., Ltd.	Shanghai	50,000	50,000	50,000	18,200	19,000	19,300
23	Kunming Donghao Titanium Co., Ltd.	Yunnan	50,000	45,000	45,000	41,000	45,000	41,500
24	Panzhuhua Tianlun Chemical Co., Ltd.	Sichuan	40,000	40,000	40,000	29,500	29,500	25,000
25	Denox Advanced Materials Co., Ltd.	Anhui	40,000	30,000	30,000	38,000	39,800	20,000
26	Suzhou Hongfeng Titanium Industry Co., Ltd.	Jiangsu	40,000	30,000	30,000	24,100	26,000	28,700
27	Huai'an Feiyang Titanium Dioxide Co., Ltd.	Jiangsu	36,000	36,000	36,000	12,000	11,600	15,800
28	Panzhuhua Hengtong Titanium Co., Ltd.	Sichuan	30,000	30,000	30,000	29,000	30,000	30,500
29	Panzhuhua Zhengyuan Technology Co., Ltd.	Sichuan	30,000	30,000	30,000	23,000	25,700	13,000
30	Nexttech Materials Co., Ltd.	Anhui	30,000	30,000	30,000	24,200	24,000	22,600
31	Guangxi Xilong Chemical Co., Ltd.	Guangxi	30,000	30,000	30,000	25,400	23,000	15,800
32	Fumin Longteng Titanium Industry Co., Ltd.	Yunnan	30,000	30,000	30,000	15,400	18,100	25,800
33	Qianjiang Fangyuan Titanium Industry Co., Ltd.	Hubei	25,000	60,000	60,000	27,600	27,600	27,600
34	Alfa Full (Guangxi) Titanium Dioxide Co., Ltd.	Guangxi	25,000	25,000	25,000	10,200	12,600	20,000
35	CNMC (Guangxi) Pigma Co., Ltd.	Guangxi	25,000	25,000	25,000	21,400	20,300	21,800
36	Hunan Chuangda Yutu Chemical Co., Ltd.	Hunan	25,000	15,000	15,000	14,700	14,700	14,500
37	Panzhuhua Taidu Chemicals Co., Ltd.	Sichuan	20,000	30,000	30,000	14,000	29,300	24,000
38	Guangxi Detian Chemical Cycle Co., Ltd.	Guangxi	20,000	20,000	20,000	17,000	18,400	18,200
39	Guangxi Baihe Chemical Co., Ltd.	Guangxi	20,000	20,000	20,000	15,000	18,900	14,100
40	Yumen Jingyang Titanium Pigment Manufacturing Co., Ltd.	Gansu	20,000	20,000	20,000	5,900	6,000	6,300
Others			329,000	167,000	167,000	75,200	43,500	82,800
<b>Total</b>			<b>5,360,000</b>	<b>4,298,000</b>	<b>4,103,000</b>	<b>3,853,500</b>	<b>3,806,600</b>	<b>3,522,600</b>

Source: CCM

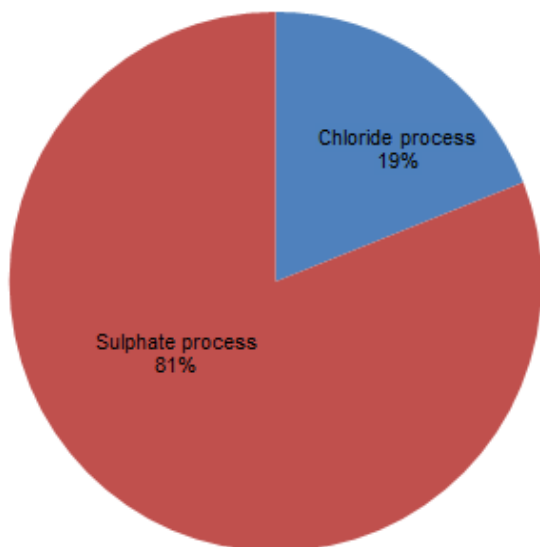
During 2020–2022, sulphate process  $TiO_2$  still dominated the domestic market; at the same time, chloride process  $TiO_2$ , the future of the industry, developed steadily. Generally, current domestic chloride process technique keeps advancing, and stable mass production improves. The next few years may see a fast growth of chloride process as it is encouraged in the course of the 14<sup>th</sup> Five-Year Period (2021–2025). Notably, Shandong Lubei Chemical Co., Ltd. joined the chloride process  $TiO_2$  club in 2022. There will be a shift to chloride process in years to come, but sulphate process would still remain the mainstream, though seeing shrinking share in the industry.

Table 1.2-2 Production situation of chloride process titanium dioxide in China, 2021–2022

No.	Supplier	Capacity, t/a		Output, tonne	
		2022	2021	2022	2021
1	LB Group Co., Ltd.	660,000	360,000	321,100	256,200
2	CITIC Titanium Industry Co., Ltd.	120,000	60,000	70,500	68,300
3	Yibin Tianyuan Haifeng Hetai Co., Ltd.	100,000	100,000	45,000	35,100
4	Pangang Group Vanadium & Titanium Resources Co., Ltd.	15,000	15,000	16,100	16,400
5	Shandong Lubei Chemical Co., Ltd.	60,000	/	43,900	/
<b>Total</b>		<b>955,000</b>	<b>535,000</b>	<b>496,600</b>	<b>376,000</b>

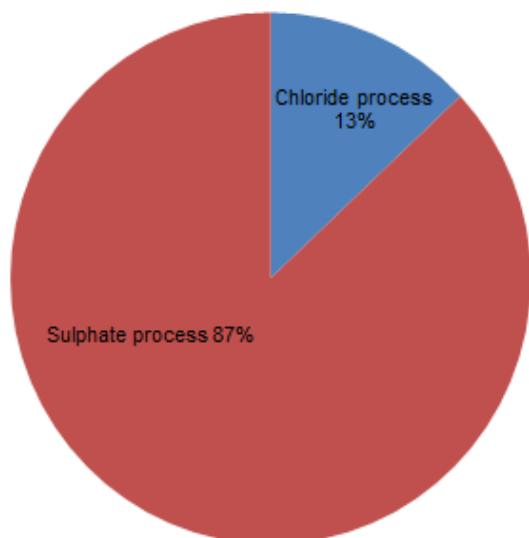
Source: CCM

Figure 1.2-1 Capacity share of top 40 titanium dioxide suppliers by process in China, 2022



Source: CCM

Figure 1.2-2 Output share of top 40 titanium dioxide suppliers by process in China, 2022



Source: CCM

### 1.3 Titanium dioxide production distribution, 2022

Domestic TiO<sub>2</sub> manufacturers are mainly distributed in 17 provinces, municipalities and autonomous regions. In particular, TiO<sub>2</sub> capacity mainly congregated in Sichuan, Shandong, Henan, Anhui, and Yunnan.

Table 1.3-1 Distribution of major titanium dioxide manufacturers by province/municipality/autonomous region in China, 2022

No.	Province/Municipality/Autonomous Region	Capacity, t/a
1	Sichuan	855,000
2	Shandong	770,000
3	Henan	650,000
4	Anhui	550,000
5	Yunnan	410,000
6	Guangxi	390,000
7	Jiangsu	336,000
8	Gansu	220,000
9	Hubei	175,000
10	Liaoning	120,000
11	Zhejiang	120,000
12	Guangdong	110,000
13	Guizhou	100,000
14	Chongqing	100,000
15	Jiangxi	50,000
16	Shanghai	50,000
17	Hunan	25,000

Source: CCM

Sichuan Province is a famous TiO<sub>2</sub> production base in China, with TiO<sub>2</sub> capacity hitting 855,000 t/a in 2022. Particularly, Panzhihua City boasts abundant titanium ore resources and the local government aims to turn the city into a renowned TiO<sub>2</sub> production base by granting many preferential policies regarding water and electricity, which stimulates the development of local TiO<sub>2</sub> industry.

TiO<sub>2</sub> production in Shandong Province is controlled by Shandong Doguide Group Co., Ltd., Shandong Lubei Chemical Co., Ltd., China National Chemical Co., Ltd. and Shandong Dawn Titanium Industry Co., Ltd.

The manufacturers in Guangxi Zhuang Autonomous Region are mainly located in Wuzhou City (including Tengxian County) and Liuzhou City where titanium ore resources are rich. With less strict local regulations on environmental protection there, many manufacturers adopt sulphate process to produce TiO<sub>2</sub>. Moreover, Guangxi can easily make full use of overseas resources because it borders Vietnam, an important titanium ore import origin for China. Most manufacturers in Guangxi only produce anatase TiO<sub>2</sub> or non-pigment TiO<sub>2</sub> for ceramics, enamel and welding rod.

In Jiangsu Province, GPRO Investment Holding Group Co., Ltd. now controls approximately 77% of the total TiO<sub>2</sub> production capacity there, being the controlling shareholder of both GPRO Titanium Industry Co., Ltd. and Jiangsu Taibai Group Co., Ltd.

LB Group (with 1,510,000 t/a in 2022 in total) has TiO<sub>2</sub> production lines in Henan, Yunnan, Gansu, Sichuan and Hubei provinces, of which the latter two, with abundant ilmenite resources, provide the company with easy access to raw materials.

#### **1.4 Domestic titanium dioxide expansion projects**

Due to technical barriers and blockade of core technologies imposed by the overseas TiO<sub>2</sub> giants, Chinese enterprises that intended to apply chloride process can only explore by themselves and accumulate experience little by little. Only a few well-capitalised chemical enterprises with enough technology accumulation have carried out chloride process projects. Nevertheless, with all things improved in the past few years, China's TiO<sub>2</sub> industry is likely to see accelerating capacity expansion in both processes in the near future.

In recent years, domestic TiO<sub>2</sub> capacity expansion was mainly based on the following favourable factors:

- Firstly, demand from downstream industries mainly showed an upward trend, especially from the coating and plastics industries. Although TiO<sub>2</sub> consumption from these two sectors dropped slightly in 2022, they are likely to remain the strong support for TiO<sub>2</sub> industry in the coming years.
- Secondly, demand from overseas markets has given domestic manufacturers room to expand further.
- Thirdly, policies and regulations have been helpful to the capacity expansion in regard to production through chloride process, so such projects are progressing faster than before.
- Fourthly, sulphate process has also improved in terms of pollutant disposal as well as industrial chain extension, so there are such ongoing projects too.

Table 1.4-1 List of projects in China expected to be built up and put into operation in the near future

No.	Company	Capacity in 2022, t/a	Expansion, t/a	Expected finish time	Technology	Note
1	Guangdong Huiyun Titanium Industry Co., Ltd.	110,000	50,000	2023	Sulphate	The Phase II (50,000 t/a) of its 80,000 t/a post-processing project has been delayed and is expected to be completed by the end of 2023.
2	Pangang Group Vanadium & Titanium Resources Co., Ltd.	235,000	60,000	2024	Chloride	Its subsidiary Pangang Group Titanium Industry Co., Ltd. is building a 60,000 t/a chloride process line, which is expected to be completed by 2024.
3	Anhui Annada Titanium Industry Co., Ltd.	80,000	50,000	2024	Sulphate	Its 50,000 t/a post-processing project is expected to be completed by 2024.
4	Guangxi Shunfeng Titanium Industry Co., Ltd.	60,000	120,000	2024	Sulphate	The company is going to relocate its production capacity and expand it to 120,000 t/a with the relocation project.
5	LB Group Co., Ltd.	1,510,000	200,000	2025	Chloride	Its subsidiary LB Sichuan Mining & Metallurgy Co., Ltd. is building a 200,000 t/a chloride process project, which is expected to be completed by 2025.
6	Hunan Chuangda Yutu Chemical Co., Ltd.	25,000	50,000	2025	Sulphate	Its subsidiary Hunan Yutu Titanium Industry New Material Co., Ltd. is pushing ahead with the 100,000 t/a sulphate process project, of which the Phase II (50,000 t/a) is expected to be completed by 2025.
7	Zhengtai New Material Technology Co., Ltd.	200,000	600,000	2025	Hydrochloric acid extraction process	Its project is expected to be completed by 2025. The company completed 200,000 t/a TiO <sub>2</sub> capacity in 2022, but the output was small. It is a wholly-owned subsidiary of the listed company Fujian Kuncai Material Technology Co., Ltd.
8	Hebei Jicheng New Material Co., Ltd.	0	320,000	2025	Chloride	The company is building a 480,000 t/a chloride process TiO <sub>2</sub> project, of which the Phase II (320,000 t/a) is expected to be completed by 2025.
9	Malion New Materials (Sichuan) Co., Ltd.	0	500,000	2025 & 2026	Sulphate	The company is building a 2.30 million t/a new energy and polymer material industrialisation project, of which the phase I (200,000 t/a TiO <sub>2</sub> ) is predicted to be finished by June 2025 and the phase II (300,000 t/a TiO <sub>2</sub> ) is expected to be completed by June 2026.
10	Guangdong Dinglong Industrial Group Co., Ltd.	0	500,000	2026	Chloride	/

Source: CCM

It is eye-catching that Zhengtai New Material Technology Co., Ltd. (Zhengtai New Material) developed hydrochloric acid extraction process TiO<sub>2</sub> with independent intellectual property rights. Zhengtai New Material put into production the 200,000 t/a hydrochloric acid extraction process TiO<sub>2</sub> production line in Feb. 2022, but it still needs some time to realise mass production.

According to relevant literature, main procedures for the hydrochloric acid extraction process TiO<sub>2</sub> are as follows:

- Acidolysis: hydrochloric acid is added to dissolve ilmenite, and then the solid is separated to obtain the titanium oxychloride solution.
- Reduction: the titanium oxychloride solution is reduced by iron powder to remove ferric ion.
- Crystallisation: after cooling, ferrous chloride in the solution crystallises, and titanium oxychloride solution without iron is obtained.
- Extraction: add organic extractant to the iron-free solution to remove impurities.
- Hydrolysis: the titanium oxychloride solution is then sprayed and hydrolysed to obtain amorphous TiO<sub>2</sub>.
- Salt treatment: add salt treatment agent to increase the colour and lustre and porosity of TiO<sub>2</sub>.
- Calcining: after high-temperature dehydration and calcination, the primary product of granular TiO<sub>2</sub> is obtained.
- Crushing: the granular TiO<sub>2</sub> is rolled and milled to obtain TiO<sub>2</sub> powder.

The process has both advantages and disadvantages, specifically:

- Advantages: hydrochloric acid and extractant can be recycled and reused, and the by-products ferrous chloride and ferric chloride can be converted into iron oxide for reuse after hot water hydrolysis. In addition, the hydrochloric acid extraction method has not high requirements for raw materials, generates less industrial wastewater and residues, and consumes less energy.
- Disadvantages: Expensive extractant, high requirements on equipment, high conditions for hydrochloric acid dissolving ilmenite all may hinder the promotion of this process. Also, concentration of titanium oxychloride is difficult to guarantee.

### 1.5 Development of chloride process

Chloride process used to develop slowly in China, with projects promoted in a steady way only by experienced big players in TiO<sub>2</sub> industry.

Since 2019, however, more companies joined in the development of chloride process TiO<sub>2</sub>. For instance, Yibin Tianyuan Haifeng Hetai Co., Ltd. built up a 50,000 t/a chloride process TiO<sub>2</sub> production line and started trial run in 2019. The company put another 50,000 t/a line into production at the end of 2021. Shandong Lubei Chemical Co., Ltd. has put its 60,000 t/a chloride process line into production since April 2022. Besides, Hebei Jicheng New Material Co., Ltd. announced a 480,000 t/a chloride-process project in 2020, of which the phase I project (160,000 t/a) was planned to be finished by 2023, but as of Nov. 2023, there is still no information about the completion of this project.

The *Guidance Catalogue for Industrial Structure Adjustment (2019 Version)* given by National Development and Reform Commission (NDRC) stipulates that addition of sulphate process TiO<sub>2</sub> capacity is restricted, while building chloride process projects with capacity of 30,000 t/a per production line or above is encouraged. However, the *Guidance Catalogue for Industrial Structure Adjustment 2023 (Draft for Comments)* removes the content of "Building chloride process projects with capacity of 30,000 t/a per production line or above is encouraged". This is probably because the capacity of most chloride process TiO<sub>2</sub> production lines exceeds 50,000 t/a for each line and the overall chloride-process TiO<sub>2</sub> capacity (including potential capacity in projects already announced) adds up to a quite big number.

Nevertheless, since the sulphate process TiO<sub>2</sub> (joint-production process excluded) is restricted according to the *Guidance Catalogue for Industrial Structure Adjustment 2023 (Draft for Comments)*, the development of chloride process TiO<sub>2</sub> is still a welcoming trend. Thus, China's TiO<sub>2</sub> industry is to witness growth in chloride-process capacity and have new players. Often these potential producers come with ambitious chloride-process projects planned, yet it remains unknown that how much proposed capacity can be built up and put into operation in the next few years. Generally, China's TiO<sub>2</sub> industry is not to expect a chloride process-dominant future in the short term.

### 1.6 Titanium dioxide feedstock situation, 2020–2022

According to the *Mineral Commodity Summaries 2023* offered by the United States Geological Survey (USGS), ilmenite consumption takes up 90% of titanium ore consumption around the world. As of the end of 2022, global titanium ore resources exceeded 2 billion tonnes (calculated by TiO<sub>2</sub> equivalent) and reserves were about 700 million tonnes, about 93% of which were ilmenite reserves (about 650 million tonnes). Except in Antarctica, titanium ore resources are found abundant in the other six continents, more specifically, scattering in 29 countries. Among them, Australia holds the most titanium ore resources. Reserves in the top 15 countries account for about 98% of the global total.



Table 1.6-1 Ilmenite &amp; rutile reserves of major titanium resources suppliers

No.	Country	2022 output, '000 tonne			Reserve, '000 tonne			Share to global total reserve
		Ilmenite	Rutile	Total	Ilmenite	Rutile	Total	
1	Australia	660	190	850	160,000	31,000	191,000	27.4%
2	China	3,400	N/A	3,400	190,000	N/A	190,000	27.2%
3	India	200	11	211	85,000	7,400	92,400	13.2%
4	Brazil	32	N/A	32	43,000	N/A	43,000	6.2%
5	Norway	430	N/A	430	37,000	N/A	37,000	5.3%
6	South Africa	900	95	995	30,000	6,500	36,500	5.2%
7	Canada	470	N/A	470	31,000	N/A	31,000	4.4%
8	Mozambique	1,200	8	1,208	26,000	890	26,890	3.9%
9	Madagascar	300	0	300	22,000	520	22,520	3.2%
10	Ukraine	200	57	257	5,900	2,500	8,400	1.2%
11	The US	200	N/A	200	2,000	N/A	2,000	0.3%
12	Vietnam	160	N/A	160	1,600	N/A	1,600	0.2%
13	Kenya	180	73	253	390	170	560	0.1%
14	Senegal	520	9	529	N/A	N/A	N/A	N/A
15	Sierra Leone	N/A	130	130	N/A	490	490	0.1%
	Others	77	14	91	14,000	N/A	14,000	2.0%
	<b>World total</b>	<b>8,929</b>	<b>587</b>	<b>9,516</b>	<b>647,890</b>	<b>49,470</b>	<b>697,360</b>	<b>100.0%</b>

Note: 1. Ilmenite & rutile output and reserves are calculated based on equivalence to titanium dioxide content.

2. The rutile output and reserves data of the US are included within ilmenite data.

3. The data are estimated.

Source: Mineral Commodity Summaries 2023 by the USGS

According to the *China Mineral Resources Report 2023* issued by the Ministry of Natural Resources of the People's Republic of China in Oct. 2023, slightly over 106 million tonnes of titanium ore resources (calculated by TiO<sub>2</sub> equivalent) had been recorded as of 2022, down by over 50% from the figure for 2021. High-quality ores only account for a very small proportion, about 2% of the total. Primary rutile ores of lower grade account for 86% of the domestic rutile ores, and the rest 14% are placers. The other 98% titanium reserves are ilmenites, of which primary ilmenite (magnetite) ores and ilmenite placers take up 86% and 14% respectively.

Titanium ore resources are found in 16 provinces (regions) in China, mainly in Sichuan, Yunnan, Shandong, Hubei and Hebei provinces. Specifically, nearly 81% of domestic titanium ores (about 92 million tonnes calculated by TiO<sub>2</sub> equivalent) are in Sichuan and Yunnan provinces.

In general, the grade of China's ores is relatively lower than that of many other titanium-rich countries. Primary ilmenite rock ores, with average content of only 5%, are concentrated in Sichuan and Hebei provinces; ilmenite placers are found in Yunnan Province, Guangxi Zhuang Autonomous Region, Hainan Province and Guangdong Province.

Absolute majority of associated primary rock-type ilmenite ores with low titanium content and only a tiny bit of easy-to-exploit-and-utilise rutile ores make China depend on import, at least in terms of high-quality titanium ores. At present, domestic ilmenite enterprises mostly produce low-grade products with underdeveloped purification technology and limited equipment scale.

The content of the domestic titanium concentrate ore is generally lower than 45%, while that of the imported one is above 50% in the majority. So a number of the domestic TiO<sub>2</sub> manufacturers prefer to use imported titanium concentrate ores in their production.

In 2022, titanium ore import dropped year on year mainly because of an increased domestic output. In 2022, Mozambique, Kenya and Vietnam remained the major providers of titanium ores to China.

Table 1.6-2 China's import volume of ilmenite by month, 2020–2022

Month	Volume, tonne		
	2022	2021	2020
Jan.	382,739	277,839	300,342
Feb.	275,123	352,761	249,244
March	135,292	395,760	233,388
April	466,854	367,164	231,508
May	203,872	226,630	320,038
June	268,068	357,775	198,631
July	301,736	250,197	216,261
Aug.	230,117	262,223	222,934
Sept.	349,491	349,740	202,740
Oct.	235,605	185,637	285,911
Nov.	327,829	528,063	252,854
Dec.	288,038	242,968	300,547
<b>Total</b>	<b>3,464,763</b>	<b>3,796,756</b>	<b>3,014,397</b>

Source: China Customs

Table 1.6-3 Top 10 import origins of ilmenite to China, 2022

No.	Origin	Volume, tonne
1	Mozambique	1,700,968
2	Kenya	304,265
3	Vietnam	270,347
4	The US	248,821
5	Norway	240,371
6	Australia	158,788
7	South Africa	74,291
8	Nigeria	73,865
9	Senegal	69,677
10	Brazil	58,031
	Others	265,339
	<b>Total</b>	<b>3,464,763</b>

Source: China Customs

Table 1.6-4 Output of titanium concentrate in China, 2020–2022

Production area (Province/Municipality/Autonomous Region)	Volume, tonne		
	2022	2021	2020
Sichuan	4,705,000	4,595,000	4,340,000
Hebei	380,000	353,000	320,000
Yunnan	369,000	311,000	323,000
Xinjiang	336,000	296,000	274,000
Shandong	57,000	78,000	271,000
Others	193,000	192,000	219,000
<b>Total</b>	<b>6,040,000</b>	<b>5,825,000</b>	<b>5,747,000</b>

Source: CCM

Both the capacity and output of titanium slag in China have mainly shown an upward trend in recent years. In TiO<sub>2</sub> production, titanium slag approach has fewer pollutants emitted compared with titanium concentrate ore approach.

Table 1.6-5 Output of titanium slag (74%–76%) in China by month, 2020–2022

Month	Volume, tonne		
	2022	2021	2020
Jan.	54,050	43,100	33,800
Feb.	47,600	40,400	29,600
March	50,500	41,500	36,000
April	47,150	40,000	27,100
May	44,100	40,600	31,400
June	38,750	38,800	37,500
July	34,900	39,050	35,000
Aug.	27,000	42,000	34,960
Sept.	28,100	46,800	36,400
Oct.	21,450	51,130	44,700
Nov.	22,150	45,000	42,800
Dec.	16,800	48,100	41,400
<b>Total</b>	<b>432,550</b>	<b>516,480</b>	<b>430,660</b>

Source: CCM

Table 1.6-6 Output of titanium slag (90%–92%) in China by month, 2020–2022

Month	Volume, tonne		
	2022	2021	2020
Jan.	25,200	23,300	23,000
Feb.	19,250	19,000	17,950
March	26,300	21,600	24,350
April	25,800	22,500	24,700
May	28,950	23,500	20,150
June	34,400	24,300	17,550
July	34,100	19,800	22,250
Aug.	30,430	22,250	22,060
Sept.	29,200	13,830	20,840
Oct.	29,050	7,670	22,100
Nov.	38,100	18,300	19,500
Dec.	38,650	17,800	20,500
<b>Total</b>	<b>359,430</b>	<b>233,850</b>	<b>254,950</b>

Source: CCM

Under mounting pressure of environmental protection from the government, basically more and more enterprises choose to use acid-soluble titanium slag or mixture of acid-soluble titanium slag and titanium

concentrate ore to produce  $\text{TiO}_2$ . At the same time, growing demand for high quality  $\text{TiO}_2$  forces manufacturers to use more acid-soluble titanium slag for better product quality.

Thus, the scale of titanium slag production in China has grown larger driven by the huge demand from downstream product sectors (also including  $\text{TiCl}_4$ , titanium sponge). However, titanium slag still does not have cost advantage compared with titanium concentrate ore in  $\text{TiO}_2$  production, which impedes a fast growth of titanium slag consumption.

## **2 Titanium dioxide and raw material prices**

### **2.1 Raw material price, 2020–H1 2023**

#### **- Ilmenite**

Big jumps in the ex-works prices of ilmenite were witnessed in 2020–H1 2021. From July 2021 to June 2023, the prices fluctuated at a relatively high level.

- 2020: The prices dipped in Q2 but then rebounded and reached for new high since June.
- 2021–June 2022: The prices kept increasing in H1 2021, and from H2 2021 to H1 2022, the prices in some major production regions in China went through several ups and downs.
- July–Nov. 2022: The prices showed a downward trend.
- Dec. 2022–June 2023: The prices continued to rise till Feb. 2023, and then the April–June period witnessed small but steady price falls.

#### **Jan. 2020–March 2020**

The prices went up, and main reasons are:

- The supply of raw materials reduced due to transportation disruption caused by COVID-19. Starting from Oct. 2019, some ilmenite manufacturers were in routine maintenance, which caused the output reduction of ilmenite. Around the Spring Festival, downstream manufacturers increased stocks, stimulating certain price increase.
- The decline in foreign ilmenite output and restricted export of ilmenite in India and Vietnam led to tight supply of ilmenite imported, along with high import price.

#### **April 2020–May 2020**

In late March, the supply of ilmenite in Panzhihua-Xichang Area returned to normal, and the inventories in manufacturers increased. However, operation in downstream manufacturers failed to come normal because of the aftermaths of COVID-19, thus the downstream demand was weak, which drove the prices of ilmenite down.

#### **June 2020–June 2021**

The prices showed an upward trend in this period owing to shrinking supply of ilmenite. Besides, in H2 2020, due to sharp increases in the prices of domestic ilmenite, demand for imported ilmenite increased. However, as the exchange rate of USD to RMB declined, overseas manufacturers raised their prices continuously.

#### **July 2021–June 2022**

The prices witnessed frequent fluctuations as demand changed during this period.

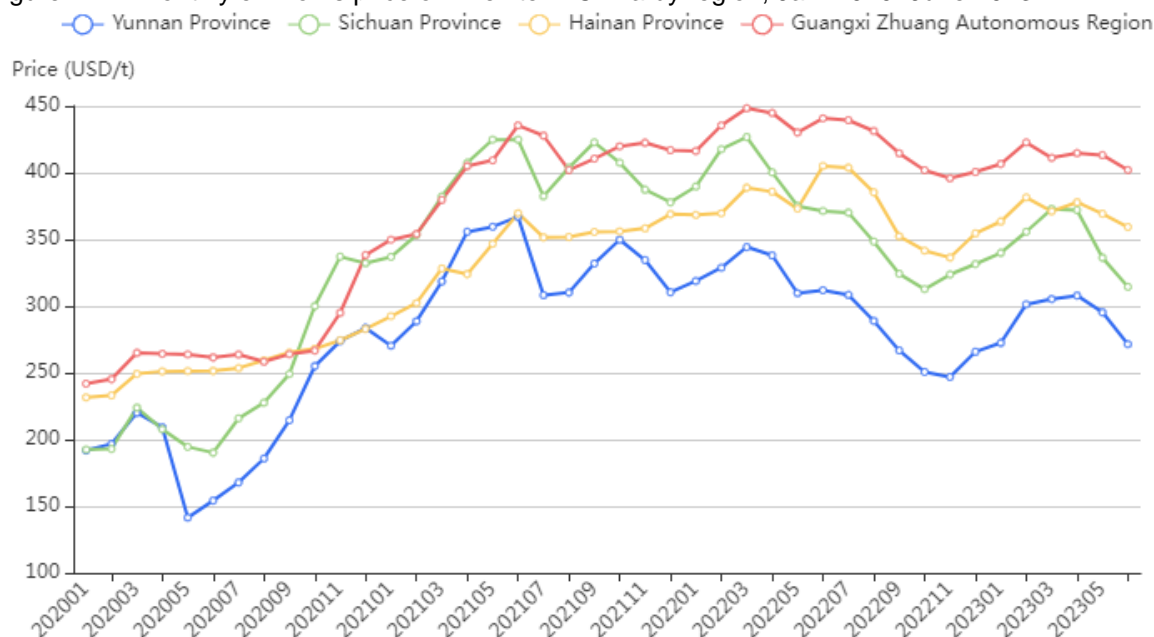
#### **H2 2022**

The overall ilmenite market was depressed in H2 2022 and the prices followed a downward trend in general mainly because downstream demand was sluggish.

#### **H1 2023**

In H1 2023, ilmenite prices fluctuated at a relatively high level as supply was tight and manufacturers were determined to hold high their prices in spite of weak downstream demand.

Figure 2.1-1 Monthly ex-works price of ilmenite in China by region, Jan. 2020–June 2023



Note: Ilmenite grading: 45%–47% in Yunnan Province, 40%–46% in Sichuan Province, 45%–54% in Hainan Province and 50%–52% in Guangxi Zhuang Autonomous Region  
Source: CCM

## - Titanium slag

### Jan. 2020–Oct. 2020

The ex-works prices of titanium slag witnessed an overall downward trend. Due to the aftermaths of COVID-19, the downstream demand became weak, leading the prices to go down. And many titanium slag manufacturers chose to suspend production or cut production because of low profits.

### Nov. 2020–June 2022

The prices went up significantly. Main reasons are as follow:

- Limited supply: The shortage of high quality titanium ores in China and the reduction of supply from some miners led to limited supply in the overall market.
- Strong downstream demand: The demand for titanium slag increased as operating rates of chloride-process TiO<sub>2</sub> and titanium sponge remained at a high level.
- High costs: The import price of high quality titanium ores continued to rise, resulting in increased costs for titanium slag producers.

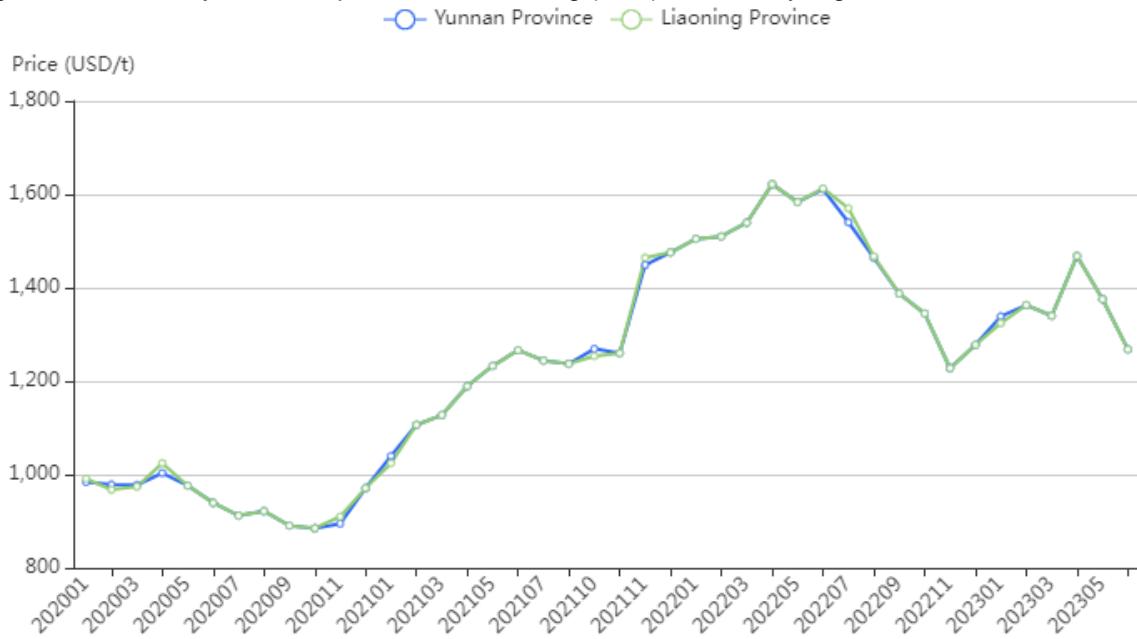
### July 2022–Nov. 2022

Titanium slag prices declined in this period because downstream market was depressed; the overall market supply exceeded the demand. Most titanium slag enterprises faced difficulty selling their products.

### Dec. 2022–June 2023

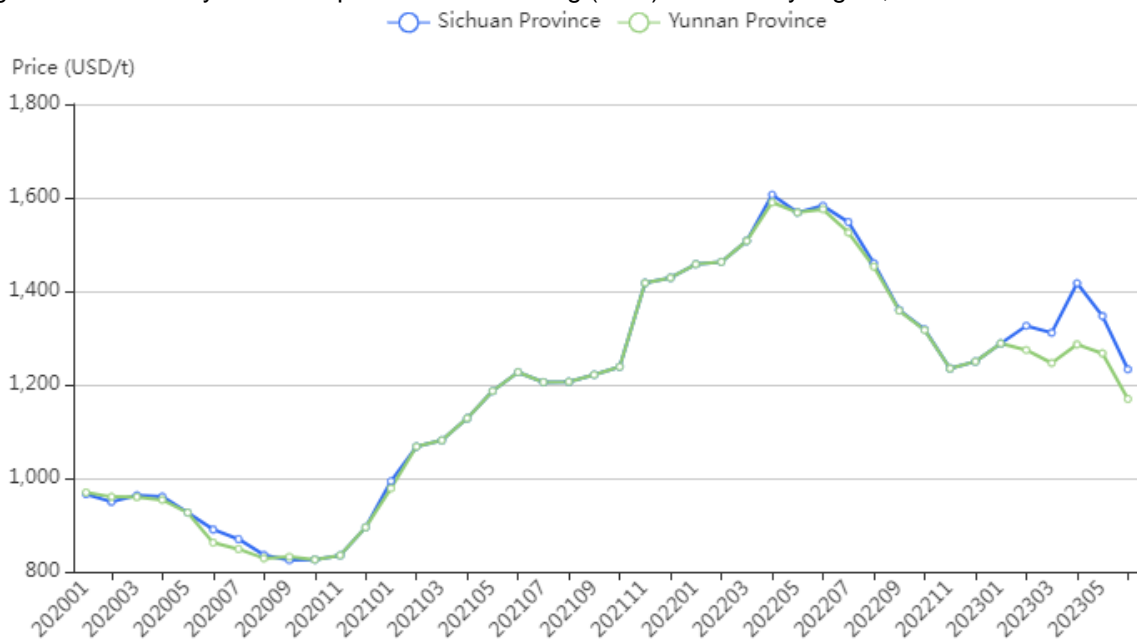
This period saw fluctuations in titanium slag prices since upstream ilmenite prices and electricity prices edged up; besides, titanium slag manufacturers were unwilling to sell their products at low prices due to high production costs.

Figure 2.1-2 Monthly ex-works price of titanium slag (92%) in China by region, Jan. 2020–June 2023



Source: CCM

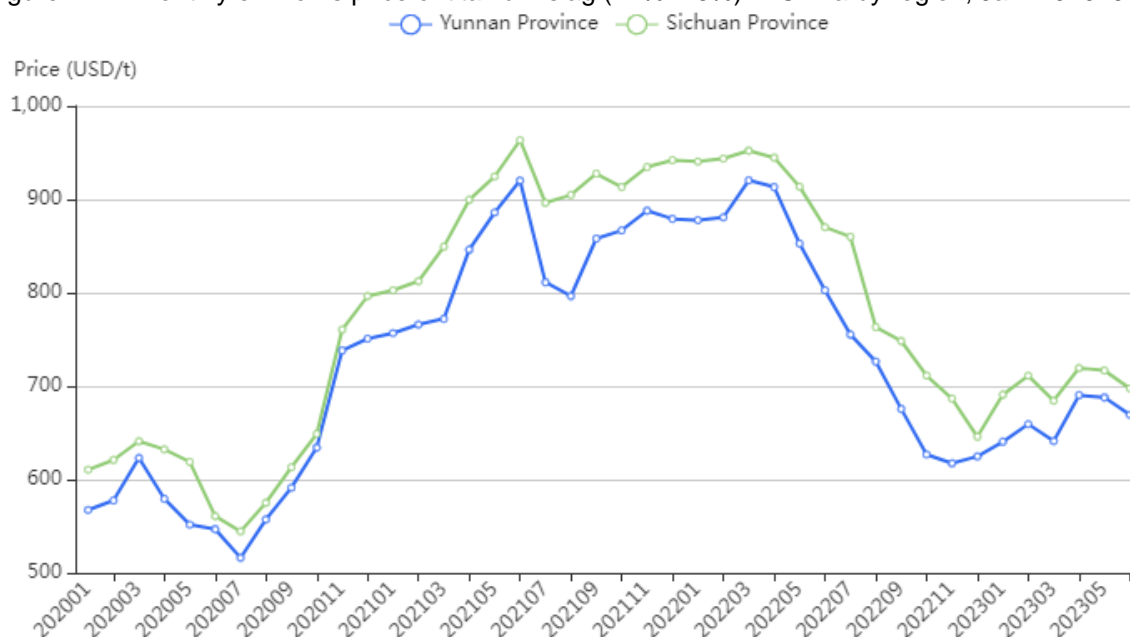
Figure 2.1-3 Monthly ex-works price of titanium slag (90%) in China by region, Jan. 2020–June 2023



Source: CCM



Figure 2.1-4 Monthly ex-works price of titanium slag (74%–76%) in China by region, Jan. 2020–June 2023



Source: CCM

## 2.2 Titanium dioxide price, 2020–H1 2023

The domestic price curve of TiO<sub>2</sub> in 2020–H1 2023 showed a "down-up-fluctuation-down" pattern. TiO<sub>2</sub> prices went down and hit the bottom in June or July 2020, then followed an upward trend till June 2021, and after that fluctuated at a relatively high level for about a year; in H2 2022, the prices dropped dramatically and then in H1 2023, the prices slightly rebounded and turned relatively stable.

### Jan. 2020–July 2020

The prices of TiO<sub>2</sub> rose for a short while but then declined. The outbreak of COVID-19 in late Jan. restricted the production of some TiO<sub>2</sub> manufacturers in the early stage and the spot supply was tightened, which drove the prices up. In Q2 2020, the prices began to drop mainly due to sluggish demand as the downstream manufacturers were affected by COVID-19, especially the foreign ones.

### Aug. 2020–June 2021

In this period, the world somewhat came back on the right track under eased COVID-19 situation with recovering economy. Demand for China's TiO<sub>2</sub> from home and abroad was revitalised, plus rising cost of ilmenite lending support to TiO<sub>2</sub> prices for most of the time. This two factors were strong to keep the TiO<sub>2</sub> price soaring.

### July 2021–June 2022

In this period, TiO<sub>2</sub> prices basically fluctuated at high level. Main reasons for this are:

- Prosperous export market supported the domestic market strongly. Thus domestic demand, though had seasonal variations, was basically good enough to maintain the TiO<sub>2</sub> price at a high level.
- The prices of ilmenite and sulphuric acid, upstream materials of TiO<sub>2</sub>, stayed at a high level, which supported the price of TiO<sub>2</sub>.

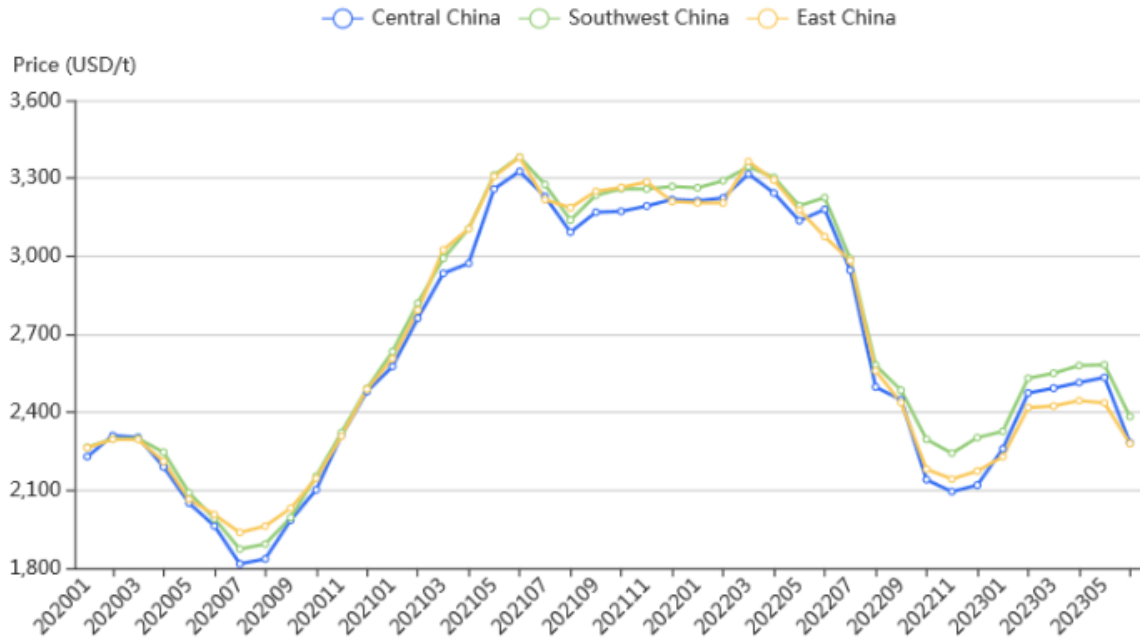
### July 2022–Dec. 2022

TiO<sub>2</sub> prices dropped dramatically in this period, as TiO<sub>2</sub> was in abundant supply while domestic real estate market remained stagnant.

### H1 2023

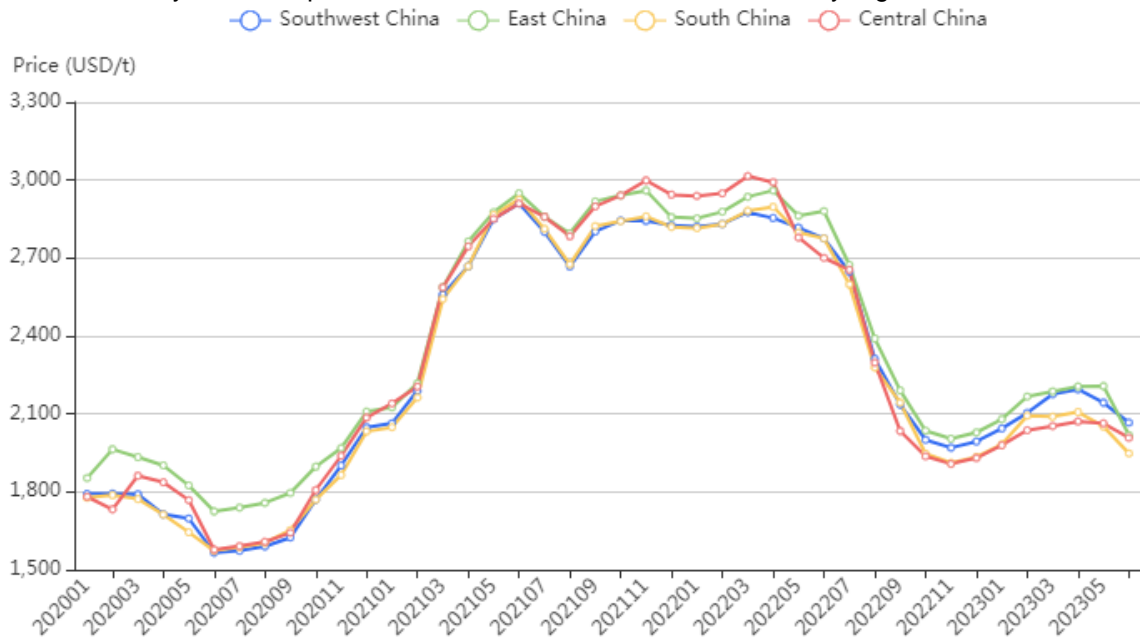
TiO<sub>2</sub> prices rebounded slightly and became stabilised under continuously slack demand as: prices of raw materials like sulphur and sulphuric acid in some regions rebounded; ilmenite prices stayed at a relatively high level; and a number of manufacturers suspended or reduced production, leading to decreased TiO<sub>2</sub> output to some extent.

Figure 2.2-1 Monthly ex-works prices of rutile titanium dioxide in China by region, Jan. 2020–June 2023



Source: CCM

Figure 2.2-2 Monthly ex-works prices of anatase titanium dioxide in China by region, Jan. 2020–June 2023



Source: CCM

### 3 Mainstream titanium dioxide suppliers, 2020–2022

#### 3.1 Overview

First-tier TiO<sub>2</sub> suppliers in China are LB Group, CNNC Hua Yuan, Lubei Chemical, Pangang Group Vanadium & Titanium Resources Co., Ltd. (Pangang Group), and GPRO Investment Holding Group Co., Ltd. (GPRO Group). They not only have large production scale, but also, as listed companies, enjoy more financing channels which makes them backbone forces for future development of chloride-processed TiO<sub>2</sub> in China.

In 2022, over 40 domestic large-scale full-process TiO<sub>2</sub> suppliers maintained normal production, of which 10 boasted TiO<sub>2</sub> output exceeding 100,000 tonnes.

Table 3.1-1 List of domestic titanium dioxide suppliers with more than 100,000-tonne output, 2022

No.	Supplier	Note
1	LB Group Co., Ltd.	Including LB Sichuan Titanium Industry Co., Ltd., LB Xiangyang Titanium Industry Co., Ltd., Henan Billions New Material Co., Ltd., Yunnan Metallurgical Xinli Titanium Co., Ltd. (with subsidiary LB Lufeng Titanium Industry Co., Ltd.) and Gansu Xingbai Titanium Industry Co., Ltd.
2	CNNC Hua Yuan Titanium Dioxide Co., Ltd.	Including Anhui Gold Star Titanium Dioxide (Group) Co., Ltd., Gansu Hecheng Titanium Dioxide Co., Ltd. and Gansu Dongfang Titanium Dioxide Co., Ltd.
3	Pangang Group Vanadium & Titanium Resources Co., Ltd.	Including Pangang Group Chongqing Titanium Industry Co., Ltd., Panzhihua Dongfang Titanium Industry Co., Ltd. and Pangang Group Titanium Industry Co., Ltd.
4	Shandong Lubei Chemical Co., Ltd.	Including Shandong Jinhai Titanium Resources Technology Co., Ltd. and Shandong Xianghai Titanium Resources Technology Co., Ltd.
5	GPRO Investment Holding Group Co., Ltd.	Including GPRO Titanium Industry Co., Ltd. (with subsidiaries Nanjing Titanium Dioxide Chemical Co., Ltd. and Xuzhou Titanium Dioxide Chemical Co., Ltd.) and Jiangsu Taibai Group Co., Ltd. (with subsidiary Jiangsu Zhentai Chemical Co., Ltd.)
6	Shandong Doguide Group Co., Ltd.	Including itself and Shandong Jinhong Titanium Dioxide Chemicals Co., Ltd., Shandong Suntiox Industrial Co., Ltd.
7	China National Chemical Co., Ltd.	Including Jinan Yuxing Chemical Co., Ltd. and Guangxi Bluestar Dahua Chemical Co., Ltd.
8	Guangxi Jinmao Titanium Co., Ltd.	/
9	Shandong Dawn Titanium Industry Co., Ltd.	/
10	Anhui Annada Titanium Industry Co., Ltd.	/

Source: CCM

#### 3.2 LB Group Co., Ltd.

##### - Company profile

LB Group Co., Ltd. (LB Group, 002601), previously known as Lomon Billions Group Co., Ltd. and Henan Billions Chemicals Co., Ltd., is headquartered in Jiaozuo City, Henan Province. In Sept. 2016, it invested USD1.35 billion to acquire 100% stake of Sichuan Lomon Titanium Industry Co., Ltd. (now the LB Sichuan Titanium Industry Co., Ltd.). Up to now, LB Group has five TiO<sub>2</sub> production bases in five provinces, including bases in Jiaozuo City (Henan Province), Mianzhu City (Sichuan Province), Xiangyang City (Hubei Province), Chuxiong Yi Autonomous Prefecture (Yunnan Province), and Jinchang City (Gansu Province). Its TiO<sub>2</sub> capacity reached 1,510,000 t/a in 2022, ranking first in the world. LB Group has established subsidiaries outside mainland China, such as Billions (Hong Kong) Co., Ltd., Billions Europe Ltd. and Billions America Corporation, to expand its business in export markets.

Table 3.2-1 Major subsidiaries of LB Group in titanium dioxide business, 2022

No.	Subsidiary	Business location	Business	Shareholding ratio
1	Henan Billions New Material Co., Ltd.	Jiaozuo City, Henan Province	TiO <sub>2</sub> production and sale	100%
2	Yunnan Metallurgical Xinli Titanium Co., Ltd.	Kunming City, Yunnan Province	TiO <sub>2</sub> production and sale	99.58%
3	LB Sichuan Titanium Industry Co., Ltd.	Mianzhu City, Sichuan Province	TiO <sub>2</sub> production and sale	100%
4	LB Xiangyang Titanium Industry Co., Ltd.	Xiangyang City, Hubei Province	TiO <sub>2</sub> production and sale	100%
5	Gansu Xingbai Titanium Industry Co., Ltd.	Jinchang City, Gansu Province	TiO <sub>2</sub> production and sale	100%
6	LB Sichuan Mining & Metallurgy Co., Ltd.	Panzhihua City, Sichuan Province	Ilmenite production and sale	100%

Note: Yunnan Metallurgical Xinli Titanium Co., Ltd.'s titanium dioxide production plant (LB Lufeng Titanium Industry Co., Ltd.) is located in Chuxiong Yi Autonomous Prefecture, Yunnan Province.

Source: CCM & LB Group Co., Ltd.

### - Production

Table 3.2-2 Capacity and output of titanium dioxide in LB Group, 2020–2022

Year	Capacity, t/a	Output, tonne
2020	1,010,000	817,200
2021	1,010,000	902,200
2022	1,510,000	989,800

Source: CCM & LB Group Co., Ltd.

The capacity of TiO<sub>2</sub> of LB Group stayed at 1,010,000 t/a in 2021 and increased to 1,510,000 t/a in 2022, with 850,000 t/a sulphate process TiO<sub>2</sub> and 660,000 t/a chloride process TiO<sub>2</sub>. The output saw fast increases in 2020–2022.

Table 3.2-3 Major events of LB Group's production, 2020–2022

Time	Major event
April, 2020	The 200,000 t/a chloride process TiO <sub>2</sub> project of LB Lufeng Titanium Industry Co., Ltd. (a subsidiary of Yunnan Metallurgical Xinli Titanium Co., Ltd.) was approved by Chuxiong Ecological Environment Bureau. A 100,000 t/a production line of the project was completed and successfully put into trial production in Q3 2022, and another 100,000 t/a production line was completed by the end of 2022.
May, 2020	LB Xiangyang Titanium Industry Co., Ltd. issued the environmental impact report of the 150,000 t/a rutile TiO <sub>2</sub> technological transformation and expansion project. The company planned to increase its TiO <sub>2</sub> capacity from 100,000 t/a to 150,000 t/a through this project. Acceptance inspection for this project was conducted in 2022.
May, 2020	LB Group signed a technical cooperation contract with Ti-Cons Technology Consulting GmbH to improve its TiO <sub>2</sub> production technology and management. Chloride process TiO <sub>2</sub> capacity in its subsidiary Henan Billions New Material Co., Ltd. will benefit from this and gradually increase its capacity to 100,000 t/a.
Aug. 2021	LB Sichuan Mining & Metallurgy Co., Ltd. planned to build 7 million t/a green and efficient mineral processing project. Upon completion, 1.6 million t/a iron ore concentrate, 400,000 t/a ilmenite and 15,000 t/a sulphur cobalt concentrate processing capacity will be added. The project is expected to be completed in 2024.
Aug. 2021	LB Group announced that its subsidiary Henan Billions New Material Co., Ltd. would expand chloride process TiO <sub>2</sub> by 100,000 t/a. The project was finished in 2022.
Oct. 2021	LB Group announced that its subsidiary LB Sichuan Mining & Metallurgy Co., Ltd. planned to invest in the construction of 200,000 t/a chloride process TiO <sub>2</sub> , and rare metals (vanadium and scandium included) comprehensive recovery demonstration project, which at the same time is supported with 1 million t/a high-salinity wastewater treatment facilities. The project is expected to be completed by 2025.

Time	Major event
Jan. 2022	LB Group announced that its subsidiary LB Xiangyang Titanium Industry Co., Ltd. would set up a 200,000 t/a TiO <sub>2</sub> post-treatment project to further increase TiO <sub>2</sub> market share.
Oct. 2022	LB Group announced that its sub-subsidiary, Gansu Billions Chemical Co., Ltd., would build a project of comprehensive utilisation of by-product sulphuric acid resources and chlor-alkali waste carbide slag for the production of 400,000 t/a rutile in Jinchang City, Gansu Province. Upon completion, this project will consume 1 million tonnes of chlor-alkali waste carbide slag and 1.5 million tonnes of by-product sulphuric acid per year, and add capacity of 400,000 t/a synthetic rutile and 1 million t/a ferrous sulphate.

Source: CCM & LB Group Co., Ltd.

As for the company's development plan in the 14<sup>th</sup> Five-Year Period (2021–2025), LB Group plans a performance target of annual revenue over RMB50 billion by 2025 from businesses such as TiO<sub>2</sub>, titanium products, mineral products, and new energy. The company will continue to focus on the TiO<sub>2</sub> business and try to enrich its product portfolio through technological innovation, transformation, and upgrading.

- TiO<sub>2</sub>

LB Group has found a way to reduce production cost of chloride process TiO<sub>2</sub> and hence will further expand capacity. It will increase the proportion of chloride process TiO<sub>2</sub> and shift toward mid- to high-end products to take the lead in the structural change in China's TiO<sub>2</sub> industry, thus further strengthening its influence.

- Raw material

In order to ensure the supply of raw materials for chloride process TiO<sub>2</sub>, in 2021, LB Group proposed the 7 million t/a green and efficient mineral processing project to ensure the supply of titanium ores. In 2022, LB Group announced to build a project of comprehensive utilisation of by-product sulphuric acid resources and chlor-alkali waste carbide slag for 400,000 t/a synthetic rutile in Gansu Province.

- Derivatives

LB Group sticks to product diversification. The company will focus on the development of titanium tetrachloride, titanium sponge, and high-end titanium alloy. It also tries to expand to derivative businesses of zirconium, iron, and scandium products. In 2022, its capacity of sponge titanium reached 50,000 t/a; in addition, by the end of 2022, both the 30,000 t/a titanium sponge project (phase II, 15,000 t/a) in Yunnan Province and the 30,000 t/a sponge titanium technology upgrading project (phase II, 15,000 t/a) in Gansu Province were under equipment installation.

- Industrial chain

LB Group, particularly the Jiaozuo base, has achieved co-production of sulphuric acid, TiO<sub>2</sub>, ferrous sulphate, iron oxide black, and scandium oxide. It has built 600,000 t/a sulphuric acid, 100,000 t/a iron pigment, 100,000 t/a scandium oxide, and 600,000 t/a gypsum production lines, which maximises resources utilisation rate and cuts pollution discharge, let alone its complete industrial chain of titanium industry covering ilmenite, rich titanium products (high titanium slag, synthetic rutile), TiO<sub>2</sub>, and titanium sponge. The company also seizes the development opportunities of the new energy industry as it has set up the 200,000 t/a battery material grade ferric phosphate project, 200,000 t/a Li-ion battery material industrialisation project, 100,000 t/a synthetic graphite anode material project, 200,000 t/a Li-ion battery anode material integration project, and 150,000 t/a electronic grade lithium ferrous phosphate project; part of lines planned in these projects had realised mass production as of the end of 2022.

Table 3.2-4 Financial figures of LB Group's major businesses, 2020–2022

Category	Sales, USD			YoY change, %			Operating cost, USD			YoY change, %			Gross profit margin		
	2022	2021	2020	2022	2021	2020	2022	2021	2020	2022	2021	2020	2022	2021	2020
<b>By industry</b>															
Chemicals and raw material manufacturing	3,459,258,072	2,973,141,552	2,065,388,922	16.4	44.0	24.0	2,426,226,215	1,715,384,124	1,332,604,183	41.4	28.7	38.4	29.9%	42.3%	35.5%
<b>By product</b>															
TiO <sub>2</sub>	2,415,656,529	2,269,418,662	1,635,153,194	6.4	38.8	25.2	1,716,766,388	1,247,650,957	1,046,718,597	37.6	19.2	40.7	28.9%	45.0%	36.0%
Iron products	370,876,080	315,044,339	284,531,447	17.7	10.7	9.4	204,766,341	162,022,402	160,209,746	26.4	1.1	11.1	44.8%	48.6%	43.7%
Sponge titanium	318,628,286	105,787,394	121,366,727	201.2	-12.8	433.5	227,984,969	149,762,522	106,978,030	186.0	40.0	558.5	28.5%	22.4%	11.9%
Zirconium products	156,705,039	145,926,537	4,146,658	7.4	3,419.1	-57.9	119,870,902	115,183,272	3,647,931	4.1	3,057.5	-53.2	23.5%	21.1%	12.0%
New energy materials	97,899,626	N/A	N/A	/	/	/	85,810,807	N/A	N/A	/	/	/	12.4%	/	/
Others	99,492,513	234,625,934	61,378,033	N/A	282.3	-36.6	71,026,808	40,764,972	15,049,879	N/A	170.9	-70.2	28.6%	18.1%	25.5%
<b>By region</b>															
Domestic	2,204,501,932	1,867,004,006	1,153,607,069	18.1	61.8	18.7	1,415,627,069	1,054,425,648	754,609,773	-9.0	39.7	34.3	31.4%	40.4%	32.2%
Overseas	1,395,953,252	1,203,798,860	952,968,990	16.0	26.3	31.5	1,010,599,145	660,958,477	577,994,410	-17.5	14.4	44.2	27.6%	45.1%	39.4%

Note: The financial figures of "New energy materials" were separated from "Others" in 2022.

Source: CCM & LB Group Co., Ltd.

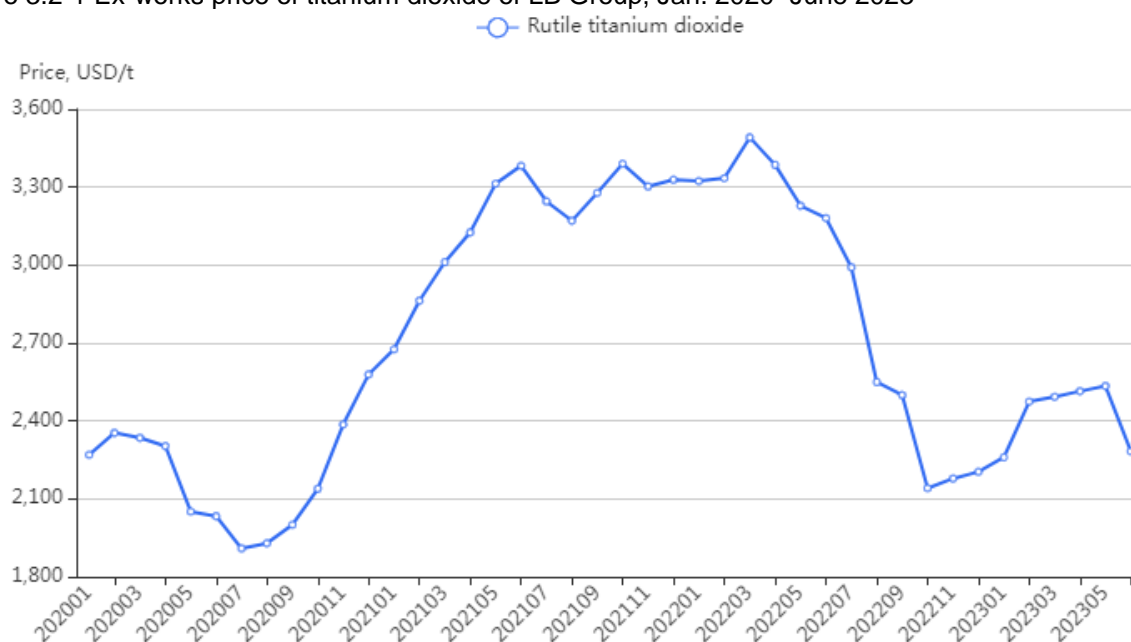
Table 3.2-5 Operating costs of LB Group's titanium dioxide business, 2020–2022

Item	2022		2021		2020	
	Value, USD	Proportion, %	Value, USD	Proportion, %	Value, USD	Proportion, %
Raw materials	1,139,330,203	66.4	787,005,235	63.1	668,529,641	63.9
Energy and power	323,066,338	18.8	251,564,603	20.2	220,728,589	21.1
Labour	72,459,624	4.2	51,099,721	4.1	48,437,043	4.6
Depreciation	67,327,961	3.9	63,560,845	5.1	67,371,508	6.4
Others	59,862,440	3.5	55,965,969	4.5	41,651,816	4.0
Freight	54,719,822	3.2	38,454,583	3.1	N/A	N/A
<b>Total</b>	<b>1,716,766,388</b>	<b>100.0</b>	<b>1,247,650,957</b>	<b>100.0</b>	<b>1,046,718,597</b>	<b>100.0</b>

Source: CCM & LB Group Co., Ltd.

### - Price

Figure 3.2-1 Ex-works price of titanium dioxide of LB Group, Jan. 2020–June 2023



Source: CCM

### 3.3 CNNC Hua Yuan Titanium Dioxide Co., Ltd.

#### - Company profile

CNNC Hua Yuan Titanium Dioxide Co., Ltd. (CNNC Hua Yuan, 002145) is headquartered in Jiayuguan City, Gansu Province. As the second largest TiO<sub>2</sub> producer in China, it has three TiO<sub>2</sub> production bases: Anhui Gold Star Titanium Dioxide (Group) Co., Ltd., Gansu Hecheng Titanium Dioxide Co., Ltd. and Gansu Dongfang Titanium Dioxide Co., Ltd.

Table 3.3-1 Major subsidiaries of CNNC Hua Yuan, 2022

No.	Subsidiary	Business location	Business	Shareholding ratio
1	Anhui Gold Star Titanium Dioxide (Group) Co., Ltd.	Ma'anshan City, Anhui Province	TiO <sub>2</sub> production	100%
2	Gansu Dongfang Titanium Dioxide Co., Ltd.	Baiyin City, Gansu Province	TiO <sub>2</sub> production	100%
3	Gansu Hecheng Titanium Dioxide Co., Ltd.	Jiayuguan City, Gansu Province	TiO <sub>2</sub> production	100%

Source: CCM & CNNC Hua Yuan Titanium Dioxide Co., Ltd.

#### - Production

Table 3.3-2 Capacity and output of titanium dioxide in CNNC Hua Yuan, 2020–2022

Year	Capacity, t/a	Output, tonne
2020	300,000	317,600
2021	300,000	324,200
2022	400,000	334,300

Source: CCM

The TiO<sub>2</sub> products of CNNC Hua Yuan are all sulphate-processed. The company's overall TiO<sub>2</sub> capacity increased to 400,000 t/a in 2022, ranking second in China. Its TiO<sub>2</sub> output increased from 317,600 tonnes in 2020 to 334,300 tonnes in 2022, with a CAGR of around 2.6%.

Table 3.3-3 Major events of CNNC Hua Yuan's production, 2020–2022

Time	Major event
Aug., 2020	CNNC Hua Yuan signed a cooperation agreement with the People's Government of Baiyin City. CNNC Hua Yuan will build a 500,000 t/a resources comprehensive utilisation project with clean production process in Yindong Industrial Park of Baiyin High Tech Zone. Upon completion, it will form 200,000 t/a crude TiO <sub>2</sub> and 300,000 t/a finished TiO <sub>2</sub> production capacity.
Oct., 2020	Xinjiang Desheng New Material Technology Co., Ltd. (Xinjiang Desheng), a subsidiary of CNNC Hua Yuan, signed a framework agreement on investment with Xinjiang Hami Municipal People's Government. Xinjiang Desheng will invest in a 2 million t/a high-quality titanium-rich material resources deep processing project, which is divided into three phases, and the first 1 million t/a production lines are scheduled to be finished before 2026. This project will guarantee the company's raw material supply for TiO <sub>2</sub> production.
Jan. 2021	CNNC Hua Yuan announced that Anhui Gold Star Titanium Dioxide (Group) Co., Ltd.'s 200,000 t/a post-processing project (phase II) would be postponed to Dec. 2021. However, in Nov. 2021, CNNC Hua Yuan announced that the project was expected to be completed and put into operation in Dec. 2022. (In March 2023, CNNC Hua Yuan announced to terminate the phase II.)
Feb. 2021	Subsidiary Gansu Dongfang Titanium Dioxide Co., Ltd. planned a 200,000 t/a crude TiO <sub>2</sub> production line and supporting auxiliary project, which will be finished by 2023. At the same time, the subsidiary planned to build 300,000 t/a finished TiO <sub>2</sub> production lines, which is expected to be completed in 2023.

Source: CCM & CNNC Hua Yuan Titanium Dioxide Co., Ltd.

Regarding the future development, CNNC Hua Yuan aims to build a green and circular industrial chain of "sulphur–phosphorus–iron–titanium–lithium" during the 14th Five-Year Period (2021–2025) with focus on TiO<sub>2</sub> business while developing the new energy sector by utilising by-products from TiO<sub>2</sub> production like waste sulphuric acid and ferrous sulphate.



Table 3.3-4 Financial figures of CNNC Hua Yuan's major businesses, 2020–2022

Category	Sales, USD			YoY change, %			Operating cost, USD			YoY change, %			Gross profit margin		
	2022	2021	2020	2022	2021	2020	2022	2021	2020	2022	2021	2020	2022	2021	2020
<b>By product</b>															
TiO <sub>2</sub>	754,712,903	793,530,967	551,310,104	-4.9	43.9	10.9	614,039,423	511,859,851	404,725,060	20.0	26.8	19.4	18.6%	35.5%	26.6%
<b>By region</b>															
Domestic	470,501,303	416,152,787	328,073,132	13.1	26.9	6.0	336,975,686	260,143,557	239,756,529	29.5	8.5	13.9	17.2%	36.1%	26.1%
Overseas	347,941,071	386,292,056	226,722,863	-9.9	70.4	18.9	277,063,738	251,716,294	164,968,531	10.1	52.6	28.3	20.4%	34.8%	27.2%

Source: CCM & CNNC Hua Yuan Titanium Dioxide Co., Ltd.

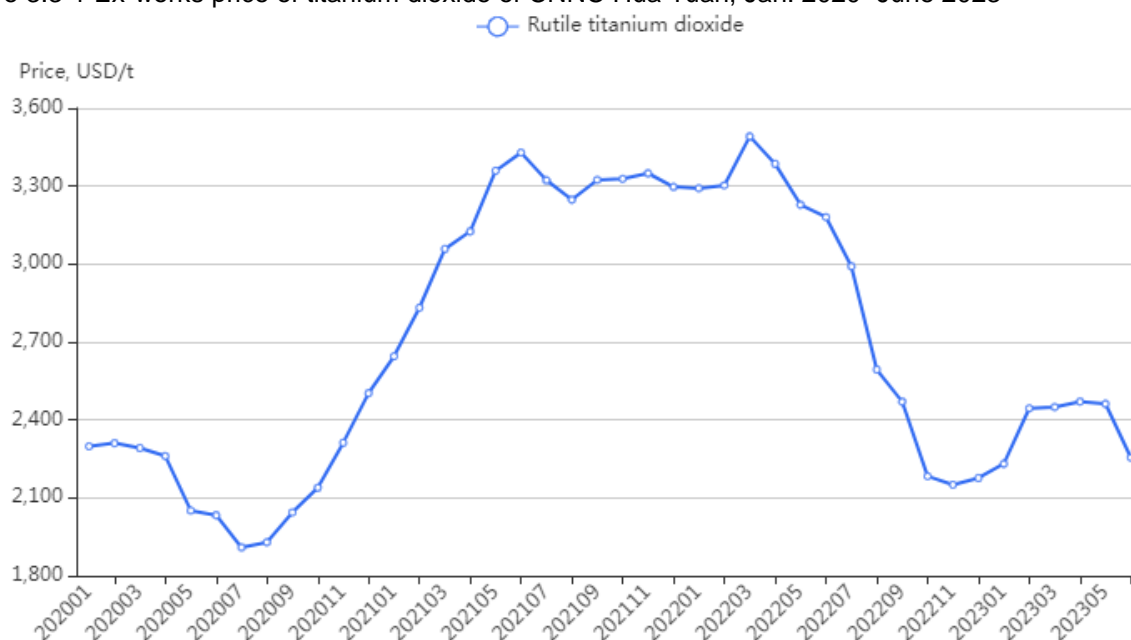
Table 3.3-5 Operating costs of CNNC Hua Yuan's titanium dioxide business, 2020–2022

Item	2022		2021		2020	
	Value, USD	Proportion, %	Value, USD	Proportion, %	Value, USD	Proportion, %
Feedstock	411,609,359	67.0	347,956,803	68.0	251,877,460	62.2
Energy	98,763,409	16.1	77,939,381	15.2	72,005,854	17.8
Labour	15,241,565	2.5	11,852,172	2.3	10,675,194	2.6
Manufacturing, depreciation and others	88,425,090	14.4	74,111,494	14.5	70,166,552	17.3
<b>Total</b>	<b>614,039,423</b>	<b>100.0</b>	<b>511,859,851</b>	<b>100.0</b>	<b>404,725,060</b>	<b>100.0</b>

Source: CCM & CNNC Hua Yuan Titanium Dioxide Co., Ltd.

- Price

Figure 3.3-1 Ex-works price of titanium dioxide of CNNC Hua Yuan, Jan. 2020–June 2023



Source: CCM

### 3.4 Pangang Group Vanadium & Titanium Resources Co., Ltd.

#### - Company profile

Pangang Group Vanadium & Titanium Resources Co., Ltd. (Pangang Group, 000629) was established in 1993 and headquarters in Panzhihua City, Sichuan Province. Its main businesses cover vanadium, titanium and electricity. Specifically, it is the biggest producer of vanadium products and a top five TiO<sub>2</sub> producer by production scale in China. Vanadium and titanium are Pangang Group's focuses for further development.

Table 3.4-1 Subsidiaries of Pangang Group, 2022

No.	Subsidiary	Business location	Business	Shareholding ratio
1	Pangang Group Titanium Industry Co., Ltd.	Panzhuhua City, Sichuan Province	Titanium products production	100%
2	Pangang Group Chongqing Titanium Industry Co., Ltd.	Chongqing Municipality	TiO <sub>2</sub> production	100%
3	Panzhuhua Dongfang Titanium Industry Co., Ltd.	Panzhuhua City, Sichuan Province	TiO <sub>2</sub> production and sale	65%
4	Panzhuhua Guotai Science & Technology Co., Ltd.	Panzhuhua City, Sichuan Province	Titanium slag production	51%

Source: CCM & Pangang Group Vanadium & Titanium Resources Co., Ltd.

## - Production

Table 3.4-2 Capacity and output of titanium dioxide in Pangang Group, 2020–2022

Year	Capacity, t/a	Output, tonne
2020	235,000	235,500
2021	235,000	244,400
2022	235,000	243,500

Source: CCM

As China's third largest producer of TiO<sub>2</sub> (by output), Pangang Group is one of the few companies in China that can produce TiO<sub>2</sub> through both sulphate and chloride processes. In 2020–2022, Pangang Group's TiO<sub>2</sub> production capacity maintained at the same level, with 220,000 t/a sulphate process TiO<sub>2</sub> and 15,000 t/a chloride process TiO<sub>2</sub> capacity. Its output fluctuated slightly in this period.

Table 3.4-3 Major events of Pangang Group's production, 2020–2022

Time	Major event
Nov. 2020	Pangang Group signed a cooperation agreement with Western Metal Materials Co., Ltd. In 2021, the two formed a strategic partnership in production, marketing, research and service to promote the sharing of cooperation results of special purpose small-grain titanium, ultra-soft titanium and titanium materials.
Oct. 2021	Pangang Group acquired 100% shares of Pangang Group Xichang Vanadium Products Technology Co., Ltd.
Sept. 2022	Pangang Group disclosed its plan for private issuing of A-shares 2022, showing that the company intended to raise capital for projects including the 60,000 t/a molten-salt chloride process TiO <sub>2</sub> project. This project is constructed by Pangang Group Titanium Industry Co., Ltd. and is expected to be completed in 2024.

Source: CCM & Pangang Group Vanadium & Titanium Resources Co., Ltd.

Table 3.4-4 Financial figures of Pangang Group's major businesses, 2020–2022

Category	Sales, USD			YoY change, %			Operating cost, USD			YoY change, %			Gross profit margin		
	2022	2021	2020	2022	2021	2020	2022	2021	2020	2022	2021	2020	2022	2021	2020
<b>By industry</b>															
Vanadium products	868,195,408	674,192,804	557,101,740	28.8	21.0	-39.5	589,667,798	468,587,040	441,018,940	25.8	6.3	-34.7	32.1%	30.5%	14.5%
Titanium products	949,839,123	1,014,604,076	633,285,467	-6.4	60.2	-2.6	890,209,912	834,627,253	579,562,652	6.7	44.0	4.4	6.3%	17.7%	11.2%
Electricity	286,257,142	281,555,226	286,205,204	1.7	-1.6	3.8	275,982,212	249,651,834	258,856,842	10.6	-3.6	6.2	3.6%	11.3%	9.6%
<b>By product</b>															
Vanadium products	868,195,408	674,192,804	557,101,740	28.8	21.0	-39.5	589,667,798	468,587,040	441,018,940	25.8	6.3	-34.7	32.1%	30.5%	14.5%
Titanium slag	130,540,033	165,149,992	112,992,298	-21.0	46.2	21.5	126,259,032	137,566,162	96,428,182	-8.2	42.7	16.6	3.3%	16.7%	15.1%
TiO <sub>2</sub>	544,599,862	608,138,077	406,140,516	-10.5	49.7	-10.7	503,198,038	463,027,873	373,146,943	8.7	24.1	-2.5	7.6%	23.9%	10.2%
Electricity	286,257,142	281,555,226	286,205,204	1.7	-1.6	3.8	275,982,212	249,651,834	258,856,842	10.6	-3.6	6.2	3.6%	11.3%	9.6%
<b>By region</b>															
Domestic	1,911,541,125	1,763,458,459	1,379,057,849	8.4	27.9	-15.7	1,593,928,733	1,408,505,966	1,193,446,845	13.2	18.0	-12.6	16.6%	20.1%	11.8%
Overseas	341,272,943	335,967,242	194,518,921	1.6	72.7	-47.4	291,735,095	272,687,611	180,337,022	7.0	51.2	-14.7	14.5%	18.8%	9.4%

Source: CCM &amp; Pangang Group Vanadium &amp; Titanium Resources Co., Ltd.

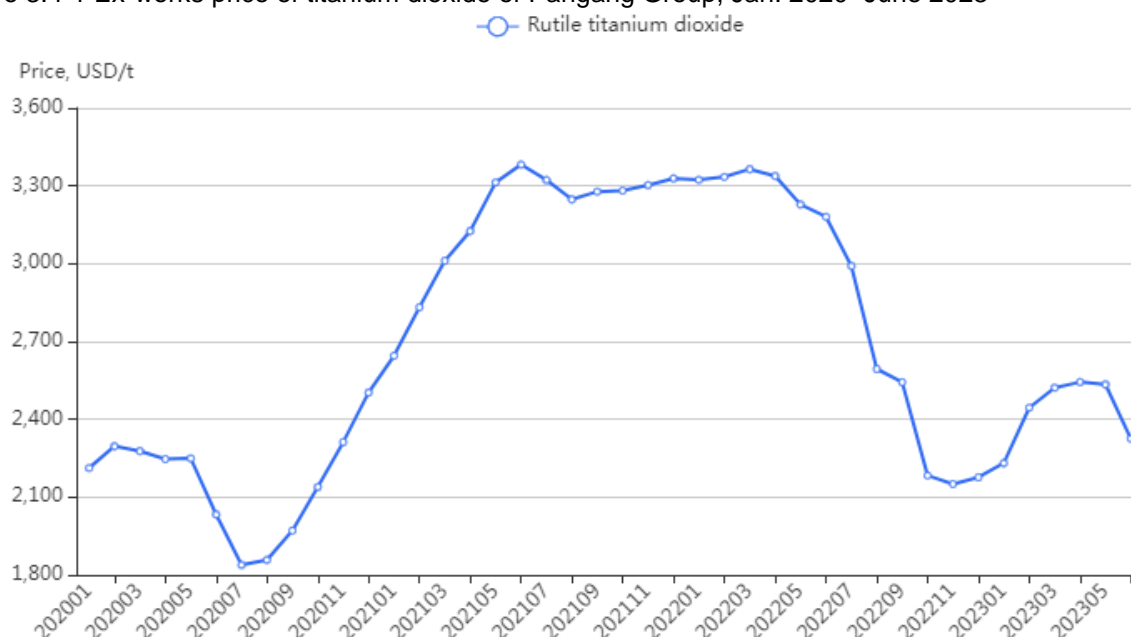
Table 3.4-5 Operating costs of Pangang Group's titanium dioxide business, 2020–2022

Item	2022		2021		2020	
	Value, USD	Proportion, %	Value, USD	Proportion, %	Value, USD	Proportion, %
Raw materials and energy	424,536,233	84.4	374,347,353	80.8	301,374,659	80.8
Others	78,661,805	15.6	88,680,520	19.2	71,772,284	19.2
<b>Total</b>	<b>503,198,038</b>	<b>100.0</b>	<b>463,027,873</b>	<b>100.0</b>	<b>373,146,943</b>	<b>100.0</b>

Source: CCM & Pangang Group Vanadium & Titanium Resources Co., Ltd.

## - Price

Figure 3.4-1 Ex-works price of titanium dioxide of Pangang Group, Jan. 2020–June 2023



Source: CCM

## 3.5 Shandong Lubei Chemical Co., Ltd.

### - Company profile

Established in 1996, Shandong Lubei Chemical Co., Ltd. (Lubei Chemical, 600727) has a registered capital of RMB528.58 million. Headquartered in Binzhou City, Shandong Province, Lubei Chemical possesses two TiO<sub>2</sub> production bases: Shandong Jinhai Titanium Resources Technology Co., Ltd. (Shandong Jinhai) and Shandong Xianghai Titanium Resources Technology Co., Ltd. (Shandong Xianghai).

Table 3.5-1 Major subsidiaries of Lubei Chemical in titanium dioxide business, 2022

No.	Subsidiary	Business location	Business	Shareholding ratio
1	Shandong Jinhai Titanium Resources Technology Co., Ltd.	Binzhou City, Shandong Province	TiO <sub>2</sub> production and sale	100%
2	Shandong Xianghai Titanium Resources Technology Co., Ltd.	Binzhou City, Shandong Province	TiO <sub>2</sub> production and sale	100%

Source: CCM & Shandong Lubei Chemical Co., Ltd.

## - Production

Table 3.5-2 Capacity and output of titanium dioxide in Lubei Chemical, 2020–2022

Year	Capacity, t/a	Output, tonne
2020	100,000	133,500
2021	200,000	153,400
2022	260,000	191,400

Source: CCM & Shandong Lubei Chemical Co., Ltd.

Both the capacity and output of TiO<sub>2</sub> of Lubei Chemical showed an upward trend in 2020–2022. Specifically, the company's TiO<sub>2</sub> capacity increased to 260,000 t/a in 2022, ranking third in China.

Table 3.5-3 Major events of Lubei Chemical's production, 2020–2022

Time	Major event
Feb. 2020	Lubei Chemical revealed the acquisition plan, showing that it would purchase 66% shares and 34% shares of Shandong Jinhai from Shandong Lubei Enterprise Group Company (Shandong Lubei) and Hangzhou Jinjiang Group; Meanwhile, Lubei Chemical would purchase 100% shares of Shandong Xianghai from Shandong Lubei. Afterwards, the two companies became the wholly-owned subsidiaries of Lubei Chemical.
Nov. 2021	Lubei Chemical announced that the 100,000 t/a rutile TiO <sub>2</sub> relocation and technical renovation project and the project of Shandong Jinhai was put into production officially, increasing Lubei Chemical's TiO <sub>2</sub> capacity to 200,000 t/a.
April 2022	Lubei Chemical announced that the 60,000 t/a chloride process TiO <sub>2</sub> project of Shandong Xianghai was officially put into production, pushing Lubei Chemical's TiO <sub>2</sub> capacity to 260,000 t/a.

Source: CCM & Shandong Lubei Chemical Co., Ltd.

With respect to future development, Lubei Chemical will stick to a diversified development strategy and focus on development of the titanium industry by relying on resource and technical advantages. The company will also enhance R&D on chloromethane products to extend the fine chemical industrial chain. It will rigorously improve waste resource utilisation.

Table 3.5-4 Financial figures of Lubei Chemical's major businesses, 2020–2022

Category	Sales, USD			YoY change, %			Operating cost, USD			YoY change, %			Gross profit margin		
	2022	2021	2020	2022	2021	2020	2022	2021	2020	2022	2021	2020	2022	2021	2020
<b>By industry</b>															
Chemicals	680,454,164	628,616,346	391,329,796	8.3	60.6	6.0	616,341,920	506,119,647	334,146,646	21.8	51.5	12.4	9.4%	19.5%	14.6%
Building materials	14,778,811	15,119,426	17,659,588	-2.3	-14.4	-3.6	14,065,986	14,603,154	16,001,500	-3.7	-8.7	-5.9	4.8%	3.4%	9.4%
<b>By product</b>															
TiO <sub>2</sub>	408,030,197	349,932,016	211,516,746	16.6	65.4	-2.9	420,832,975	294,857,047	194,061,545	42.7	51.9	3.4	-3.1%	15.7%	8.3%
Ferrous sulphate	13,079,330	N/A	N/A	/	/	/	5,553,121	N/A	N/A	/	/	/	57.5%	/	/
Chloromethane	183,728,307	188,851,221	104,601,908	-2.7	80.5	25.1	139,356,781	147,053,426	78,811,246	-5.2	86.6	50.5	24.2%	22.1%	24.7%
Raw salt	27,552,640	21,975,809	15,399,709	25.4	42.7	-5.9	8,596,462	8,970,881	8,681,671	-4.2	3.3	11.7	68.8%	59.2%	43.6%
Bromine	11,855,488	19,942,271	12,641,381	-40.6	57.8	39.6	4,414,184	5,046,895	3,522,423	-12.5	43.3	27.8	62.8%	74.7%	72.1%
Fertiliser	36,208,202	47,915,027	47,152,666	-24.4	1.6	17.3	37,588,397	50,191,398	49,033,110	-25.1	2.4	20.9	-3.8%	-4.8%	-4.0%
Cement	14,778,811	15,119,426	17,659,588	-2.3	-14.4	-3.6	14,065,986	14,603,154	16,001,500	-3.7	-8.7	-5.9	4.8%	3.4%	9.4%
Others	10,614,349	6,433,675	393,839	65.0	1,533.6	-81.9	9,351,490	6,101,736	160,328	53.3	3,705.8	-97.4	11.9%	5.2%	59.3%
<b>By region</b>															
Domestic	514,062,312	474,002,533	308,493,256	8.5	53.7	N/A	444,123,225	379,607,481	259,278,632	17.0	46.4	N/A	13.6%	19.9%	16.0%
Overseas	191,785,012	176,166,913	100,872,581	8.9	74.6	22.3	195,636,170	147,217,055	90,993,191	32.9	61.8	25.6	-2.0%	16.4%	9.8%

Source: CCM & Shandong Lubei Chemical Co., Ltd.

Table 3.5-5 Operating costs of Lubei Chemical's titanium dioxide business, 2020–2022

Item	2022		2021		2020	
	Value, USD	Proportion, %	Value, USD	Proportion, %	Value, USD	Proportion, %
Raw materials	372,902,002	83.9	249,267,384	80.7	151,116,603	75.7
Labour	9,048,033	2.0	6,829,090	2.2	7,453,623	3.7
Electricity	19,638,532	4.4	11,862,182	3.8	10,872,042	5.4
Others	42,838,567	9.6	40,917,296	13.2	30,099,885	15.1
<b>Total</b>	<b>444,427,135</b>	<b>100.0</b>	<b>308,875,951</b>	<b>100.0</b>	<b>199,542,153</b>	<b>100.0</b>

Note: Due to rounding, the total may not equal 100.0%.

Source: CCM & Shandong Lubei Chemical Co., Ltd.

### 3.6 GPRO Investment Holding Group Co., Ltd.

#### - Company profile

Headquartered in Nanjing City, Jiangsu Province, GPRO Investment Holding Group Co., Ltd. (GPRO Group)'s main businesses cover manufacturing, real estate, financial, tourism, and food industries.

GPRO Titanium Industry Co., Ltd. (GPRO Titanium, 000545), a holding subsidiary of GPRO Group, is a listed company. It is a large-scale sulphate process TiO<sub>2</sub> producer in China, with rutile TiO<sub>2</sub> and anatase TiO<sub>2</sub> as main products. Its TiO<sub>2</sub> production bases are Nanjing Titanium Dioxide Chemical Co., Ltd. (Nanjing Titanium) and Xuzhou Titanium Dioxide Chemical Co., Ltd. (Xuzhou Titanium). Specifically, Nanjing Titanium produces rutile TiO<sub>2</sub> and Xuzhou Titanium produces both rutile and anatase TiO<sub>2</sub>.

Jiangsu Taibai Group Co., Ltd. (Jiangsu Taibai), another subsidiary of GPRO Group, is also a main domestic TiO<sub>2</sub> manufacturer. It produces both rutile and anatase TiO<sub>2</sub>, with rutile TiO<sub>2</sub> accounting for about 90%. In March 2020, 100% equity of Jiangsu Taibai was transferred to GPRO Group.

Table 3.6-1 Main subsidiaries of GPRO Group, 2022

No.	Subsidiary	Business location	Business
1	GPRO Titanium Industry Co., Ltd.	Jilin City, Jilin Province	TiO <sub>2</sub> production and sale
2	Nanjing Titanium Dioxide Chemical Co., Ltd.	Nanjing City, Jiangsu Province	TiO <sub>2</sub> production
3	Xuzhou Titanium Dioxide Chemical Co., Ltd.	Xuzhou City, Jiangsu Province	TiO <sub>2</sub> production
4	Jiangsu Taibai Group Co., Ltd.	Zhenjiang City, Jiangsu Province	TiO <sub>2</sub> production
5	Jiangsu Zhentai Chemical Co., Ltd.	Zhenjiang City, Jiangsu Province	TiO <sub>2</sub> production and sale

Source: CCM & GPRO Investment Holding Group Co., Ltd.



## - Production

Table 3.6-2 Capacity and output of titanium dioxide in GPRO Group, 2020–2022

Year	Capacity, t/a	Output, tonne
2020	260,000	187,600
2021	260,000	204,000
2022	260,000	190,000

*Note: The capacity and output of Jiangsu Taibai are consolidated into GPRO Group since 2020.  
Source: CCM*

Table 3.6-3 Major events of GPRO Group's production, 2020–2022

Time	Major event
Jan. 2020	Nanjing Titanium, a subsidiary of GPRO Titanium, and Nippon Paint (China) Holdings Co., Ltd. signed a cooperation agreement on the supply and application of TiO <sub>2</sub> .
March 2020	GPRO Group announced to acquire 100% shares of Jiangsu Taibai Group Co., Ltd. (Jiangsu Taibai), and would promote GPRO Titanium to acquire Jiangsu Taibai within 36 months after Jiangsu Taibai completed the industrial and commercial change registration.
March 2021	Nanjing Titanium signed a cooperation agreement with Jiangsu Jiuwu Hi-Tech Co., Ltd. The latter would help dispose of titanium gypsum solid wastes for Nanjing Titanium.

*Source: CCM & GPRO Investment Holding Group Co., Ltd.*

**- GPRO Titanium**

Table 3.6-4 Financial figures of GPRO Titanium's major businesses, 2020–2022

Category	Sales, USD			YoY change, %			Operating cost, USD			YoY change, %			Gross profit margin		
	2022	2021	2020	2022	2021	2020	2022	2021	2020	2022	2021	2020	2022	2021	2020
<b>By business</b>															
TiO <sub>2</sub>	362,607,997	376,841,456	260,253,992	-3.8	44.8	-4.0	343,065,544	305,643,967	245,102,688	12.2	24.7	6.7	5.4%	18.9%	5.8%
Supply chain	5,632,556	6,769,102	6,087,500	-0.2	11.2	49.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Commercial factoring	6,542,423	7,617,057	7,518,246	-0.1	1.3	18.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<b>By product</b>															
Anatase TiO <sub>2</sub>	258,021,417	297,115,683	207,355,622	-13.2	43.3	-4.4	245,987,597	241,703,351	194,134,278	1.8	24.5	8.6	4.7%	18.7%	6.4%
Rutile TiO <sub>2</sub>	79,980,717	68,385,052	50,833,305	17.0	34.5	-6.0	72,993,328	54,256,114	49,347,069	34.5	10.0	1.8	8.7%	20.7%	2.9%
<b>By region</b>															
Domestic	289,865,973	299,655,757	216,603,467	-3.3	38.3	-9.7	271,889,471	236,668,853	196,791,359	14.9	20.3	-0.8	6.2%	21.0%	9.1%
Overseas	84,917,002	91,571,858	57,256,270	-7.3	59.9	37.9	79,220,187	74,456,418	53,713,092	6.4	38.6	54.9	6.7%	18.7%	6.3%

Source: CCM & GPRO Titanium Industry Co., Ltd.

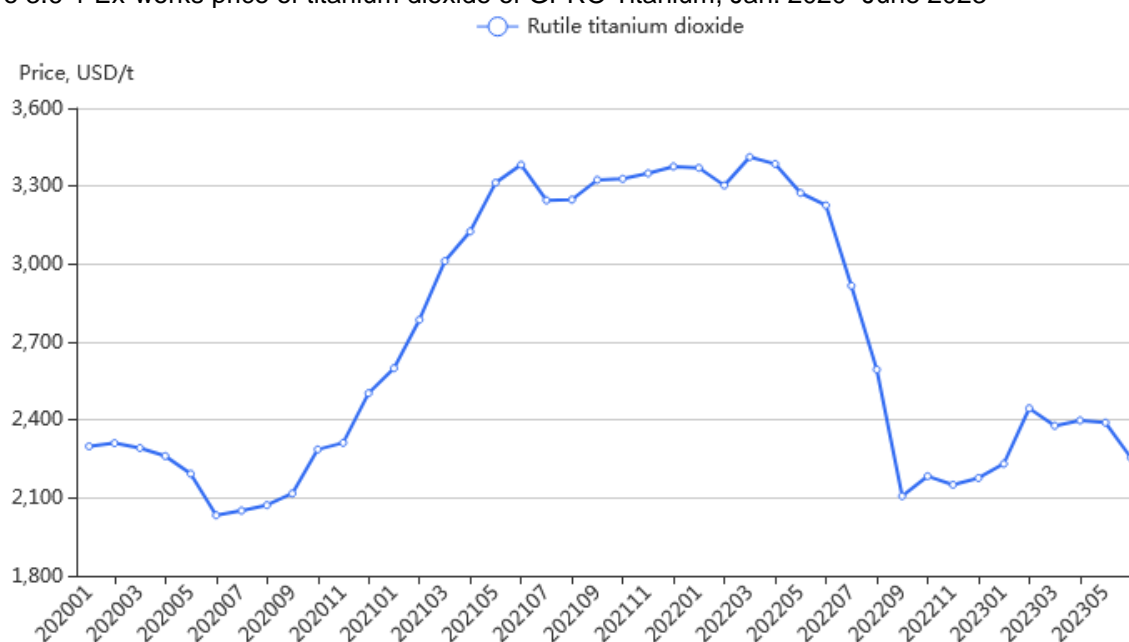
Table 3.6-5 Operating costs of GPRO Titanium's titanium dioxide business, 2020–2022

Item	2022		2021		2020	
	Value, USD	Proportion, %	Value, USD	Proportion, %	Value, USD	Proportion, %
Feedstock	195,131,599	61.2	186,785,240	63.1	135,339,433	55.6
Energy	74,455,426	23.3	62,364,674	21.1	61,888,453	25.4
Labour	14,370,941	4.5	15,478,292	5.2	13,481,736	5.5
Depreciation	12,050,092	3.8	13,115,612	4.4	16,653,925	6.8
Others	22,972,867	7.2	18,215,647	6.2	16,117,801	6.6
<b>Total</b>	<b>318,980,925</b>	<b>100.0</b>	<b>295,959,465</b>	<b>100.0</b>	<b>243,481,347</b>	<b>100.0</b>

Source: CCM & GPRO Titanium Industry Co., Ltd.

- Price

Figure 3.6-1 Ex-works price of titanium dioxide of GPRO Titanium, Jan. 2020–June 2023



Source: CCM

### 3.7 Shandong Doguide Group Co., Ltd.

- Company profile

Established in 2002, Shandong Doguide Group Co., Ltd. (Shandong Doguide) has a registered capital of RMB100 million. Headquartered in Zibo City, Shandong Province, Shandong Doguide is mainly dedicated to the production and sale of TiO<sub>2</sub>, sulphuric acid, purifying agent, etc. And it is one of the large-scale sulphate process TiO<sub>2</sub> producers in China.

Table 3.7-1 Major subsidiaries of Shandong Doguide in titanium dioxide business, 2022

No.	Subsidiary	Business location	Business	Shareholding ratio
1	Shandong Jinhong Titanium Dioxide Chemicals Co., Ltd.	Zibo City, Shandong Province	TiO <sub>2</sub> production	58.5%
2	Shandong Suntiox Industrial Co., Ltd.	Zibo City, Shandong Province	Chemical fibre grade TiO <sub>2</sub> production	80%

Source: CCM

### - Production

Table 3.7-2 Capacity and output of titanium dioxide in Shandong Doguide, 2020–2022

Year	Capacity, t/a	Output, tonne
2020	220,000	170,000
2021	220,000	189,100
2022	220,000	170,000

Source: CCM

## 3.8 Anhui Annada Titanium Industry Co., Ltd.

### - Company profile

Anhui Annada Titanium Industry Co., Ltd. (Anhui Annada, 002136), headquartered in Tongling City, Anhui Province, is also one of the large-scale sulphate process TiO<sub>2</sub> producers in China. Anhui Annada itself is mainly involved in the production and sale of TiO<sub>2</sub>; its subsidiary Tongling Nayuan Material Science and Technology Co., Ltd. specialises in iron phosphate business.

### - Production

Table 3.8-1 Capacity and output of titanium dioxide in Anhui Annada, 2020–2022

Year	Capacity, t/a	Output, tonne
2020	80,000	85,300
2021	80,000	102,800
2022	80,000	101,700

Source: CCM

TiO<sub>2</sub> products of Anhui Annada are all sulphate-processed. In 2020–2022, TiO<sub>2</sub> capacity of Anhui Annada maintained at 80,000 t/a, with about 20,000 t/a of anatase TiO<sub>2</sub> and 60,000 t/a of rutile TiO<sub>2</sub>. In 2021, Anhui Annada's yearly output for the first time crossed the 100,000 tonnes, based on improved management.

Table 3.8-2 Major events of Anhui Annada's production, 2020–2022

Time	Major event
Dec. 2020	Anhui Ananda issued the EI report of the 50,000 t/a of rutile TiO <sub>2</sub> for plastics and inks upgrading project. The project is expected to be completed in 2024.

Source: CCM

Table 3.8-3 Financial figures of Anhui Annada's major businesses, 2020–2022

Category	Sales, USD			YoY change, %			Operating cost, USD			YoY change, %			Gross profit margin		
	2022	2021	2020	2022	2021	2020	2022	2021	2020	2022	2021	2020	2022	2021	2020
<b>By industry</b>															
Chemicals and raw material manufacturing	396,227,292	302,898,260	166,030,170	30.8	82.4	7.9	311,338,030	254,082,184	146,030,032	22.5	74.0	9.60	21.4%	16.1%	12.1%
<b>By product</b>															
TiO <sub>2</sub>	229,744,769	241,110,794	146,685,047	-4.7	64.4	3.2	206,171,233	205,733,518	130,178,131	0.2	58.0	N/A	10.3%	14.5%	11.1%
Iron phosphate	166,482,522	61,787,466	19,345,123	169.4	219.4	63.6	105,166,797	49,149,543	16,012,753	113.4	206.9	N/A	36.8%	22.3%	19.1%
<b>By region</b>															
Domestic	340,922,434	248,055,154	131,837,803	37.4	88.2	6.2	254,049,893	206,012,146	114,962,135	23.3	79.2	N/A	23.5%	16.2%	12.0%
Overseas	64,361,072	57,589,752	35,651,170	11.8	61.5	15.6	57,288,137	48,510,886	31,315,529	18.1	54.9	N/A	11.0%	15.8%	12.2%

Note: The financial figures were applicable to industries, products or regions where the company's operating income or operating profit is more than 10%.

Source: CCM & Anhui Annada Titanium Industry Co., Ltd.

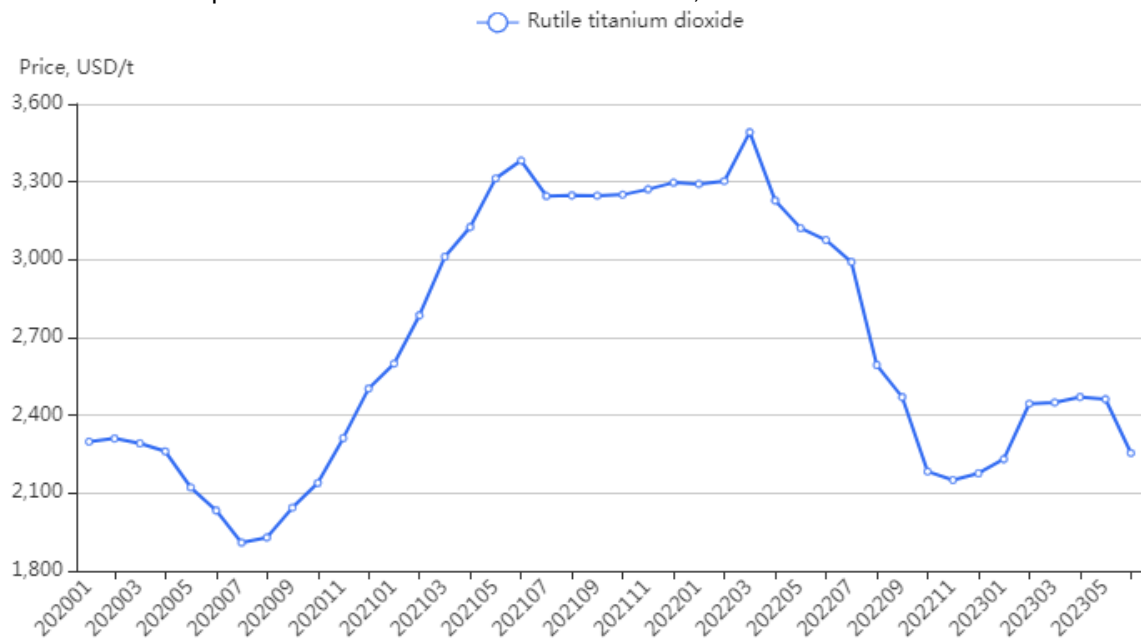
Table 3.8-4 Operating costs of Anhui Annada's chemicals and raw material manufacturing business, 2020–2022

Item	2022		2021		2020	
	Value, USD	Proportion, %	Value, USD	Proportion, %	Value, USD	Proportion, %
Raw material, fuel and energy	261,104,305	83.9	211,827,130	83.4	110,450,886	75.6
Manufacturing	11,004,507	3.5	9,115,755	3.6	6,713,907	4.6
Labour	7,020,042	2.3	6,778,627	2.7	6,543,113	4.5
Depreciation	32,209,175	10.3	26,360,671	10.4	22,322,126	15.3
<b>Total</b>	<b>311,338,030</b>	<b>100.0</b>	<b>254,082,184</b>	<b>100.0</b>	<b>146,030,032</b>	<b>100.0</b>

Source: CCM & Anhui Annada Titanium Industry Co., Ltd.

- Price

Figure 3.8-1 Ex-works price of titanium dioxide of Anhui Annada, Jan. 2020–June 2023



Source: CCM

## 4 Highlighted cases

### 4.1 Enterprise dynamics during 2020–2022

China's titanium industry has come to a phase where the increasing demand could be satisfied at lower costs. As the market has turned better but competition has become fiercer year by year, heavier investments have been poured in the titanium industry.

Domestic enterprises make restructuring and asset acquisitions mainly through the following ways:

- Big enterprises acquire small ones to expand their production scale.
- Merge with another company of similar size to meet the requirements of the industry policy.

Table 4.1-1 Events of titanium dioxide enterprises in China, 2020–2022

Time	Event	Status	Note
21 March, 2020	GPRO Investment Holding Group Co., Ltd., controlling shareholder of GPRO Titanium Industry Co., Ltd., announced to acquire 100% shares of Jiangsu Taibai Group Co., Ltd.	Finished	There is horizontal competition between GPRO Titanium Industry Co., Ltd. and Jiangsu Taibai Group Co., Ltd. after the acquisition. GPRO Investment Holding Group Co., Ltd. has promised to fix that in 36 months.
7 Dec., 2022	LB Group Co., Ltd. announced to purchase the ilmenite beneficiation plants, high titanium slag lines and related assets of LB Wuding Titanium Industry Co., Ltd.	Finished	The purchased assets from LB Wuding Titanium Industry Co., Ltd. include 50,000 t/a ilmenite concentrate beneficiation capacity and 80,000 t/a high titanium slag capacity.

Note: Here the events mainly focus on stock exchange announcements.

Source: CCM

In addition to horizontal mergers and acquisitions, TiO<sub>2</sub> enterprises also make full use of the surrounding environment and create conditions for co-production to reduce wastes and achieve resources recycling. For example, LB Group, CNNC Hua Yuan and Anhui Annada have entered lithium battery industry; Guangdong Huiyun Titanium Industry Co., Ltd. has built a "sulphur—titanium—iron—calcium" industry chain.

### 4.2 Policy and legislation

Environmental protection is a basic national policy in China and it is playing an increasingly important role in Chinese industries. The establishment of the Ministry of Environmental Protection in 2008 demonstrated China's determination to reduce pollution and achieve sustainable development.

In 2018, the State Council reformed its subordinate institutions. The Ministry of Environmental Protection was revoked and replaced by the Ministry of Ecology and Environment (MEE), whose main responsibilities are to formulate and implement eco-environmental policies, plans and standards, to take the charge of ecological environment monitoring and law enforcement, to supervise and manage pollution prevention and treatment activities, as well as to organise environmental protection inspections. The establishment of the MEE highlights the Chinese government's commitment to environmental protection.

Recent years, with increasing attentions being paid to environmental protection by government departments, the TiO<sub>2</sub> industry in China has faced with unprecedented pressure as an industry of high pollution, high energy consumption, and high water consumption. During this period, the most influential actions upon China's TiO<sub>2</sub> industry were the central environmental protection inspections starting from Dec. 2015.

Central inspection teams were formed under the leadership of the Ministry of Environmental Protection in Jan. 2016. These teams were scheduled to head altogether to 31 provinces/municipalities/autonomous regions through several batches. The inspection work did not have a day off; local environmental protection authorities were also required to conduct appropriate inspections and supervise rectification work before and after the inspections by the central government. Such inspections are unprecedented in terms of both time spent and regions covered. Major TiO<sub>2</sub> production bases were all affected for quite a time. The majority of TiO<sub>2</sub> manufacturers had to suspend or cut production given the stricter requirements and meticulous inspection.

After the first round of central inspection, on 29 March, 2018, the spokesperson of MEE stated that the Ministry planned to carry out the second round during 2018–2021. It aims to establish a dual-inspection system with the central government and provincial governments complementing each other to improve the long-term mechanism for environmental protection.

In addition, before the official announcement of a planned second round, the first round was then still ongoing in certain regions, teams of central inspection launched environmental protection reviews now and then to check the implementation of the rectification plans. At the same time, environmental protection actions against severe air pollution were conducted in Beijing-Tianjin-Hebei Region.

Major impacts of the environmental protection inspections upon domestic TiO<sub>2</sub> industry are:

First, environmental protection cost grows ever higher. Since 2016, environmental protection policies have become stricter in China. Once deemed unqualified, those companies would suffer environmental protection penalties, production suspension for rectification, which involuntarily drives up the cost of pollution treatment. Currently, most domestic TiO<sub>2</sub> production goes through sulphate process and the waste water treatment cost accounts for more than 10% of the production cost.

Second, the living space of small- and medium-sized producers has been narrowed. According to laws and regulations, environmental protection facilities must be designed, constructed and put into operation simultaneously with the production lines. For sulphate process TiO<sub>2</sub> production, however, requirements for resources utilisation and environmental protection facilities are higher than those in chloride process TiO<sub>2</sub> production, because of extra treatment of by-products. Therefore, the sulphate process TiO<sub>2</sub> producers face greater pressure on environmental protection investment and operation. Particularly, small- and medium-sized producers have greater risks of being eliminated due to their weaknesses in capital and technology.

In order to effectively utilise titanium resources, reduce pollution and energy consumption, regulate market order and upgrade the industry, a series of policies has been put forward to regulate China's TiO<sub>2</sub> industry. These policies point out four orientations in future regulatory work:

- Firstly, restrain expansion of currently dominant sulphate process technology;
- Secondly, encourage the development of chloride process;
- Thirdly, push TiO<sub>2</sub> producers to improve environmental protection technology;
- Fourthly, promote industry integration.

Table 4.2-1 Relevant policies & legislations on Chinese titanium dioxide industry, 2012–2022

Issue time	Document	Issued by	Content
July 2012	<i>12<sup>th</sup> Five-Year Plan for Comprehensive Utilisation of Vanadium &amp; Titanium Resources</i>	NDRC	Weed out backward TiO <sub>2</sub> production lines in 2015, including: the sulphate process production line with capacity less than 20,000 t/a; the chloride process production line with capacity less than 15,000 t/a.
April 2016	<i>Draft of Negative List for Market Access (pilot version)</i>	NDRC	Forbid the construction of new TiO <sub>2</sub> projects with the sulphate process. The pilot areas were Tianjin, Shanghai, Fujian and Guangdong provincial level administration regions. Full coverage across China was officially implemented in Dec. 2018.
Jan. 2017	<i>Notice of the Ministry of Finance and the State Administration of Taxation on Comprehensively Promoting the Reform of Resource Tax</i>	SAT	Reduce resource tax on eligible cut-and-fill mining and mines at the stage of exhaustion. Encourage the exploitation of low-grade minerals and waste slag.
Oct. 2019	<i>Guidance Catalogue for Industrial Structure Adjustment (2019 version)</i>	NDRC	New capacity of sulphate process TiO <sub>2</sub> is listed in the Restricted Catalogue, while chloride process project with a capacity of over 30,000 t/a (included) per production line is listed in the Encouraged Catalogue.
Dec. 2020	<i>Catalogue of Prohibited Commodities in Processing Trade</i>	MOFCOM and GACC	TiO <sub>2</sub> was removed from the Catalogue from 1 Dec., 2020.
March 2021	<i>Guiding Opinions on the Comprehensive Utilisation of Bulk Solid Wastes in the 14<sup>th</sup> Five-Year Plan (2021–2025)</i>	NDRC	To scale up high-value utilisation of industrial by-product gypsum. To explore ways to recycle industrial by-product gypsum such as titanium gypsum and fluorogypsum.
Nov. 2021	<i>14<sup>th</sup> Five-Year Plan for Green Industrial Development</i>	MIIT	To promote large-scale comprehensive utilisation of industrial solid wastes. To promote efficient and collaborative utilisation of natural resources, and strengthen the development of coexisting and associated mineral resources such as vanadium and titanium resources in vana-titano magnetite ores.



<b>Issue time</b>	<b>Document</b>	<b>Issued by</b>	<b>Content</b>
Jan. 2022	<i>Guiding Opinions on Promoting High-Quality Development of Iron and Steel Industry</i>	MIIT, NDRC and MEE	To promote application of comprehensive beneficiation and utilisation technology of refractory ores and promote comprehensive exploration and utilisation of vanadic titanomagnetite.
June 2022	<i>Notice on Issuing the Action Plan for Improving Industrial Water Utilisation Efficiency</i>	MIIT, NDRC, etc.	The water consumption of unit product is 60 m <sup>3</sup> /t in TiO <sub>2</sub> industry in 2020 and the goal is to reduce the figure by 5% by 2025.

Source: Above-mentioned issuing departments & CCM

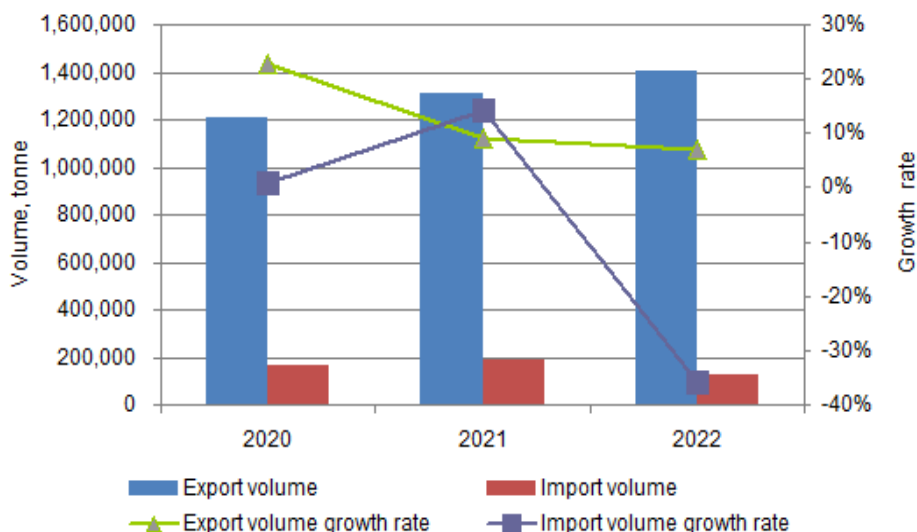
## 5 Import and export analysis

### 5.1 Overview 2020–2022

The export volume of TiO<sub>2</sub> from China continued to reach new highs in 2020–2022, along with improvement of product quality and contraction of TiO<sub>2</sub> production capacity overseas. With TiO<sub>2</sub> export exceeding 1,200,000 tonnes in 2020 and further surpassing 1,400,000 tonnes in 2022, China has been playing an increasingly important role in the international TiO<sub>2</sub> market.

In contrast, China's annual TiO<sub>2</sub> import has kept below 200,000 tonnes in this period. Although China's TiO<sub>2</sub> production technology has been improved and the quality elevated, China still has to rely on high-end TiO<sub>2</sub> import to meet domestic demand.

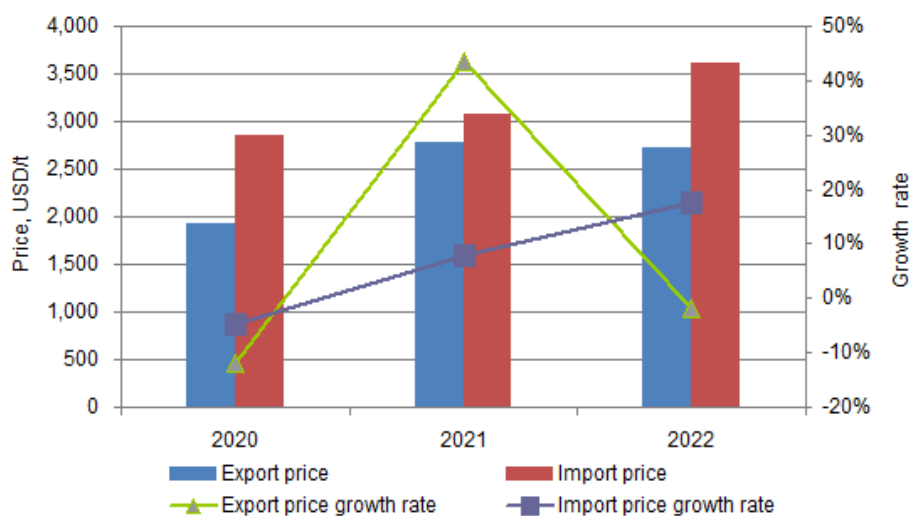
Figure 5.1-1 China's import and export volume of titanium dioxide, 2020–2022



Source: CCM & China Customs

With regard to the TiO<sub>2</sub> import and export prices, the price gap between imported and exported TiO<sub>2</sub> was significant in 2020–2022, indicating that the majority of export products from China were still mid- to low-end ones. However, in 2021, the price gap narrowed significantly, mainly due to the increases in overseas demand and freight costs.

Figure 5.1-2 China's import and export prices of titanium dioxide, 2020–2022



Source: CCM & China Customs

### 5.2 Import analysis 2020–2022

The import volume of TiO<sub>2</sub> to China picked up from 168,276 tonnes in 2020 to 191,934 tonnes in 2021, but plunged to 123,093 tonnes in 2022. The annual average import price in 2020 slipped to USD2,844/t, but it

recovered to USD3,072/t in 2021, and rose to USD3,612/t in 2022.

In 2020–2022, dependency on TiO<sub>2</sub> imports in China was 4.8%, 5.0% and 3.2%, respectively; the dependency ratio kept at a low level mainly came from the following factors:

● **Breakthrough of domestic chloride process technology**

At present, five domestic producers have mastered the chloride process technology. In 2022, the capacity and output of chloride process TiO<sub>2</sub> in China reached 955,000 t/a and 496,600 tonnes, respectively. The output of chloride process TiO<sub>2</sub> accounted for 12.9% of the national total, an increase of 3.8 percentage points from the 9.1% in 2020.

● **Released capacity and increasing output in China**

Domestic output increased from 3,522,600 tonnes in 2020 to 3,853,500 tonnes in 2022, at a CAGR of 4.6%.

● **High import price**

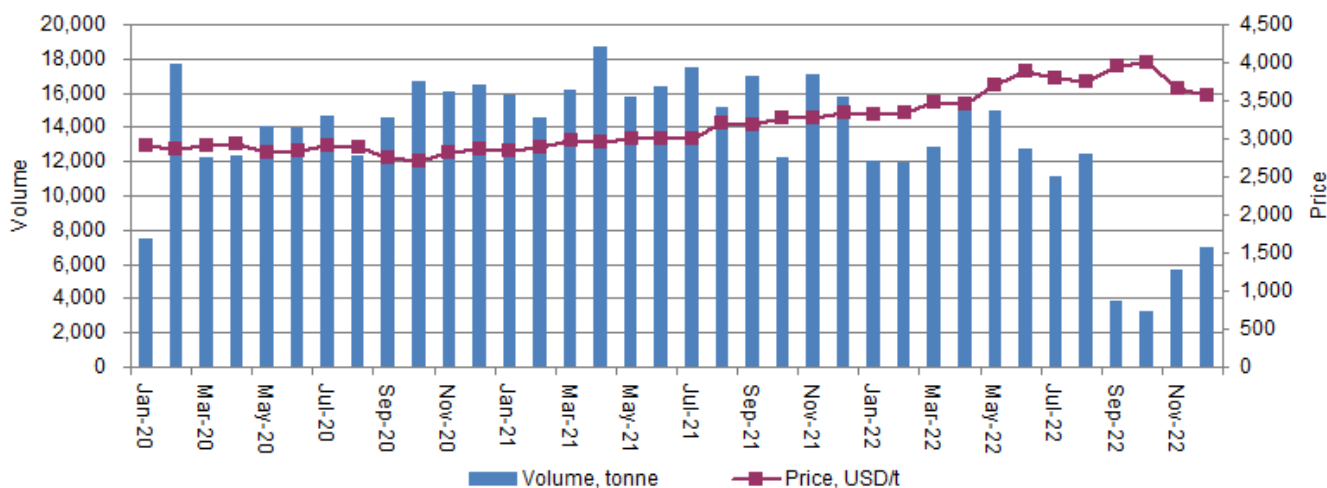
In the past three years, the exchange rate fluctuated a lot, and import price of TiO<sub>2</sub> was greatly affected. Since most of the imported TiO<sub>2</sub> is produced with chloride process, these high-end products came at high price.

In 2020, the price fell below USD3,000/t, and hit the bottom in Oct. at USD2,701/t. China's monthly TiO<sub>2</sub> import remained above 12,000 tonnes all the year except Jan. It is fair to say that COVID-19 barely affected the import volume of TiO<sub>2</sub>.

In 2021, the import price of TiO<sub>2</sub> showed an obvious upward trend triggered by price hike globally. During this period, world-renowned TiO<sub>2</sub> suppliers raised their prices multiple times amid the prosperous global TiO<sub>2</sub> market.

In 2022, the import price of TiO<sub>2</sub> went up higher and fluctuated at a high level; the highest monthly price reached USD4,000/t in Oct., setting a new record. China's TiO<sub>2</sub> import volume fell significantly mainly because of sluggish demand in domestic market as well as increased output of domestic chloride-process TiO<sub>2</sub> to meet the need for higher-end TiO<sub>2</sub>.

Figure 5.2-1 China's import volume and price of titanium dioxide, Jan. 2020–Dec. 2022



Source: CCM & China Customs

**5.3 Export analysis 2020–2022**

China exported 1,203,975 tonnes in 2020, 1,311,626 tonnes in 2021 and 1,405,747 tonnes in 2022, which showed an obvious upward trend with a CAGR of 8.1% during this period.

China's export volume of TiO<sub>2</sub> kept increasing mainly for the follow reasons:

- Lower price of TiO<sub>2</sub> from China
- Improved quality of TiO<sub>2</sub> made in China
- Surging demand in overseas markets

The top 10 export destinations in 2022 took up 55.0% of the total TiO<sub>2</sub> export, and the share was 54.5% in 2021 and 52.3% in 2020. China's TiO<sub>2</sub> export market is diverse, involving more than 140 countries. In 2020–2022, China's TiO<sub>2</sub> was mainly exported to some developing countries such as India, Brazil, Vietnam, Turkey and Indonesia. It is worth noting that TiO<sub>2</sub> exports to India continued to grow because of rigid demand for infrastructure there.

Table 5.3-1 China's top 10 export destinations of titanium dioxide, 2020–2022

No.	Country	2022		Country	2021		Country	2020	
		Quantity, tonne	Price, USD/t		Quantity, tonne	Price, USD/t		Quantity, tonne	Price, USD/t
1	India	187,596	2,608	India	168,884	2,752	India	135,810	1,879
2	Brazil	89,769	2,763	Brazil	89,021	2,703	Brazil	99,277	1,907
3	South Korea	74,060	2,740	South Korea	85,233	2,837	South Korea	73,149	2,008
4	Russia	73,322	2,787	Turkiye	74,592	2,756	Vietnam	62,696	1,992
5	Vietnam	70,089	2,689	Vietnam	62,617	2,812	Turkiye	59,377	1,916
6	Turkiye	67,922	2,652	Indonesia	62,477	2,775	Indonesia	49,657	1,940
7	Belgium	57,434	2,846	United Arab Emirates	56,453	2,753	Malaysia	38,729	1,944
8	Indonesia	57,243	2,703	Malaysia	44,181	2,770	Canada	38,324	1,852
9	United Arab Emirates	55,399	2,699	France	36,810	2,746	Egypt	37,525	1,996
10	Malaysia	40,422	2,743	Thailand	34,481	2,782	France	35,087	1,916
	Others	632,492	2,754	Others	596,878	2,785	Others	574,346	1,938
	<b>Total/Average</b>	<b>1,405,747</b>	<b>2,727</b>	<b>Total/Average</b>	<b>1,311,626</b>	<b>2,775</b>	<b>Total/Average</b>	<b>1,203,975</b>	<b>1,933</b>

Source: CCM & China Customs

Asia-Pacific region, Europe and South America were the core regions for China's TiO<sub>2</sub> export in this period.

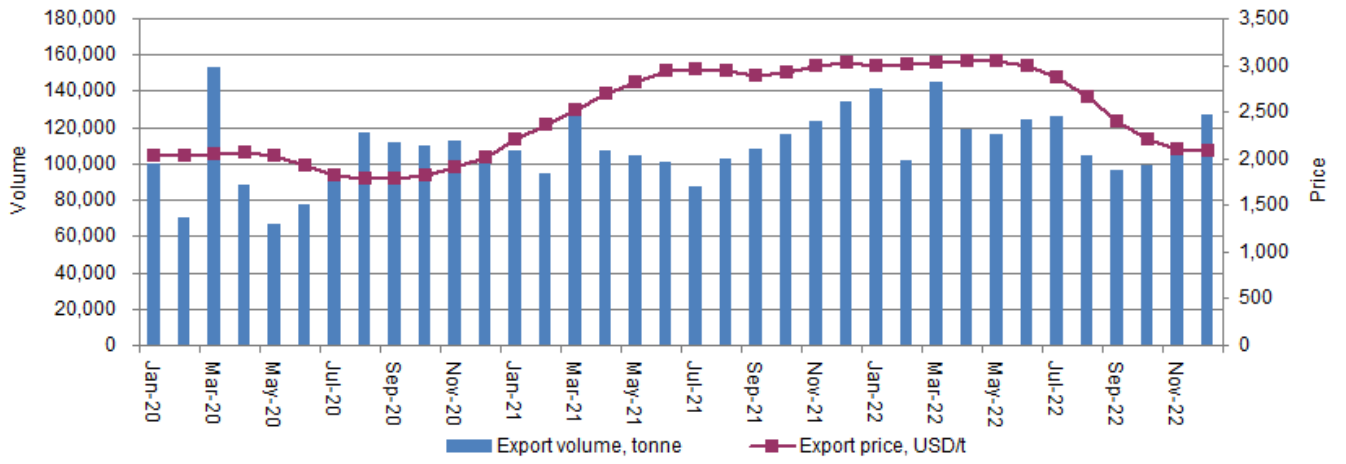
Table 5.3-2 China's titanium dioxide export volume by region, 2020–2022

Region	Export volume, tonne			Share		
	2022	2021	2020	2022	2021	2020
Asia	545,975	547,905	473,320	38.8%	41.8%	39.3%
West Europe	198,506	198,133	177,492	14.1%	15.1%	14.7%
Central and Eastern Europe	184,195	150,896	127,065	13.1%	11.5%	10.6%
South America	159,102	147,580	157,342	11.3%	11.3%	13.1%
Middle East	128,246	117,977	103,183	9.1%	9.0%	8.6%
Africa	108,484	97,115	84,322	7.7%	7.4%	7.0%
USMCA (NAFTA)	69,690	39,409	67,138	5.0%	3.0%	5.6%
Oceania	11,551	12,610	14,113	0.8%	1.0%	1.2%
<b>Total</b>	<b>1,405,747</b>	<b>1,311,626</b>	<b>1,203,975</b>	<b>100.0%</b>	<b>100.0%</b>	<b>100.0%</b>

Note: Due to rounding, the total may not equal 100.0%.

Source: CCM & China Customs

Figure 5.3-1 China's export volume and price of titanium dioxide, Jan. 2020–Dec. 2022



Source: CCM & China Customs

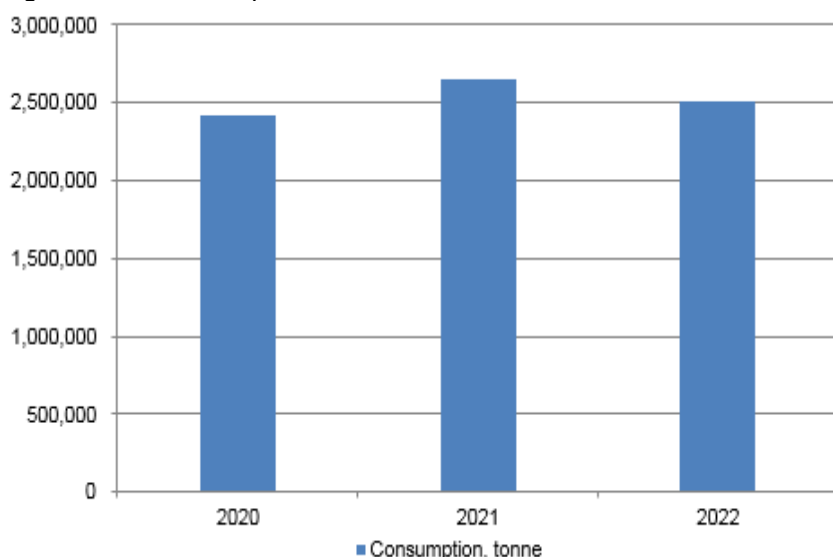
## 6 Consumption

### 6.1 Titanium dioxide consumption in China, 2020–2022

China, as an industrial power, is not only a powerhouse for TiO<sub>2</sub> production, but also a big consumer of TiO<sub>2</sub>. In 2020–2022, annual domestic TiO<sub>2</sub> consumption was 2,414,878 tonnes, 2,646,584 tonnes and 2,514,287 tonnes, respectively.

Top four downstream application fields of TiO<sub>2</sub> (by TiO<sub>2</sub> consumption) are coating, plastics, papermaking and chemical fibre in China. In 2022, coating industry contributed to nearly 59% of China's total TiO<sub>2</sub> consumption, followed by plastics with 18% and papermaking with 13%.

Figure 6.1-1 Consumption volume of titanium dioxide in China, 2020–2022



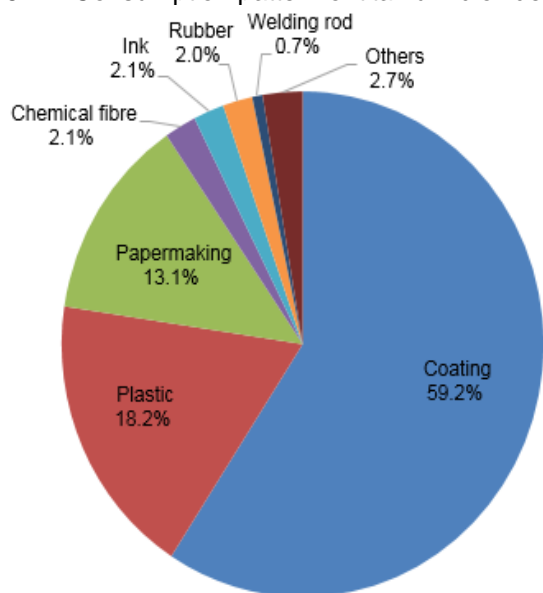
Source: CCM

Table 6.1-1 Consumption volume of titanium dioxide by major end use segment in China, 2020–2022

Industry	Consumption volume, tonne		
	2022	2021	2020
Coating	1,487,664	1,602,722	1,470,815
Plastics	458,111	483,273	459,000
Papermaking	328,593	326,014	270,240
Chemical fibre	53,583	53,668	49,012
Ink	51,840	50,340	48,900
Rubber	50,173	48,702	44,388
Welding rod	17,375	17,676	18,084
Others	66,949	64,189	54,439
<b>Total</b>	<b>2,514,287</b>	<b>2,646,584</b>	<b>2,414,878</b>

Source: CCM

Figure 6.1-2 Consumption pattern of titanium dioxide in China, 2022

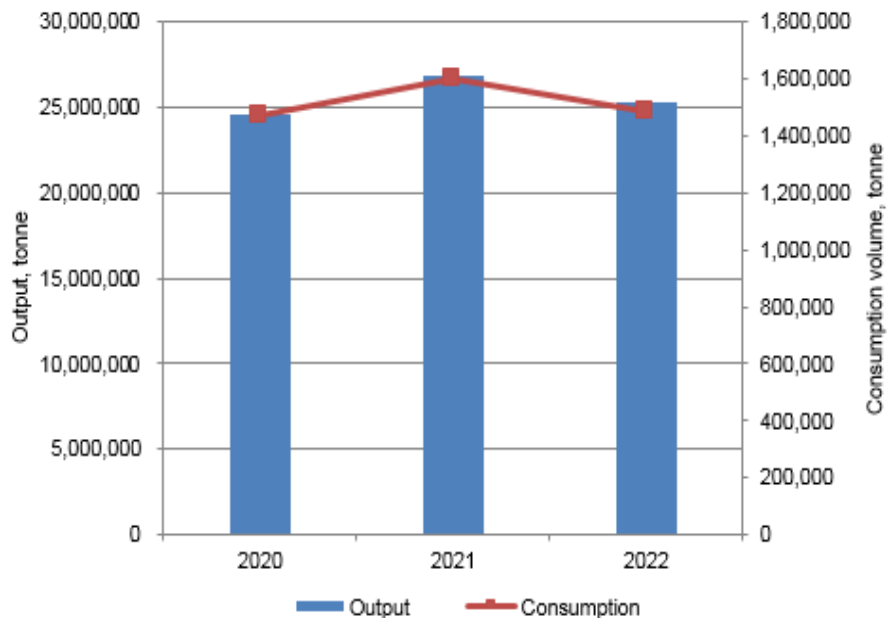


Note: Due to rounding, the total may not equal 100.0%.  
Source: CCM

### 6.1.1 Coating

Coating is the largest TiO<sub>2</sub> downstream sector in China. In 2020–2022, the TiO<sub>2</sub> consumption in coating industry was 1,470,815 tonnes, 1,602,722 tonnes and 1,487,664 tonnes, respectively. In the same period, the output of coatings increased first and then declined. In coating industry, architectural coating consumed about half of the TiO<sub>2</sub> for this sector, followed by industrial protective coating with a share of 27%.

Figure 6.1.1-1 Titanium dioxide consumption in the coating industry and output of coatings in China, 2020–2022



Source: CCM

### - Architectural coating

In 2020–2021, the output of architectural coating grew steadily, mainly driven by the real estate industry and renovation of old houses. For one thing, due to large number of houses in China and the advancement of old house renovation, demand for architectural coatings increased continuously; for another, growths in population and urbanisation rate, infrastructure construction and the real estate industry brought greater market demand for architectural coatings.

In 2022, however, in an economic environment much affected by COVID-19 and external factors, the fragile balance between supply and demand in the real estate industry was broken, and the sagging real estate market resulted in the declined demand for architectural coatings. A piece of good news is that old house renovation still moved forward.

- Real estate industry

The real estate industry in China has a great demand for coatings. Therefore, how the real estate industry fares greatly affects the demand for coatings and thus the consumption of TiO<sub>2</sub>. At present, the overall real estate market in China is still large, though it faces great challenges.

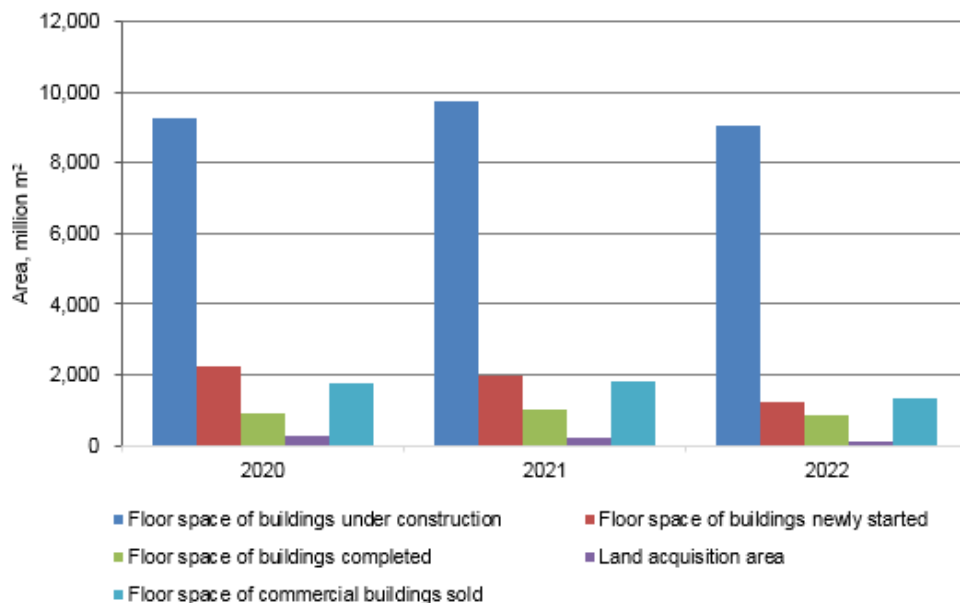
In 2022, adjustment in the real estate industry deepened. The investment in real estate development decreased by almost 10% year on year to USD1,984.32 billion (RMB13,289.50 billion). The floor space of buildings under construction was about 9,050 million m<sup>2</sup> and the floor space of buildings completed was 862 million m<sup>2</sup>, decreased by 7% and 15% year on year, respectively, and the floor space of commercial buildings sold decreased by 24% year on year to over 1,358 million m<sup>2</sup>. What's worse, floor space of houses newly started and land acquisition area of real estate development enterprises fell significantly by 39% and 53% year on year.

Multiple factors led to the turn of the market. On the one hand, negative population growth, economic downturn and recurrent COVID-19 cases weakened people's willingness to buy houses. On the other hand, oversupply of housing caused by excessive investments in previous years, coupled with high-profile debt crises of real estate enterprises, reduced new development projects. The consumption of TiO<sub>2</sub> in the real estate industry was thus affected.

- Renovation of old houses

According to the Ministry of Housing and Urban-Rural Development of the People's Republic of China, there were about 160,000 old communities in China in 2019, involving more than 42 million households and a construction area of about 4 billion m<sup>2</sup>, with an average construction area of 25,000 m<sup>2</sup> each community. If calculated on the ratio of external wall area to building area of 0.7, the external wall area of each community is 17,500 m<sup>2</sup>. Assuming that 50% of the external wall area needs renovating with coating usage of 5 kg per square metre, and 25,000 old communities are renovated every year, there will be about 1.09 million tonnes of coatings used in old house renovation each year. In 2022, 52,500 communities were renovated in China.

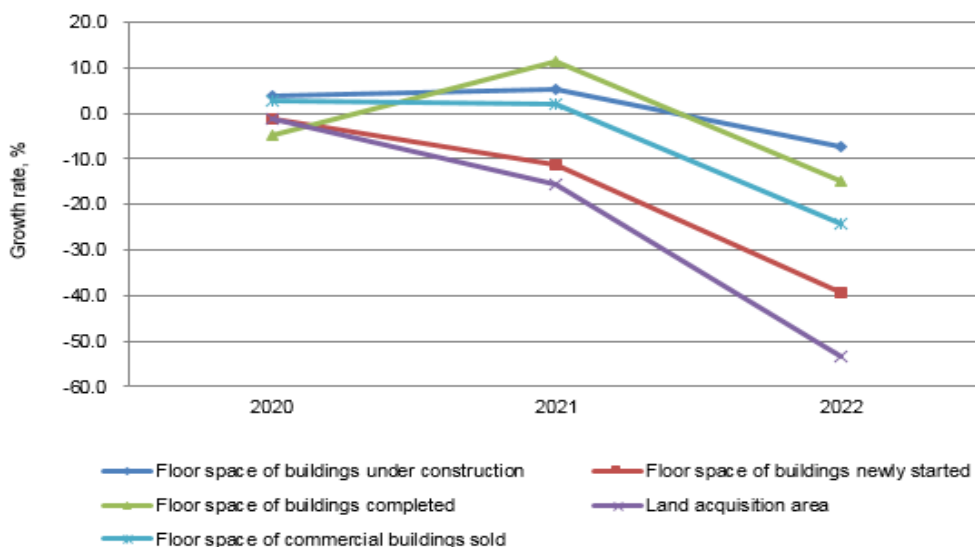
Figure 6.1.1-2 Brief analysis of the economic operation of real estate industry



Source: National Bureau of Statistics (NBS)



Figure 6.1.1-3 Growth rate of real estate development and sales in China, 2020–2022



Source: NBS

On the whole, affected by factors such as the downward-going macroeconomy, COVID-19 resurgence, and government policy change, the real estate industry has been facing mounting pressures since 2020, and the situation is likely to continue in the next two years. Therefore, the recovery in demand for architectural coatings may require more patience.

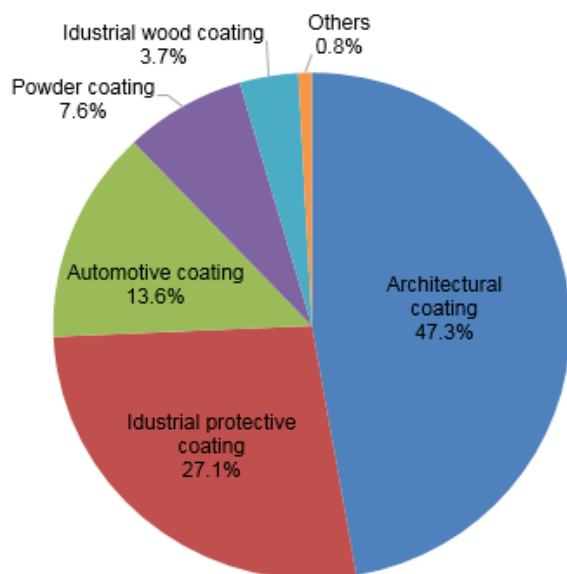
- Industrial protective coating

Industrial protective coating took up the second largest share of TiO<sub>2</sub> consumption. In China, industrial protective coating covers marine, container and other anti-corrosion coating.

The demand for marine coating mainly comes from the shipbuilding and ship repairing industries. According to China Association of the National Shipbuilding Industry, in 2022, the accomplished shipbuilding output decreased by over 4% year on year to about 37.9 million DWT (dead weight tonnage), which is the major cause of the decline in TiO<sub>2</sub> consumption by marine coatings in 2022. China's ship repairing market was relatively stable in 2022. The number of ship repairing projects in China accounted for more than 40% of the world's total, and was still the largest ship repairing market globally.

In 2022, the significant decline in container production led to declined demand for container coatings, thus reducing TiO<sub>2</sub> consumption. According to the China Container Industry Association, China's container production output fell sharply to slightly over 3.6 million TEU (twenty-feet equivalent unit) in 2022, down about 45% year on year.

Figure 6.1.1-4 Titanium dioxide consumption pattern in the coating industry in China, 2022



Note: Due to rounding, the total may not equal 100.0%.  
Source: CCM

TiO<sub>2</sub> used in the coating industry requires good application performance in terms of chroma, hiding force, tinting strength and dispersity to ensure the quality of coatings. As a common practice, the rutile type is widely applied in architectural coatings, because exterior wall coatings require excellent weatherability.

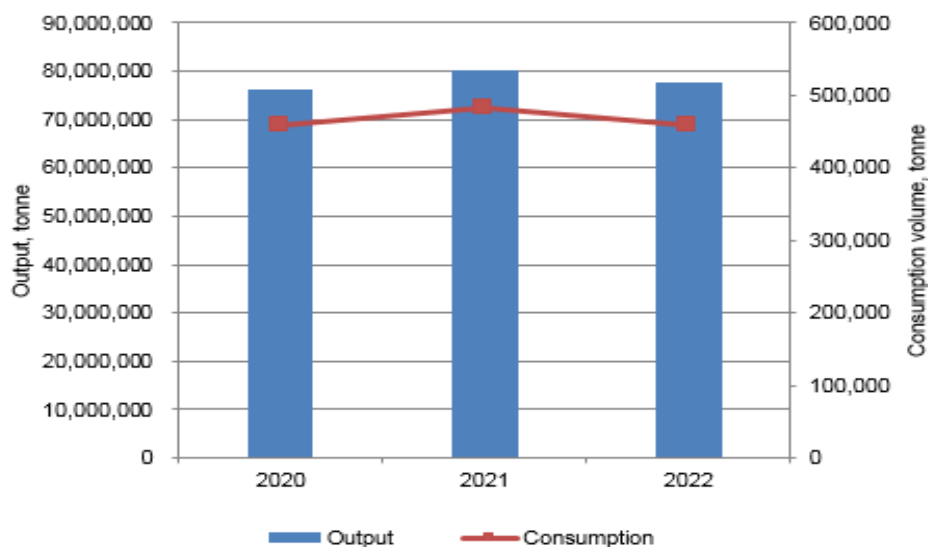
Rutile TiO<sub>2</sub> is also welcomed in industrial coating, which is mainly used on the surface of industrial products. And TiO<sub>2</sub> with better performance is required in this field. For example, the product used in automobile production must have good covering ability, anti-corrosion performance and sound weatherability. Coil coating and wood coating, used in household appliances and furniture, have looser requirements on weatherability. Powder coating requires only good covering ability and chroma, and both anatase and rutile types can meet the requirement.

### 6.1.2 Plastics

China is the world's largest producer of plastics and plastics is China's second largest consumption field of TiO<sub>2</sub>. In 2020–2022, China's TiO<sub>2</sub> consumption in plastics industry was 459,000 tonnes, 483,273 tonnes and 458,111 tonnes, respectively.

In the past three years, yearly output of plastics in China was 76,032,000 tonnes, 80,040,000 tonnes and 77,716,000 tonnes, respectively. Generally, TiO<sub>2</sub> consumption in plastics goes hand in hand with the output of plastics. In 2022, daily plastic product and plastic pipe were the top two TiO<sub>2</sub> consuming sub-sectors in the plastics industry, taking up 18% and 17% of the industry's total, respectively.

Figure 6.1.2-1 Titanium dioxide consumption in the plastics industry and output of plastics in China, 2020–2022

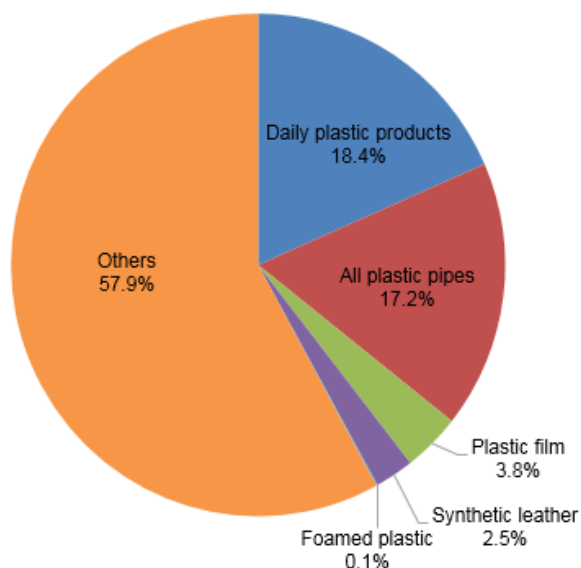


Source: CCM & NBS

The amount of TiO<sub>2</sub> added in plastics varies, generally ranging between 0.5%–5.0%. Daily plastic products consume the most of TiO<sub>2</sub>; usually, average TiO<sub>2</sub> addition in these products is about 30 kilograms per tonne. In 2022, mainly affected by the weakened demand under the COVID-19 re-emergence in China, the production of daily plastic products went down almost 9% year on year to 6,396,000 tonnes, playing a leading role in cutting down TiO<sub>2</sub> consumption.

Another big consumption sector in the industry is all plastic pipes. In 2020–2022, annual output of all plastic pipes in China was 16,360,000 tonnes, 16,770,000 tonnes and 16,450,000 tonnes, respectively; the output is mainly decided by the development trends in the real estate industry, the renovation of old houses and the construction of urban pipelines.

Figure 6.1.2-2 Titanium dioxide consumption pattern in the plastics industry in China, 2022



Note: Due to rounding, the total may not equal 100.0%.

Source: CCM

TiO<sub>2</sub> is used as colourant and reinforcer in the plastics industry, which requires high hiding power, good achromic ability, weatherability and surface-treatment effect. Rutile type is applied more widely than anatase type in plastics used outdoors.

As to TiO<sub>2</sub> addition in plastic products, it varies according to type and quality. It can be mixed with resin

powder or plasticiser. It can also be processed into master batch first, which is a concentrated mixture of pigments and/or additives encapsulated during a heat process into a carrier resin, which is then cooled and cut into a granular shape. The master batch can be used by mixing with plastic resin in certain ratio according to different process requirements of the plastics and injection moulds.

During the 14th Five-Year Period (2021–2025), three development goals for the plastics processing industry have been put forward, including:

- Scale development: to keep steady growth in the output, revenue, operating profit and export value of plastic products;
- Technological innovation: R&D investment of key enterprises shall be no less than 3.2% of their revenue. Superior resources should be better integrated;
- Green development: to promote the application of new technologies for energy conservation, emission reduction, and low-carbon and clean production, and to promote the use of new energy and the adoption of environment friendly new materials, processes and technologies to reduce energy consumption.

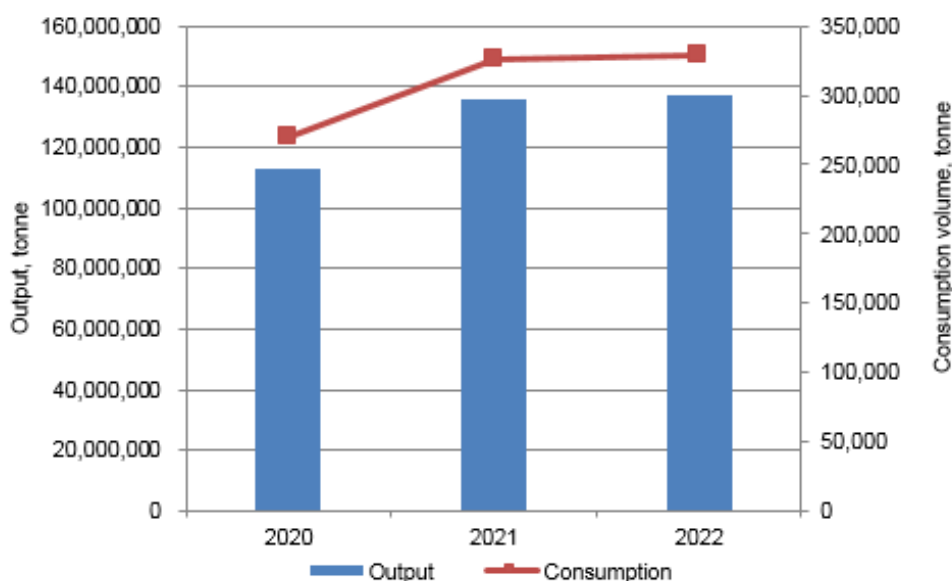
It is believed that with gradually recovering economy, the production of and demand for plastics will grow steadily in the next few years. Therefore, demand for TiO<sub>2</sub> from this sector will also increase.

### 6.1.3 Papermaking

Papermaking is the third largest TiO<sub>2</sub> consumption field in China, which accounted for about 13% of the total consumption volume in 2022.

In 2020–2022, TiO<sub>2</sub> consumption in the papermaking industry increased from 270,240 tonnes to 328,593 tonnes, at a CAGR of 10%. The output of paper in China increased from 112,600,000 tonnes in 2020 to 136,913,600 tonnes in 2022, at a CAGR of 10%.

Figure 6.1.3-1 Titanium dioxide consumption in the papermaking industry and output of paper in China, 2020–2022



Source: CCM & NBS

One of the most important applications of TiO<sub>2</sub> in papermaking is decorative paper, which is mainly used to make furniture, floor and wallpaper. Incomplete statistics show that TiO<sub>2</sub> content in decorative paper is 20%–40%, while that in other paper is 1%–5%. With the increase of domestic consumption level and the demand for house decoration and high-grade furniture, demand for decorative paper is expected to keep rising, thus driving up the consumption of TiO<sub>2</sub> in this field.

For different kinds of paper, the required TiO<sub>2</sub> addition and quality are different. In general, quality requirements for TiO<sub>2</sub> used in the papermaking industry are: good covering force, good achromic ability, uniform granularity, good dispersity in water and high purity. TiO<sub>2</sub> is mainly used as fillers and colourants in papermaking industry in China.

Traditionally, anatase TiO<sub>2</sub> is extensively used in papermaking, which has better whiteness than the rutile

type. But in recent years, the quality of rutile TiO<sub>2</sub> in China has improved greatly, including the whiteness. Thus, more and more paper producers prefer to use the rutile ones to improve their products' anti-aging ability.

Besides, paper for different purposes requires different types of TiO<sub>2</sub>. For example, rutile TiO<sub>2</sub> is used in decorative paper, mainly owing to its excellent oxidative stability and weather resistance. The rutile TiO<sub>2</sub> made through chloride process is much preferred for its better whiteness, rutile crystal content and stability. In contrast, banknote paper requires sulphate anatase TiO<sub>2</sub> to better satisfy its requirement of opacity.

During the 14<sup>th</sup> Five-Year Period, development goals for the papermaking industry by 2025, proposed by China Paper Association, are listed as follows:

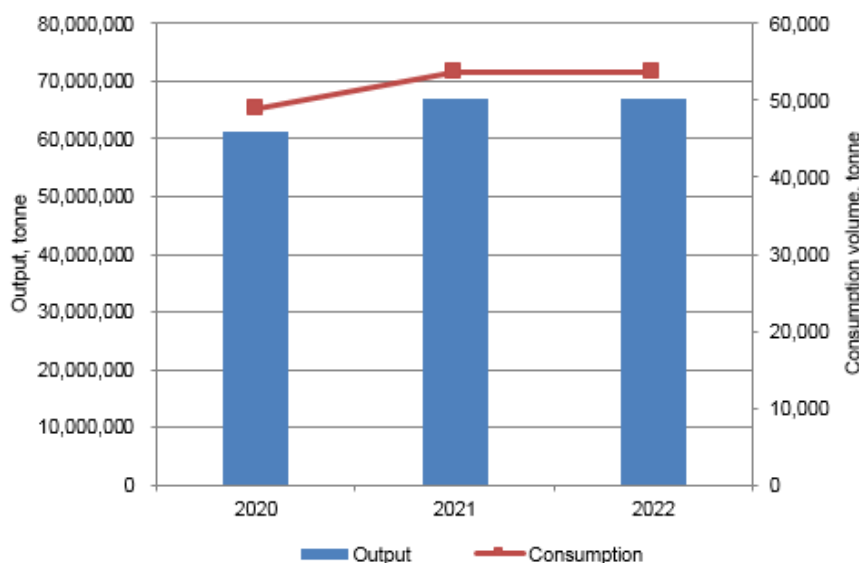
- The output of paper and paperboard will reach 140 million tonnes in China, and the annual per capita consumption will reach 100kg;
- The output of virgin pulp will reach 30 million tonnes;
- The output of paper products will reach 90 million tonnes;
- Product structure will be optimised, and product quality & variety improved.

The papermaking industry may witness steady growth in the next five years, and the demand for paper products will increase continuously, thereby driving up the demand for TiO<sub>2</sub> in this industry.

#### 6.1.4 Chemical fibre

The chemical fibre industry's TiO<sub>2</sub> consumption accounted for some 2% of the total in 2022. It jumped from 49,012 tonnes in 2020 to 53,668 tonnes in 2021, and kept relatively stable in 2022 with 53,583 tonnes. Quite similar trend was seen in the chemical fibre output in China in this period, as annual output for these three years was 61,265,000 tonnes, 67,085,000 tonnes and 66,978,400 tonnes, respectively.

Figure 6.1.4-1 Titanium dioxide consumption in the chemical fibre industry and output of chemical fibre in China, 2020–2022



Source: CCM & NBS

Major categories using TiO<sub>2</sub> in the chemical fibre industry are terylene, polyamide fibre, and viscose fibre. According to statistics from China Chemical Fibres Association, in 2022, the output of terylene and polyamide fibre remained stable, at 53,430,000 tonnes and 4,100,000 tonnes, respectively; while the output of viscose fibre dropped by over 4% to 3,853,000 tonnes. But it is worth noting that in 2019–2021, the output of terylene and polyamide fibre increased at CAGR of about 6% and 9%, respectively. Many other chemical fibres have also developed quickly in China in recent years.

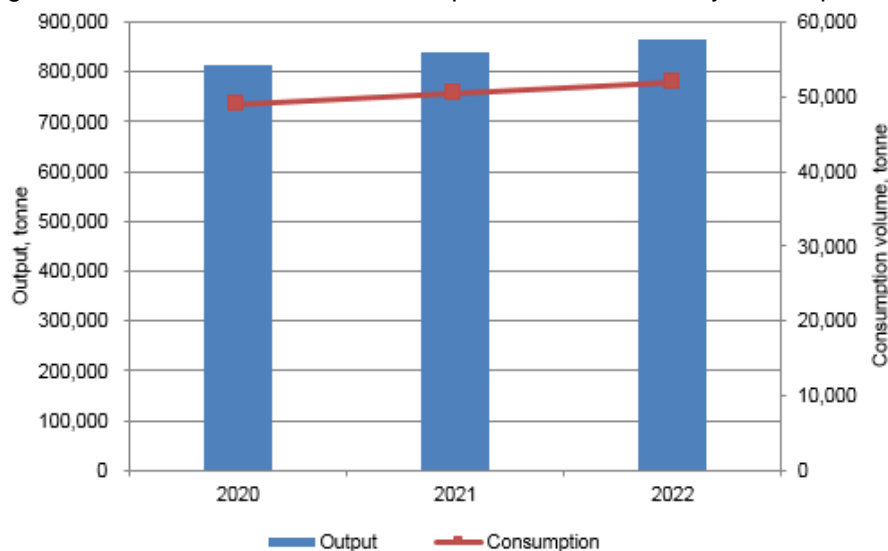
TiO<sub>2</sub> is usually used as a delustrant in the chemical fibre industry, with the effect generally being achieved at an addition of 2 kilograms per tonne. Requirements for TiO<sub>2</sub> used in the chemical fibre industry are: good whiteness, strong tinting strength, stable chemical properties, good dispersion, fine and uniform particles and good water dispersion. The particle size of fibre grade TiO<sub>2</sub> usually falls between 0.15 µm and 0.35 µm, and the process to make this kind of TiO<sub>2</sub> is complicated.

Compared with delustrated fibre, semi-dull fibre is more popular in China. It is reported that the average TiO<sub>2</sub> addition is only 0.20%–0.50% in semi-dull fibre, while in delustrated fibre, the application is 0.50%–1.50%.

### 6.1.5 Ink

With steady increase of China's ink output, TiO<sub>2</sub> consumption in the ink industry reached 51,840 tonnes in 2022, growing at a CAGR of 3% in 2020–2022; the volume accounted for about 2% of the total TiO<sub>2</sub> consumption in China in 2022.

Figure 6.1.5-1 Titanium dioxide consumption in the ink industry and output of ink in China, 2020–2022



Source: CCM

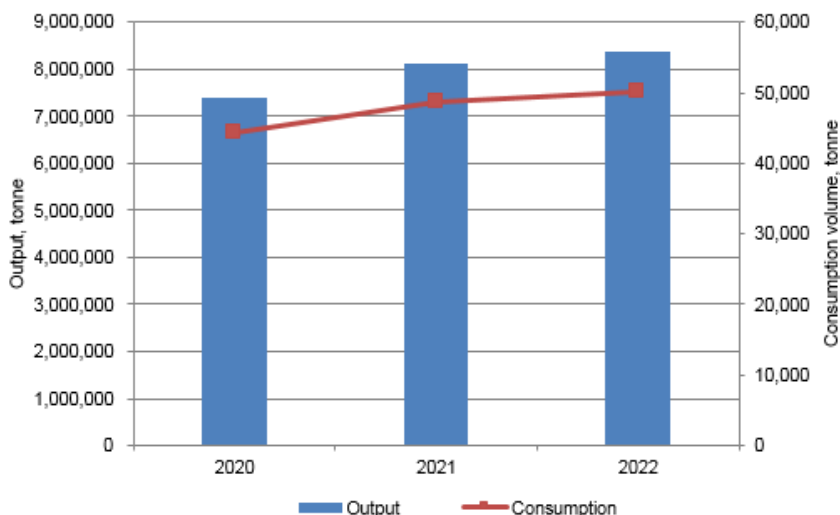
The amount of TiO<sub>2</sub> added to ink products is relatively large, typically between 20% and 50%. In recent years, the consumption of TiO<sub>2</sub> in ink has increased along with the rise of ink output. As the demand for packaging in China still goes up, the consumption of TiO<sub>2</sub> in ink will continue to grow steadily.

In ink production, different types of ink products have different quality requirements. Generally speaking, TiO<sub>2</sub> used in the ink industry should have high covering ability and tinting strength, good achromic ability, moisture, chroma, dispersity. Rutile type is preferable in this field. And imported TiO<sub>2</sub> usually has better chroma and tinting strength than homemade one.

### 6.1.6 Rubber

In 2020–2022, annual TiO<sub>2</sub> consumption in the rubber industry was 44,388 tonnes, 48,702 tonnes and 50,173 tonnes, respectively, with a CAGR of 6%. The industry accounted for 2% of the total TiO<sub>2</sub> consumption in 2022. During the same period, the output of synthetic rubber in China grew at a similar rate, reaching 8,362,100 tonnes in 2022.

Figure 6.1.6-1 Titanium dioxide consumption in the rubber industry and output of synthetic rubber in China, 2020–2022



Source: CCM & NBS

TiO<sub>2</sub> is used in tyre, rubber duct, rubber overshoes, texrope belt and so on. Thereinto, tyre consumes the largest amount of TiO<sub>2</sub>. Usually, a certain amount of rutile TiO<sub>2</sub> is added to tyre to enhance the resistance to ozone and ultraviolet ray.

TiO<sub>2</sub> products used in rubber industry should have good heat resistance, covering ability, achromic ability and good dispersity. In general, the anatase type is preferred in the rubber industry. However, tyre requires good weatherability and high ultraviolet-resistance, and thus uses more rutile type.

According to the latest rubber industry development plan, during the 14th Five-Year Period, total output in rubber industry should follow a stable uptrend with slightly lowered average annual growth rate, and the scale, influence and export share of China's rubber industry should be strengthened. The plan also sets output targets for main rubber products by 2025, including:

- Tyre: the output will be 704 million, and radialisation rate reach 96%;
- Cycle tyre: the cover tyre and inner tube of motorcycle will reach 120.7 million and 211.1 million, respectively; those of bicycle will be 420 million and 550 million, respectively; those of electric bicycle will be 363 million and 77 million, respectively;
- Other rubber products: 4.5 billion pieces for seal products, 2.5 billion pieces for rubber damper, 6 million pieces for engineering rubber products and 1.5 billion pieces for rubber products in electronic appliances.

In the next few years, the output of tyres and other rubber products is expected to increase steadily, and the demand for TiO<sub>2</sub> in the rubber industry will also increase.

### 6.1.7 Other consumption fields

There are also other fields using TiO<sub>2</sub>, such as welding rod, enamel, tile, cosmetics, pharmaceutical, electronics, leather, food, alloy and glass. Generally speaking, TiO<sub>2</sub> consumption in these fields is relatively small.

## 7 Forecast on development of China's titanium dioxide industry

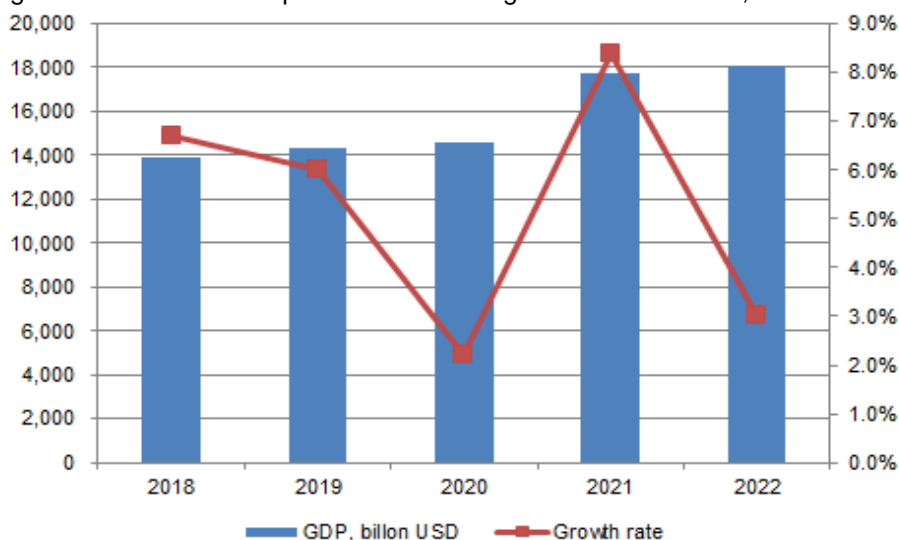
### 7.1 Drivers

#### Growing economy

China's economy has kept growing and its resilience continues to be highlighted. The GDP growth rate stayed above 6% in 2018–2019. In 2020–2022, China still managed to achieve GDP positive growth in spite of the severe damage caused by COVID-19.

However, China still faces uncertain situations and problems that are likely to persist in the medium and long run. China will accelerate fostering a "dual circulation" development pattern in which domestic economic cycle plays the leading role while international economic cycle serves as an extension and a supplement to combat global economic downturn and shrinking international market.

Figure 7.1-1 GDP development and annual growth rate in China, 2018–2022



Source: National Bureau of Statistics

#### Increasing domestic demand from downstream industries

Major downstream industries of  $\text{TiO}_2$  such as coating, plastics and papermaking, will basically maintain a growth trend in their output during 2023–2027. Coating is the largest consumer of  $\text{TiO}_2$ , and there will still be considerable demand for coatings in the real estate industry and the renovation of old houses. Therefore, the demand for  $\text{TiO}_2$  in coatings will show an overall uptrend in the next few years.

- Real estate industry: Statistics show that in 2022, floor space of buildings newly started and land acquisition area of real estate development enterprises took further dives in China. In the next few years, China's real estate sector will go into an adjustment period. The adjustment would be reflected in  $\text{TiO}_2$  consumption in the coating industry accordingly. Nevertheless, it should be noted that as the number of houses in China continues to grow, demand for redecoration will keep expanding, stimulating the demand for coatings. Thus, the real estate market still has the potential to boost the demand for  $\text{TiO}_2$ .
- Renovation of old houses: With the advancement of the old house renovation project in China, the demand for coatings will continue to expand.

In addition, downstream industries of  $\text{TiO}_2$  have gradually expanded to fields like cosmetics, toys, food and medicine. With the development of economy and researches on broadening the application, the demand for  $\text{TiO}_2$  will become larger.

#### Increasing export demand

China's export volume of  $\text{TiO}_2$  has been increasing in the past few years thanks to demand from some developing countries like India, Brazil, and Vietnam. Infrastructure construction accelerates rapidly in these countries.

#### Development of both production techniques

Currently in some overseas markets, especially in developed countries, chloride process is the main production technique, while in China, though there are producers like LB Group that have built chloride process  $\text{TiO}_2$  production lines, sulphate process still dominates. In the future, stricter environmental



regulations will accelerate the development of the chloride process TiO<sub>2</sub>, yet the improvement of sulphate process is also believed to forge ahead.

Waste sulphuric acid is the main pollutant when applying sulphate process. Now it can be recycled to produce phosphate. For example, all of the waste sulphuric acid of LB Sichuan Titanium Industry Co., Ltd. is used to produce phosphate, which reduces the pollution significantly. Other improvements to sulphate process include: using acid-soluble titanium slag instead of titanium concentrate as raw material, utilising waste heat from sulphur-based sulphuric acid production, recycling of waste acid and concentrated acid, etc.

It is worth mentioning that the technology of converting ferrous sulphate to ferric phosphate has attracted the attention of TiO<sub>2</sub> manufacturers. Ferrous sulphate is a by-product of TiO<sub>2</sub>; it can react with phosphoric acid to produce ferric phosphate, a raw material for lithium iron phosphate. This by-product can be used for high-efficient and value-added purposes through the construction of iron phosphate production lines. Not only can the manufacturing costs of TiO<sub>2</sub> be reduced, but also the industrial chain can be extended, so as to realise a green and circular economy through comprehensive utilisation of resources. As of H1 2023, domestic TiO<sub>2</sub> manufacturers including LB Group, CNNC Hua Yuan, Yibin Tianyuan Group Co., Ltd. (Yibin Tianyuan), Guangdong Huiyun Titanium Industry Co., Ltd. (Huiyun Titanium), GPRO Titanium, and Anhui Annada had stepped into new energy sector by utilising their own advantages. This indicates that large manufacturers will continue to develop sulphate process TiO<sub>2</sub> business.

In addition, improved sulphate process has its own advantages. It can produce both high-end rutile TiO<sub>2</sub> and low-end anatase TiO<sub>2</sub>, while chloride process can only produce rutile TiO<sub>2</sub>.

Table 7.1-1 Progress of some new energy projects of titanium dioxide enterprises as of H1 2023

No.	Company	Project	New energy product	Location	Project status	Note
1	Henan Billions New Energy Material Co., Ltd.	300,000 t/a Li-ion battery material green manufacturing project	300,000 t/a Li-ion battery grade ferric phosphate	Jiaozuo City, Henan Province	The environmental impact assessment information of this project was publicised on 15 May, 2023 for the first time.	The company is a holding subsidiary of LB Group.
2	Yibin Tiancheng Lithium Battery New Materials Co., Ltd.	100,000 t/a Liferric phosphate cathode material project	100,000 t/a Liferric phosphate	Yibin City, Sichuan Province	Yibin Tianyuan announced on 29 April, 2023 that it planned to set up a subsidiary to construct this project.	The company is a wholly-owned subsidiary of Yibin Tianyuan.
3	Gansu Dongfang Titanium Dioxide Co., Ltd.	500,000 t/a Liferric phosphate project (phase I)	100,000 t/a Ferric phosphate	Baiyin City, Gansu Province	CNNC Hua Yuan said on 21 April, 2023 that this project had started commissioning.	The company is a wholly-owned subsidiary of CNNC Hua Yuan.
4	Huiyun Titanium	Ferrous sulphate comprehensive utilisation R&D pilot line project	15,000 t/a Ferric phosphate	Yunfu City, Guangdong Province	Huiyun Titanium announced on 21 April, 2023 that this project had obtained environmental approval.	/
5	Anhui GPRO New Energy Technology Development Co., Ltd.	GPRO new energy battery material integration project (phase I)	100,000 t/a Ferric phosphate, 50,000 t/a liferric phosphate	Huaibei City, Anhui Province	GPRO Titanium said on 17 March, 2023 that this project had been advanced as schedule and it was predicted to be put into production in late 2023.	The company is a wholly-owned subsidiary of GPRO Titanium.
6	Tongling Anxuanda New Energy Technology Co., Ltd.	50,000 t/a High-performance ferric phosphate project	50,000 t/a Ferric phosphate	Tongling City, Anhui Province	Anhui Annada said on 31 March, 2023 that this project had been under smooth construction (this project was completed and put into production in Q3 2023).	The company is a joint venture of Anhui Annada's holding subsidiary.

Source: CCM

## 7.2 Barriers

### Backward production process

In 2022, LB Group had 1,510,000 t/a TiO<sub>2</sub> production capacity, ranking first worldwide, followed by Chemours (1,250,000 t/a) and Tronox (1,080,000 t/a). LB group has narrowed the chloride-processed TiO<sub>2</sub> capacity gap between the company and global TiO<sub>2</sub> giants in recent years. However, about 87% of China's TiO<sub>2</sub> was produced with sulphate process in 2022, while more than 70% of TiO<sub>2</sub> from the top five foreign producers (Chemours, Tronox, Venator, Kronos and INEOS) was produced through chloride process. Chemours and INEOS even apply chloride process in all their TiO<sub>2</sub> production lines.

The overall quality of China's TiO<sub>2</sub> is still far from high-end application. Domestic TiO<sub>2</sub> is mostly of lower grade that can only be used in the bottom-end products such as latex paint for building, and the export destinations are mainly countries which need low-grade TiO<sub>2</sub> in large amount. Only a small proportion is for developed areas such as the US, Japan and Western Europe.

### Reliance on high-quality ilmenite imports

Domestic titanium concentrate output increased from 5,747,000 tonnes in 2020 to 6,040,000 tonnes in 2022. However, during the same period, the dependency on ilmenite imports in China remained above 50%, with the import volume climbing from 3,014,397 tonnes in 2020 to 3,464,763 tonnes in 2022. At present, China TiO<sub>2</sub> industry is ushering in a new round of capacity expansion. Once the new capacity comes into mass production, the next things may be supply shortage of ilmenite and ensuing soaring price. Moreover, it may even break the balance of supply and demand of ilmenite in China and perhaps in the world.

### Tighter supply of titanium ore

Since the price fall in 2012, major titanium ore suppliers worldwide have slashed their capital expenditure; therefore, there has been hardly any new mine exploited and some existing mines are getting close to exhaustion. China will see new TiO<sub>2</sub> capacity be put into production in the future, but domestic titanium ore resources might fail to satisfy the growing demand from TiO<sub>2</sub> production. The supply of titanium ore will be further tightened.

### Large gap between TiO<sub>2</sub> suppliers

In 2022, there were over 42 TiO<sub>2</sub> suppliers in China, and only 15 suppliers had capacity of or above 100,000 t/a; the combined capacity of the 15 suppliers accounted for slightly over three fourths of China's total. This means that most TiO<sub>2</sub> producers are of small production scale.

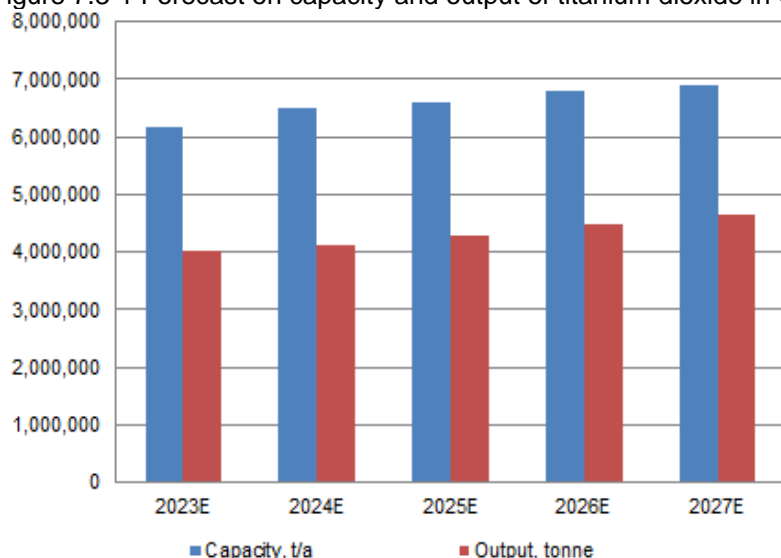
TiO<sub>2</sub> producers of small production scale are likely to be shut down if they fail to meet relevant environmental protection standards with stricter domestic environmental policies. Besides, TiO<sub>2</sub> industry was for the first time included in the *Energy Efficiency Benchmark and Baseline Levels for Key Industrial Sectors (2023)*, requiring that TiO<sub>2</sub> enterprises should complete technical renovation to meet relevant energy consumption levels or withdraw from the market by the end of 2026. This indicates that TiO<sub>2</sub> industry will accelerate energy conservation, carbon reduction, and renovation and thus enterprises with outdated and small-scale capacity tend to be phased out in the future.

## 7.3 Forecast on titanium dioxide production in China, 2023–2027

With the phase-out of backward capacity and restriction on sulphate process TiO<sub>2</sub> capacity expansion, and if the elimination threshold is raised to 50,000 t/a, about 516,000 t/a production capacity will be evaporated. Meanwhile, in the next few years, the proportion of chloride process TiO<sub>2</sub> capacity is expected to further increase.

There are some projects still under construction in 2023. If these projects are launched, domestic TiO<sub>2</sub> capacity and output will keep growing. It is estimated that by 2027, the total TiO<sub>2</sub> capacity will come close to 7 million t/a and the output will climb to about 4.7 million tonnes in China.

Figure 7.3-1 Forecast on capacity and output of titanium dioxide in China, 2023–2027



Source: CCM

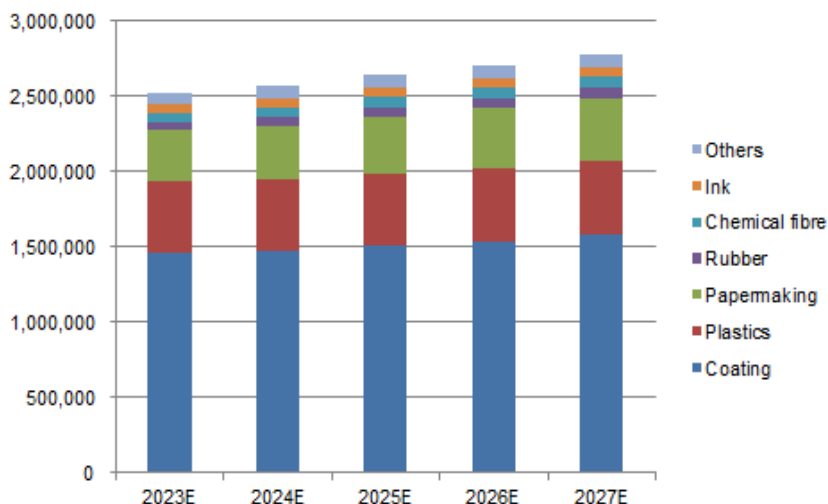
In the next five years, coating, plastics and papermaking industries will still be the three largest downstream sectors, together consuming 90% or so TiO<sub>2</sub> products in China.

The coating market absorbs the biggest portion of TiO<sub>2</sub>. Affected by the downturn in the real estate industry, it is expected that in 2023–2027, the demand from the coating industry will decline slightly or remain stable in the first two years, then it will gradually resume growth as the economy recovers and policies to stabilise the market take effect. In the long term, major customers such as marine, renovation, and automobile enterprises will continue to support the coating market. Besides, coating industry will follow an environment-friendly and water-based path as the 14<sup>th</sup> Five-Year Plan promoted and the general trend in the industry demonstrated.

At present, TiO<sub>2</sub> demand from plastics industry accounts for about 18% of the total in China. As environmental protection requirements push the industry to upgrade and the government encourages high-tech and light-weight products, China's plastics industry is expected to see a jump in demand and thus consume more TiO<sub>2</sub>, growing at a CAGR of about 1.2% in consumption volume during 2023–2027.

Being the third largest application field of TiO<sub>2</sub>, papermaking makes up about 13% of the total consumption. TiO<sub>2</sub> demand growth from this industry will slow down due to the elimination of outdated capacity as well as paperless trend in the digital age, which may be offset somewhat by surging demand for decorative paper though. It is expected that the demand for TiO<sub>2</sub> in papermaking industry will grow at a CAGR of about 5% in 2023–2027.

Figure 7.3-2 Forecast on consumption volume of titanium dioxide in main application industries in China, 2023–2027



Source: CCM

## 8 Opportunity

### 8.1 Raw material

Huge opportunities in China's TiO<sub>2</sub> market await domestic and foreign titanium mining and processing producers. Titanium ore accounts for about 60% of TiO<sub>2</sub> production costs. Therefore, the supply of titanium ore is decisive for the development of TiO<sub>2</sub> industry.

According to the USGS, China's ilmenite reserves were 190 million tonnes in 2022, and titanium ore reserves ranked second only to Australia. Despite the large reserves, supply of titanium ore is still tight as the grade of titanium ore resources is low and the mining is difficult in China, so a large amount of imports is still required.

On one hand, producers have paid much attention to the integration of domestic titanium ore resources. For instance, in March 2020, the controlling shareholder of Yibin Tianyuan Haifeng Hetai Co., Ltd. signed a Strategic Cooperation Framework Agreement with Panzhihua State-owned Investment (Group) Co., Ltd., and the two sides will carry out in-depth cooperation in merger and reorganisation, industrial resources integration and other fields revolving around titanium industry. Besides, leading TiO<sub>2</sub> producer CNNC Hua Yuan expressed to set integration of industrial chain as its strategic goal. Experience shows that ilmenite self-sufficiency plays an important role in improving TiO<sub>2</sub> quality, reducing operating costs and boosting financial results. Given that, the company will focus on expanding ilmenite capacity via M&A to build a stable ilmenite supply chain.

On the other hand, domestic chloride process TiO<sub>2</sub> producers have to use imported high-grade titanium ores because the technique requires higher quality and purity of titanium ores. That is why domestic chloride process TiO<sub>2</sub> producers and titanium ore distributors have been looking for high-quality titanium ore sources overseas. As most of the world's large-scale high-quality titanium ore resources have been controlled by large international companies, it is very necessary for Chinese chloride process TiO<sub>2</sub> producers to negotiate a stable supply with high-quality titanium ore suppliers.

In 2020–2022, the dependency on ilmenite imports remained above 50%, but domestic demand for high-quality ilmenite still cannot be well satisfied. In this context, domestic TiO<sub>2</sub> manufacturers need to continuously expand its overseas reach in search of high-quality titanium ore resources. Besides, they need to introduce new technology, increase research and development and other means to improve the optimal utilisation of titanium ore resources.

### 8.2 Technical supporting/cooperation

In recent years, domestic TiO<sub>2</sub> industry leaders have begun to build facilities for chloride process TiO<sub>2</sub> production. Communication and cooperation between domestic and overseas technology suppliers in this sector have been increasing. It is expected that more domestic players will embrace chloride process and technological exchanges will increase further.

For example, on 31 May, 2020, LB Group announced it had signed a technical cooperation contract with Ti-Cons Technology Consulting GmbH. The two parties would cooperate in the fields of intelligent automatic control system, production optimisation, improvement of production organisation, new products and product quality, environmental protection issues, reduction of production costs, etc.

However, we should notice that leaders in chloride process TiO<sub>2</sub> production as Chemours, Tronox and Venator who have the most advanced techniques and technologies have so far never transferred the core technologies to any other company. The existing chloride process production equipment in China has been self-developed or with the help of foreign technical consultation. Since the technology adopted here in China is not complete and mature, enormous challenges and difficulties are inescapable.

Table 8.2-1 Progress of China's chloride process titanium dioxide project, 2023–2026

No.	Company	Expansion, t/a	Expected finish time
1	Hebei Jicheng New Material Co., Ltd.	480,000	2023–2025
2	Pangang Group Vanadium & Titanium Resources Co., Ltd.	60,000	2024
3	LB Group Co., Ltd.	200,000	2025
4	Guangdong Dinglong Industrial Group Co., Ltd.	500,000	2026

Source: CCM

### 8.3 Development of titanium dioxide for special purpose

Due to the stricter environmental protection policies in China recent years, the demand for TiO<sub>2</sub>-based SCR (selective catalytic reduction) catalyst has grown strong. SCR catalyst is of importance to nitric oxide pollution reduction and is mainly composed of nanoscale TiO<sub>2</sub>. It not only saves energy and protects the environment, but also shows good photostability and high reactivity in the reaction. With features of non-toxicity, low cost and no secondary pollution, it is a nano-functional material with wide application prospect. Currently, nanoscale TiO<sub>2</sub> is mainly used in wastewater treatment, air purification, sterilisation, medical technology and environmental protection material production. It is worth noting that new applications also boost the demand for nanoscale TiO<sub>2</sub>. Such as nanoscale TiO<sub>2</sub> for lithium batteries, which is an excellent lithium battery material because of its good lithium intercalation capacity, low toxicity, low energy consumption, good stability and eco-friendliness. Besides, it can also be used for some capacitor materials, solar energy materials, temperature-reducing and energy-saving materials, etc.

In addition, real estate and automobile industries are in need of ever more high-end TiO<sub>2</sub> products. Seeing this, domestic TiO<sub>2</sub> producers have been hurrying up to develop higher-quality special purpose TiO<sub>2</sub> to fill the market gap. For example:

- In June 2020, TiO<sub>2</sub> type DR-2589 developed by Kunming Donghao Titanium Co., Ltd. and Inter-China Chemical Co., Ltd. debuted. It is reported that DR-2589 is used in high weather-resistant plastics, with properties of good lightness in colouring, hiding power and dispersion, excellent processability, thermal resistance and chalking resistance.
- In April 2022, Inter-China Chemical Co., Ltd. and Kunming Donghao Titanium Co., Ltd. jointly launched the TiO<sub>2</sub> type DR-2688. DR-2688 is used in high weather-resistant plastics, with properties of excellent polycarbonate degradation resistance, outstanding polycarbonate yellowing resistance, and excellent processability.

### 8.4 Trading

In Nov. 2020, the Ministry of Commerce and the General Administration of Customs of the People's Republic of China issued the *NO. 54 Notice on the Adjustment of the Catalogue of Commodities Prohibited from Processing Trade* (the Catalogue). TiO<sub>2</sub> was removed from the Catalogue since 1 Dec. 2020, which is propitious to TiO<sub>2</sub> exports.

With improvement in quality and broadening application, the competitiveness of China's TiO<sub>2</sub> has been greatly improved in recent years. China's TiO<sub>2</sub> export volume has maintained a rapid growth, and more and more foreign end users have turned their eyes to China. Meanwhile, domestic producers have been actively exploring overseas markets. In addition, as the energy crisis has kept simmering and energy costs have remained high, operating rates of TiO<sub>2</sub> industry in some foreign countries have reduced, which is conducive to China's TiO<sub>2</sub> exports.

CCM believes that it would be wise for foreign companies to work with Chinese producers to establish distribution networks worldwide.

## 9 Contact information of major suppliers in China

Table 9-1 Contact information of major producers in China

No.	Producer	Website	Telephone	Fax	Address
1	LB Group Co., Ltd.	www.billionschem.com	86-391-3126553/3126699	86-391-3126111	No. 1669 Jiaoke Road, Jiaozuo City, Henan Province, P. R. China
2	CNNC Hua Yuan Titanium Dioxide Co., Ltd.	www.zhtb.com	86-943-8270027	86-555-3501312	504 Nanhuan Road, Baiyin District, Baiyin City, Gansu Province, P. R. China
3	Nanjing Titanium Dioxide Chemical Co., Ltd. (GPRO Group)	www.nthcl.com	86-025-58366818	86-025-58366800	No. 229 East Dawei Road, Nanjing Chemical Industry Park, Jiangsu Province, P. R. China
4	Shandong Lubei Chemical Co., Ltd.	www.lubeichem.com	86-543-6455877/86-543-6452777	86-543-6451577	Lubei High-tech Development Zone, Wudi County, Binzhou City, Shandong Province, P. R. China
5	Pangang Group Vanadium & Titanium Resources Co., Ltd.	www.pgvt.cn	86-812-3385366	86-812-3385285	Pangang Culture Square, 21 Pangang Avenue, East District, Panzhihua City, Sichuan Province, P. R. China
6	Shandong Doguide Group Co., Ltd.	www.doguide.net	86-533-4161746	86-533-4167746	No. 55 Hengli River, Qiugu, Boshan District, Zibo City, Shandong Province, P. R. China
7	China National Chemical Co., Ltd.	www.chemchina.com.cn	86-776-2994352/86-531-67612778	86-776-2993908/86-531-67612796	No. 62 North Sihuan West Road, Haidian District, Beijing Municipality, P. R. China
8	Guangxi Jinmao Titanium Co., Ltd.	www.jinmao-ti.com	86-774-7301933	86-774-7290558	Chemical Industrial Park, Teng County, Wuzhou City, Guangxi Zhuang Autonomous Region, P. R. China
9	Shandong Dawn Titanium Industry Co., Ltd.	www.dawntio2.com	86-535-8825068	/	New Materials, New Energy Industrial Park, Longkou Economic Development Zone, Longkou City, Shandong Province, P. R. China
10	Yunnan Dahutong Industrial & Trade Co., Ltd.	www.yndht.com	86-871-68327488/86-812-6211371	86-871-68316444/86-812-6210817	20th Floor, Building A, Hecheng International, No. 1088 Haiyuan Middle Road, High-tech Zone, Kunming City, Yunnan Province, P. R. China
11	Ningbo Xinfu Titanium Dioxide Co., Ltd.	www.xinfu-tio2.com	86-574-86669696	86-574-86669818	No. 1 Yuejintang Road, Zhenhai District, Ningbo City, Zhejiang Province, P. R. China
12	CITIC Titanium Industry Co., Ltd.	www.jzty.com.cn	86-416-7183439/7182822	86-416-7182388	No. 1 Jintai Road, Taihe District, Jinzhou City, Liaoning Province, P. R. China
13	Guangdong Huiyun Titanium Industry Co., Ltd.	www.gdtitanium.com	86-766-8611868	86-766-8613336	Fuxing Road, Liudu Town, Yunan District, Yunfu City, Guangdong Province, P. R. China
14	Yibin Tianyuan Haifeng Hetai Co., Ltd.	www.ybty.com	86-831-5980821	86-831-5980823	No. 61 Port Park Road, Lingang Economic and Technological Development Zone, Yibin City, Sichuan Province, P. R. China

No.	Producer	Website	Telephone	Fax	Address
15	Guizhou Sunward Fuquan Chemicals Co., Ltd.	www.sunwardchemical.com	86-871-63102972	/	Shuanglong Industrial Park, Niuchang Town, Fuquan City, Qiannan Prefecture, Guizhou Province, P. R. China
16	Panzhuhua Taihai Technology Co., Ltd.	www.tisea.cn	86-812-6210820	86-812-6210820	Vanadium Titanium Industrial Park, Panzhuhua City, Sichuan Province, P. R. China
17	Anhui Annada Titanium Industry Co., Ltd.	www.andty.com	86-562-3867940	86-562-3864285	No. 1288 South Section of Tongguan Avenue, Tongling City, Anhui Province, P. R. China
18	Panzhuhua Haifengxin Chemical Industry Co., Ltd.	www.tioxite.com	86-812-6210138	86-812-6210199	No. 70 Taiyuan Road, Vanadium Titanium Industrial Park, Panzhuhua City, Sichuan Province, P. R. China
19	Guangxi Shunfeng Titanium Industry Co., Ltd.	www.shunfeng.cc	86-774-2678099	86-774-2678080	No. 15 Longcheng East Road, Longxu Town, Longxu District, Wuzhou City, Guangxi Zhuang Autonomous Region, P. R. China
20	Jiangxi Tikon Titanium Co., Ltd.	/	86-794-8355555	86-794-8352555	No. 4 Antang Road, Fubei Town, Linchuan District, Fuzhou City, Jiangxi Province, P. R. China
21	Panzhuhua Xingzhong Titanium Industry Co., Ltd.	www.xztypt.com	86-812-621369	/	Vanadium Titanium High-tech Industrial Park, Panzhuhua City, Sichuan Province, P. R. China
22	Shanghai Pengbo Titanium Dioxide Co., Ltd.	www.pengbotio2.com	86-021-57266998	86-021-57266998	No. 55 Lane 66, Xiasheng Road, No. 2 Industrial Zone, Jinshanwei Town, Jinshan District, Shanghai Municipality, P. R. China
23	Kunming Donghao Titanium Co., Ltd.	www.kmdhty.cn	86-871-68854222	/	Kunming Titanium Salt Industrial Base, Fumin County, Kunming City, Yunnan Province
24	Panzhuhua Tianlun Chemical Co., Ltd.	www.pzhtl.com	86-812-3161186	86-812-3161196	An'ning Industrial Zone, Yanbian County, Panzhuhua City, Sichuan Province, P. R. China
25	Denox Advanced Materials Co., Ltd.	denox.net.cn	86-562-2611727	86-562-2611099	No. 399 Changshan Avenue, Economic and Technological Development Zone, Tongling City, Anhui Province, P. R. China
26	Suzhou Hongfeng Titanium Industry Co., Ltd.	www.szhongfeng.com.cn	86-512-65396890	86-512-66729852	No. 151 Bao'an Road, High-tech Zone, Suzhou City, Jiangsu Province, P. R. China
27	Huai'an Feiyang Titanium Dioxide Co., Ltd.	www.chinafeiyang.com/news.html	86-517-85730098	86-517-85733099	Erbao Village, Shitang Town, Huaian District, Huaian City, Jiangsu Province, P. R. China
28	Panzhuhua Hengtong Titanium Co., Ltd.	www.hengtongty.com	86-812-3509212	86-812-3509218	No. 31 Titanium Avenue, Vanadium Titanium High-tech Industrial Development Zone, Panzhuhua City, Sichuan Province, P. R. China

No.	Producer	Website	Telephone	Fax	Address
29	Panzhuhua Zhengyuan Technology Co., Ltd.	/	86-812-8102209	/	Baima Vanadium and Titanium Industrial Park, Miyi County, Panzhihua City, Sichuan Province, P. R. China
30	Nexttech Materials Co., Ltd.	www.nexttechmat.com	86-562-5327558	/	Jincheng Industrial Park, Tongling City, Anhui Province, P. R. China
31	Guangxi Xilong Chemical Co., Ltd.	www.bb-hy.com	86-775-8736388	/	Wangmao Industrial Park, Bobai County, Yulin City, Guangxi Zhuang Autonomous Region, P. R. China
32	Fumin Longteng Titanium Industry Co., Ltd.	/	86-871-68854066	86-871-68854068	Beiyong Titanium Industrial Park, Yongding Town, Fumin County, Kunming City, Yunnan Province, P. R. China
33	Qianjiang Fangyuan Titanium Industry Co., Ltd.	www.fyfb.com	86-27-83412402	86-027-83412907	No. 99 Zhanghua North Road, Qianjiang City, Hubei Province
34	Alfa Full (Guangxi Tengxian) Titanium Dioxide Co., Ltd.	www.alfafull.com	86-774-7502178	86-774-7502121	Mengjiang Town, Teng County, Nanning City, Guangxi Zhuang Autonomous Region, P. R. China
35	CNMC (Guangxi) Pgma Co., Ltd.	djzky.cnmc.com.cn/pgma/in dex.html	86-774-8831108	86-774-8831108	No.1 Power Plant South Road, Pinggui District, Hezhou City, Guangxi Zhuang Autonomous Region, P. R. China
36	Hunan Chuangda Yutu Chemical Co., Ltd.	www.hncdyt.cn	86-734-8300502	86-734-8300502	Jinjialing Village, Chashan'ao Town, Zhuhui District, Hengyang City, Hunan Province, P. R. China
37	Panzhuhua Taidu Chemicals Co., Ltd.	/	86-510-83220520	86-510-83220520	Vanadium Titanium Industrial Park, Panzhihua City, Sichuan Province, P. R. China
38	Guangxi Detian Chemical Cycle Co., Ltd.	www.gxdchem.com	86-771-3723388	86-771-3723388	Leiping Town, Daxin County, Guangxi Zhuang Autonomous Region, P. R. China
39	Guangxi Baihe Chemical Co., Ltd.	/	86-771-5508881	86-771-5511380	Baihe Base of Pingguo County, Guangxi Zhuang Autonomous Region, P. R. China
40	Yumen Jingyang Titanium Pigment Manufacturing Co., Ltd.	/	86-937-3272185	86-937-3272186	Jianhua Industrial Park, Yumen East Town, Yumen City, Gansu Province, P. R. China

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17<sup>th</sup> Floor, Huihua Commercial & Trade Building, No. 80 Xianlie Zhong Road Guangzhou,  
510070, P.R.China

Website: <http://www.cnchemicals.com>

Tel: +86-20-37616606

Fax: +86-20-37616968

Email: [econtact@cnchemicals.com](mailto:econtact@cnchemicals.com)