

# TITANIUM FEEDSTOCK ANNUAL REVIEW *SAMPLE*

NEW EDITION TO BE RELEASED Q2 2014

## PROPOSED TABLE OF CONTENTS\*

### EXECUTIVE SUMMARY

#### 1.0: INTRODUCTION

- 1.1 The titanium industry
- 1.2 An overview of titanium feedstock producers
- 1.3 Structure of report
- 1.4 Confidentiality and disclaimer

#### 2.0: TITANIUM FEEDSTOCK MARKETS

- 2.1 Titanium feedstock sector
- 2.2 World sources of titanium feedstock
- 2.3 TiO<sub>2</sub> pigment production
- 2.4 Other end-uses
- 2.5 Co-products: pig iron

#### 3.0: HISTORICAL INFORMATION

- 3.1 History of mineral sands mining
- 3.2 Mining methods then and now
- 3.3 Historic analysis of trends in feedstock sector

#### 4.0: FEEDSTOCK SUPPLY

- 4.1 Introduction
- 4.2 Feedstock supply in 2013
- 4.3 Supply developments in 2012 and 2013
- 4.4 Supply outlook to 2015

#### 5.0: FEEDSTOCK DEMAND AND PRICING

- 5.1 Introduction
- 5.2 Feedstock demand in 2013
- 5.3 Feedstock demand by market segment
- 5.4 Feedstock pricing and trends in 2013

#### 6.0: FEEDSTOCK TRADE AND ANALYSIS

- 6.1 Imports in 2013
- 6.2 Exports in 2013
- 6.3 Analysis of trade trends

#### 7.0: NEW PROJECTS

- 7.1 New projects and overview of potential new supply

#### 8.0: STRATEGIC ISSUES

#### APPENDIX 1 – INTRODUCTION TO THE INDUSTRY/GLOSSARY

#### APPENDIX 2 – PRODUCER PROFILES

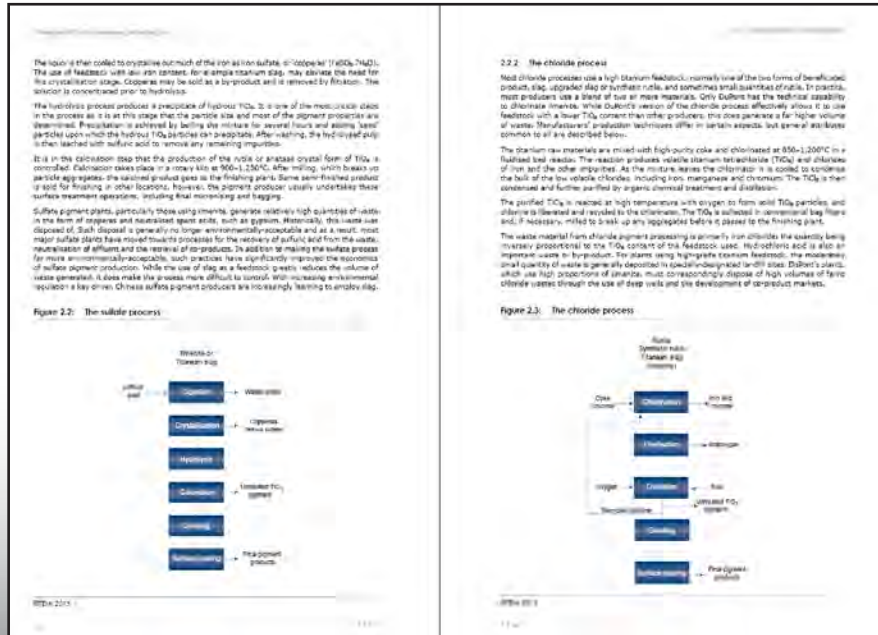
#### APPENDIX 3 – NEW PROJECT PROFILES

\* minor changes may be made to this outline prior to publication

# SAMPLE OF 2013 EDITION

## FEEDSTOCK MARKETS

- World resources of titanium minerals, including charts and written summary for major producing countries.
- Processing technologies for pigment production are explained including flowcharts.
- Other end-uses for titanium raw materials outlined.



**3.2 The early days of feedstock production (1700s to 1900s)**

**Australia**

Mineral sands were first mined in Australia in the 1850s, at Ballina on the north coast of New South Wales (NSW). By the late 1940s, rutile and zircon mining had begun in Queensland and further south in New South Wales. A combined rutile and zircon concentrate was sold to the US, while the lower-quality ilmenite was discarded or stockpiled.

During the 1950s, the Australian mineral sands industry grew substantially. A large number of companies started mining operations along the country's east coast from NSW to Queensland, with rutile being the primary product sought and zircon as a by-product.

Several companies began mining mineral sands, particularly ilmenite, in Western Australia (WA) during that time.

In 1957, Cribba Sands Pty. Limited was incorporated and began operations near Bubbly Creek. Another company, Western Titanium, discovered its mining sites south of Cape (also near Bubbly Creek). In 1959, Neerambi Sands Limited (formerly Neerambi Sands) began mining at North Cape and supplied ilmenite to British Titan (later renamed Neerambi).

The Ernsdell field was discovered in WA in north 1960, and became popular due to its high-grade titanium, ilmenite and rutile ore. Eventually, three companies went into production there: Jennings Mining, Allied Ernsdell and Neerambi Titanium. All three later became part of Neerambi Global Sands Consolidated (NSC).

**Canada**

In Canada, the first rock ilmenite deposits were discovered in 1946 at Lake Umbagog, New Brunswick. The first rock ilmenite mine was opened in 1948. In 1946, Quebec Iron and Titanium Corporation was established. It officially became QIT Far et Proche (QIT) in 1950, and built a smelter complex at Sorel, Quebec. By the late 1950s, the smelter facility was well established and Sorel slag became a major feedstock for many sulfate pigment plants.

**India**

India's mineral sands industry expanded during the 1930s, with the country increasingly exporting more ilmenite, zircon and monazite.

In 1932, P. V. Ramani and Sons (Travancore) Pvt. Limited was established in India. The firm was the forerunner of Kerala Minerals and Metals Limited and changed hands three times before the Kerala Government acquired it in 1958.

In 1930, the Indian and Travancore Governments established Indian Railways Earths Limited (IRE) to produce monazite on a commercial scale. By 1963, the company was under the administrative control of the Indian Government's Department of Atomic Energy.

IRE went on to acquire a number of private companies engaged in the mining and sale of monazite in India's south, including at Kerala and Tamil Nadu.

**Norway**

The huge Tvedestrand deposit in Norway was discovered in 1934, and ilmenite mining began there in 1950. Tvedestrand handles the operations and has been supplying ilmenite to the European pigment industry's since production started.

**Norway**

Det Norske Staal paved the way for rutile mining in Sorel, Quebec, which began in 1957.

**Sweden**

The Ernsdell deposit was discovered in the Moravia in 1951, and mining began in 1955. Ernsdell's CO<sub>2</sub> is approximately 100-ton from flow.

**Vietnam**

Vietnam State Mining & Metallurgical Plant began producing rutile and zircon in the region during 1962.

**US**

Following World War II, the US in particular saw rapid economic and military changes that stimulated strong growth in the TiO<sub>2</sub> pigment market and feedstock supply chain. Pigment plants using the sulfate process were constructed in North America and Europe, while demand for rutile grew due to its increased use as a welding flux, and in the newly-developed hardfacing process that produces chromium metal.

In the 1950s, DuPont had developed the chloride process to produce TiO<sub>2</sub> from ilmenite ore. The company had built its second chlorination plant by 1950 in New Johnsonville, Tennessee. The New Johnsonville plant had an initial 43,000 tpa capacity, which was expanded to 100,000 tpa by 1964. TiO<sub>2</sub> demand also experienced strong growth during the 1960s as pigment and welding flux demand rose, and ilmenite mines opened in New Jersey.

## HISTORICAL INFORMATION

This section provides historical perspective from 1789 until after the global financial crisis of 2008.



Aerial view of KZN Sands plant  
Image courtesy Exxaro Resources

annual due to weakness in the demand for high-grade titanium feedstocks. Total synthetic rutile consumption was estimated at 435,000 TiO<sub>2</sub> units in 2012.

While demand for ilmenite slag was also lower in 2012, the deficit was relatively marginal compared to other chloride feedstocks. TCI's estimates consumption of chloride slag for pigment manufacture in 2012 is 1.38 million TiO<sub>2</sub> units, down 2% on the levels witnessed in 2011. Demand in 2012 was largely influenced by the switch in feedstock preference towards chloride slag by both chloride pigment producers and titanium sponge producers. A large proportion of chloride slag off-take in the current market is still bound by legacy contracts and therefore provides a significant economic advantage over other feedstocks. Off-take for upgraded slag (UGS), on the other hand, declined almost 20% year-on-year.

Global chloride titanium off-take is dominated by Outokumpu, which uses it as a direct titanium feed at a number of its pigment plants. The company's off-take in 2012 was substantially lower than in 2011, driven by titanium content reduction at these plants.

**Figure 4.4: Changes in chloride-grade feedstock demand by product type: 2010-2014**

**4.3 Feedstock demand by end-use**

Global demand for titanium feedstocks continues to be dominated by pigment manufacture, which accounted for 86% of total consumption in 2012, while titanium metal and other end uses each accounted for 7%. Demand for pigment feedstocks is estimated at 2.29 million TiO<sub>2</sub> units in 2012, much lower than that for 2011, and this directly correlates with a decline in global pigment production. Approximately 12% growth in global pigment production is forecast between 2012 and 2014. This will drive greater consumption of titanium feedstocks although demand is likely to stay slightly below 2012 before rebounding in 2014. Based on TCI's forecasts, a total increase in feedstock demand of 140,000 TiO<sub>2</sub> units is expected during the period to 2014, more than 80% of which is likely to be influenced by demand growth in pigment manufacture. All feedstock types are expected to experience increased demand to varying degrees across chloride ilmenite, the demand for which is likely to be capped by supply availability. While Kemira Resources' Nova Stage 2 expansion in Mozambique and TCI's Grande Côte project in Senegal will add new synthetic ilmenite to the global supply base, these proposals are expected to offset the declining output at Dow, Thib (Virginia) and Outokumpu mines.

**Table 4.1: Feedstock demand by market: 2010-2014**  
700 TiO<sub>2</sub> units

Market	2010	2011	2012	2013	2014	2015-2014
Global						
China						
Other Asia						
Rest of World						
USA						
Europe						
Latin America						
Other						
Total						

**Table 4.2: Feedstock demand by end-use between 2010 and 2014**

Given the much higher growth rates in titanium metal and other end use applications, the demands of titanium feedstock demand by pigment use has been declining. Accounting for only approximately 8% of global feedstock demand in 2012, titanium metal applications have not managed to reach 7% in 2012, underpinned by robust demand for titanium metal in the aviation sector. Nevertheless, the aviation market share of TiO<sub>2</sub> pigment, titanium metal and other end-use applications is likely to remain unchanged during the period to 2014.

**4.4 Feedstock trade**

Total titanium feedstock volumes identified in cross-border trade statistics in 2012 amounted to 6.87 million tonnes (4.8 million TiO<sub>2</sub> units), including imports of nonconsumers that are predominantly processed into final products and sold within China. Compared to 2011, the total feedstock import volume in 2012 was approximately 9% higher, measured in TiO<sub>2</sub> units. Despite weak demand in the downstream TiO<sub>2</sub> pigment sector, the higher import volumes identified could be attributed to the increases committed under long-term contracts between pigment and feedstock producers, and possibly some anomalies in trade statistics that may have included double-counted shipments. Figure 4.5 shows global titanium feedstock import volumes identified on a monthly basis in TiO<sub>2</sub> units.

**Figure 4.5: Monthly global titanium feedstock imports: 2010-2012**

# DEMAND AND PRICING

- Pricing for titanium feedstock products and outlook for the following two years.
- Analysis of activity in the feedstock sector plus major producers supply and demand dynamics.

**World titanium feedstock import statistics by country and product: 2008-2012**

**Import statistics from more than 20 countries**

**Includes forecasting to 2014**

Country	Product	2008	2009	2010	2011	2012
Belgium	Rutile					
	Synthetic rutile					
	Titanium slag					
CIS	Ilmenite					
	Rutile					
	Titanium slag					
Canada	Ilmenite					
	Titanium slag					
China	Ilmenite					
	Rutile					
	Titanium slag					
Eastern Europe	Ilmenite					
	Rutile					
	Titanium slag					
Finland	Titanium slag					
France	Ilmenite					
	Rutile					
	Titanium slag					
Germany	Ilmenite					
	Rutile					
	Titanium slag					
Italy	Titanium slag					
Japan	Ilmenite					
	Rutile					
	Titanium slag					
Malaysia	Ilmenite					
	Rutile					
Mexico	Ilmenite					
	Leucocoxene					
	Rutile					
	Titanium slag					
Netherlands	Synthetic Rutile					
	Ilmenite					
	Rutile					
Saudi Arabia	Titanium slag					
	Synthetic Rutile					
	Ilmenite					
Singapore	Rutile					
	Titanium slag					
	Synthetic Rutile					
South Korea	Ilmenite					
	Rutile					
Spain	Ilmenite					
	Titanium slag					
Taiwan	Ilmenite					
	Rutile					
	Titanium slag					
	Synthetic Rutile					
UK	Ilmenite					
	Rutile					
	Titanium slag					
	Synthetic Rutile					
US	Ilmenite					
	Leucocoxene					
	Rutile					
	Titanium slag					
Rest of World	Synthetic Rutile					
	Ilmenite					
	Rutile					
Total	Titanium slag					
	Ilmenite					
	Rutile					
	Synthetic rutile					
	Leucocoxene					



Table 5.2: World production of titanium feedstocks: 2008-2012 ('000 TiO<sub>2</sub> units)

Country	Product	2008	2009	2010	2011	2012
Australia	Ironoxide for pigment	2000	2000	2000	2000	2000
	Ironoxide	2000	2000	2000	2000	2000
	Rutile	2000	2000	2000	2000	2000
	Sulfate rutile	2000	2000	2000	2000	2000
	Total	8000	8000	8000	8000	8000
Canada	Total (slag)	2000	2000	2000	2000	2000
	Total	10000	10000	10000	10000	10000
China	Ironoxide for pigment	2000	2000	2000	2000	2000
	Rutile	2000	2000	2000	2000	2000
	Sulfate rutile	2000	2000	2000	2000	2000
	Total	6000	6000	6000	6000	6000
India	Ironoxide for pigment	2000	2000	2000	2000	2000
	Rutile	2000	2000	2000	2000	2000
	Sulfate rutile	2000	2000	2000	2000	2000
	Total	6000	6000	6000	6000	6000
Newway	Ironoxide for pigment	2000	2000	2000	2000	2000
	Slag	2000	2000	2000	2000	2000
	Total	4000	4000	4000	4000	4000
	Mozambique	Ironoxide for pigment	2000	2000	2000	2000
Rutile		2000	2000	2000	2000	2000
Sulfate rutile		2000	2000	2000	2000	2000
Total		6000	6000	6000	6000	6000
CIR	Ironoxide for pigment	2000	2000	2000	2000	2000
	Rutile	2000	2000	2000	2000	2000
	Sulfate rutile	2000	2000	2000	2000	2000
	Total	6000	6000	6000	6000	6000
South Africa	Rutile	2000	2000	2000	2000	2000
	Sulfate rutile	2000	2000	2000	2000	2000
	Total	4000	4000	4000	4000	4000
	US	Ironoxide for pigment	2000	2000	2000	2000
Ironoxide		2000	2000	2000	2000	2000
Total		4000	4000	4000	4000	4000
Vietnam		Ironoxide for pigment	2000	2000	2000	2000
	Sulfate rutile	2000	2000	2000	2000	2000
	Total	4000	4000	4000	4000	4000
	China	Ironoxide for pigment	2000	2000	2000	2000
Ironoxide		2000	2000	2000	2000	2000
Rutile		2000	2000	2000	2000	2000
Total		6000	6000	6000	6000	6000

Country	Product	2009	2010	2011	2012
World	Ironoxide for pigment	2000	2000	2000	2000
	Ironoxide	2000	2000	2000	2000
	Rutile	2000	2000	2000	2000
	Sulfate rutile	2000	2000	2000	2000
	Total	8000	8000	8000	8000

5.3 Supply developments in 2013 and outlook to 2014

**Chloride ironoxide**  
Supply of chloride ironoxide from Australia is expected to decline further in 2013, following Sula's decision to close its Enabba North mine from April 2013. The closure of the operation, which is a significant source of chloride ironoxide, is expected to reduce some 140,000 units from global supply. In the US, chloride ironoxide from Sula's Virginia operation is expected to become predominantly rutile from 2013 to 2014 as it will be reassigned internally for US manufacture, thus reducing its availability for pigment use. There will be a hiatus at China's Xie operations, with mining at Guangdong completed in October 2012 and the reopening due for start-up in 2014. Nevertheless, output at the company's N313 Mainy Basin operation is expected to increase substantially from 2013. Following reduction of the mining difficulties experienced in 2012, TZMI estimates that chloride ironoxide output from the N313 operation will increase to 70,000 TiO<sub>2</sub> units by 2014. Another important source of chloride ironoxide is Kennametal's Mena operation in Mozambique. The Phase 2 expansion was completed there in late 2012, and commencing its current output will be in 2013. Chloride ironoxide from Mena is expected to increase progressively in 2013 and 2014 as the operation ramps up towards its design capacity. TZMI's current base case supply forecast assumes that some of the Mena material will be allocated for US manufacture unless new chloride ironoxide sources are brought online to sustain Sula's current US production. While the method of analysis may mask some of the impact for the supply of chloride ironoxide from a particular region, there is no impact on overall global net supply.

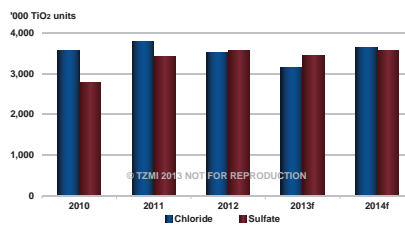
**Rutile**  
In 2013, Sula's annual rutile production is expected to be significantly lower following the company's decision to close its Enabba North mine while reducing output at its Mena and Mainy Basin operations. These developments, together with the closure of Enabba's Mena mine, are expected to result in 2013 global rutile supply being substantially lower at 200,000 TiO<sub>2</sub> units, a reduction of close to 20% year-on-year.

Nevertheless, output at the Sierra Rutile Limited (SRL) operation in Sierra Leone is expected to be higher in 2013 and 2014, assuming that the basic and fluorspar processing units remain on schedule. SRL's total rutile output is expected to reach 150,000 TiO<sub>2</sub> units by 2014.

# FEEDSTOCK SUPPLY

Included in this section is a breakdown of supply by country, by product type and by major suppliers. Production figures for the past 4 years are identified, plus forecasting for the following 2 years.

Chloride versus sulfate feedstock supply: 2010-2012



Production statistics from the top 10 countries

## TRENDS AND OUTLOOK

Trends observed in 2012 analysed and assessed for impact on the feedstock sector.

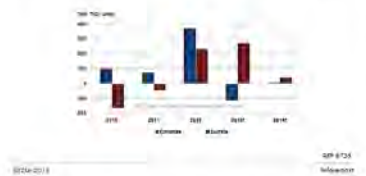
4.2 Supply/demand analysis and industry outlook to 2014

In the latter 2010 and 2011, there was a significant difference in the chloride and sulfate market balances. While the chloride-grade feedstock market was in a moderate surplus position, sulfate-grade feedstocks recorded a substantial deficit estimated at 184,000 TiO<sub>2</sub> units and 46,000 TiO<sub>2</sub> units in 2010 and 2011, respectively. The chloride feedstock surplus is predominantly accounted for by chloride ironoxide, specifically Ironoxide (rutile or sulfate) and rutile (SRL) feedstocks that are normally made available to the open market. The addition of significant ironoxide from Sula's Enabba North operation over the closing of its US line, combined with record production by Dowel, resulted in a considerable 'rutile' surplus.

High-grade rutile feedstocks were historically in balance during that period, even with the introduction of RFT's new high-grade rutile (china slag) product. In contrast, sulfate-grade feedstocks displayed significant deficits due initially to the under-performed recovery in China's pig-iron demand leading to a high consumption of sulfate ironoxide. Despite supply growth, sulfate (rutile) in 2011, with increased sulfate ironoxide production in China and Vietnam plus the impact of Sula's (formerly Bauxite Resources Limited) Sogaoguo operation in the Hunan Basin of Henan-South (Australia) in southern China, the overall sulfate feedstock market remained in deficit.

During 2012, the market dynamics changed completely. The market was no longer driven by high overall supply but rather an increasing surplus position in an environment of reduced demand influenced by the strengthening price in the downstream TiO<sub>2</sub> pigment market. Global TiO<sub>2</sub> production declined materially last year as end-market companies (in particular, pigment) closed refineries and some substitution further eroded demand levels at Q4, leaving the industry unable to meet the rising demand. As a consequence, demand for feedstocks fell significantly. TZMI's supply/demand projections indicated a surplus position of close to 600,000 TiO<sub>2</sub> units at the end of 2012, and a resultant build-up of feedstock inventory on the heels of feedstock and pigment reductions. Figure 4.1 shows the supply/demand balance between chloride and sulfate feedstocks for the period 2010 to 2014.

Figure 4.1: Supply/demand balance for all titanium feedstocks: 2010-2014



While both the chloride and sulfate feedstock markets were overall in surplus in 2012, the chloride feedstock market was more severely impacted, predominantly due to the under-scale production capacity of the major chloride producers that took place during 2012. The surplus position for the chloride feedstock market in 2012 was 180,000 TiO<sub>2</sub> units, compared to a surplus of 230,000 TiO<sub>2</sub> units in the sulfate feedstock market.

In the short term, the chloride market is expected to move into deficit before becoming a balanced market in 2014. The market for high-grade feedstocks, in particular, will see supply tightening considerably for the remainder of 2013, given the production cutbacks implemented by a number of feedstock producers beyond 2014, increasing supply deficits as expected unless new supply is brought on stream.

Among the chloride-grade feedstocks, the chloride slag market is expected to remain in deficit during the first half of the year and 2014. TZMI's current forecast also demands for chloride slag will grow at 6% per annum from the 1.27 million TiO<sub>2</sub> units in 2012 to 1.54 million TiO<sub>2</sub> units in 2014. The market for chloride ironoxide is expected to remain in balance through to 2014, assuming there is no feedstock demand change in the pigment production end.

In terms of high-grade rutile feedstocks, the market for rutile (SRL) and upgraded slag are expected to show a balance or minor deficit depending on the timing of the reconstruction of feedstock supply. This will be largely influenced by the developments of the underlying feedstocks and TZMI's current forecast suggest that a deficit to the reconstruction beyond 2014 is highly unlikely. The sulfate market, on the other hand, is expected to remain over-supplied in the absence of any significant response in end-user supply until demand from the downstream TiO<sub>2</sub> sector begins to weaken. TZMI's forecast suggests that the supply of sulfate-grade feedstock in 2013 is likely to remain at a similar level to that witnessed in 2012, due to the addition of new capacity from the Mena Phase 2 expansion and a number of new capacity in Australia (such as Australian Bauxite Resources' new mine and the Guangdong project). Mainy Basin (China) sulfate ironoxide output from China and Vietnam is expected to increase, however, under construction. Sierra Rutile and TiO<sub>2</sub> Rutile Ltd are expected to commence production in late 2013/early 2014, and will then add to the global supply.

Trade analysis

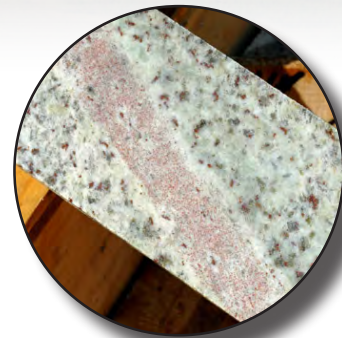
Supply and demand forecasts

Feedstock pricing

# NEW PROJECTS

The titanium feedstock sector has enjoyed renewed interest in the past couple of years due to increased investor activity, supply challenges and rising prices for minerals.

This section includes a synopsis of projects in the pipeline. It also includes an outline of each project and its development status.



# STRATEGIC ISSUES

The feedstock sector underwent a period of consolidation in 2012, following the prior two years which were marked by significant supply challenges and rapidly rising prices for all feedstocks.

This section discusses the challenges faced in 2012 and the outlook through to 2014.



# APPENDICES

## APPENDIX 1 *Introduction to the TiO<sub>2</sub> industry*

## APPENDIX 2 *Producer profiles* Includes profiles for 29 major producers

## APPENDIX 3 *New projects profiles* Includes profiles for 33 new projects

**SAMPLE PROFILE**

TITANIUM FEEDSTOCK ANNUAL REVIEW 2013

APPENDIX 2

### Indian Rare Earths Limited

**Ownership** Indian Government (Department of Atomic Energy)

**Address** Plot No 1207 Veer Savakar Marg near Siddhi Vinayak Temple Prabhadevi, Mumbai 400 028 INDIA

**Tel:** +91 22 2438 2042  
**Website:** irel.gov.in  
**Email:** dir\_mktg@irel.gov.in

**Key personnel** R N Patra – Chairman and Managing Director  
Deependra Singh – Director Marketing

**Background** Indian Rare Earths Limited (IRE) was incorporated in August 1950 as a private limited company jointly owned by the Government of India and Government of Travancore, Cochin, with the primary intention of taking up commercial scale processing of monazite sand at its first unit namely Rare Earths Division (RED), Aluva, Kerala for the recovery of thorium.

After becoming a fully-fledged Central Government Undertaking in 1963 under the administrative control of Department of Atomic Energy (DAE), IREL took over a number of private companies engaged in mining and separation of beach sand minerals in southern part of the country and established two more divisions: one at Chavara, Kerala and the other at Manavalakurichi, Tamil Nadu.

**Operations** IRE operates three mining sites:

#### Chavara Mineral Division (Q grade products)

The Chavara plant is located 10 km north of Kollam (formerly Quilon) and 85 km from Trivandrum, the capital of the State of Kerala.

The plant operates on a mining area containing up to 40% heavy minerals and extending over a length of 23 km from Neendakara to Kayamkulam. Extensive deposits are mined by dry as well as wet (dredging) mining and mineral separation for the extraction of a high TiO<sub>2</sub> (about 60%) ilmenite, together with accessory rutile and zircon.

Current annual production capacity of the Chavara unit is 154,000 tonnes of ilmenite, 9,500 tonnes of rutile, 14,000 tonnes of zircon and 10,000 tonnes of sillimanite. Additionally, the plant has facilities for annual production of 6,000 tonnes of ground zircon called zirflor (~45 micron) and 500 tonnes of microzir (1-3 micron).

#### Manavalakurichi Mineral Division (MK grade products)

The MK mining and processing operations are situated 25 kms north of Cape Comorin, in the State of Tamil Nadu. Annual production is approximately 100,000 tonnes of ilmenite of 55-56% TiO<sub>2</sub> grade, 3,600 tonnes of rutile and 10,000 tonnes of zircon in addition to 4,000 tonnes of monazite and 12,000 tonnes of garnet. >>

### Indian Rare Earths Limited

**Operations (cont.)**

<< **Orissa Sands Complex (OSCOM) ('OR' grade products)**  
On India's east coast at Chatrapur, about 150 km south of Bhubaneswar, the capital of Orissa, IRE dredges a major mineral sands deposit with a nominal ilmenite production capacity of 220,000 tpa of 50% TiO<sub>2</sub> ilmenite and associated minerals including rutile, zircon, sillimanite and garnet. The OSCOM plant capacity is also undergoing a staged expansion, commencing with a new 600 tpa dredge. The first stage of expansion is expected to increase production capacity to 500,000 tpa of ilmenite and co-products by 2012.

#### Rare Earths Division (RED) Aluva

RED is an exclusively value adding chemical plant wherein the monazite produced by MK is chemically treated to separate thorium as hydroxide and rare earths in a composite chloride form. On the banks of Periyar River, the plant commenced operations in 1952 to process 1,400 tonnes of monazite every year. The capacity of the plant has gradually increased to treat about 4,200 tonnes of monazite. Rare earth products include mixed rare earth chlorides, cerium compounds and polishing powders, neodymium oxide and small amounts of other rare earth oxides.

The plant is currently engaged in the processing of accumulated Thorium concentrate with a consequential dip in rare earths production. IRE plans to produce high pure individual rare earth compounds at RED from Rare Earths Chloride to be supplied by MoPP, OSCOM.

**Recent developments**

In January 2011, IREL signed a memorandum of understanding with National Aluminium Company Limited to make value added products from beach sand and minerals. It is estimated that the project will cost Rs400 crore and is to be established in the Ganjam District in Orissa. The proposed titanium plant will reportedly produce titanium slag initially with the titanium plant following during a later phase of the project. Output from the slag and titanium plants will predominantly cater for domestic demand.

For the year ending 31 March 2012, net profit for the period was reported at Rs 17,044.92 lakh.

In September 2012 it was also reported that IREL start production of Rare Earths Chloride at Monazite Processing Plant (MoPP) that is being commissioned at OSCOM, Odisha in 2013.

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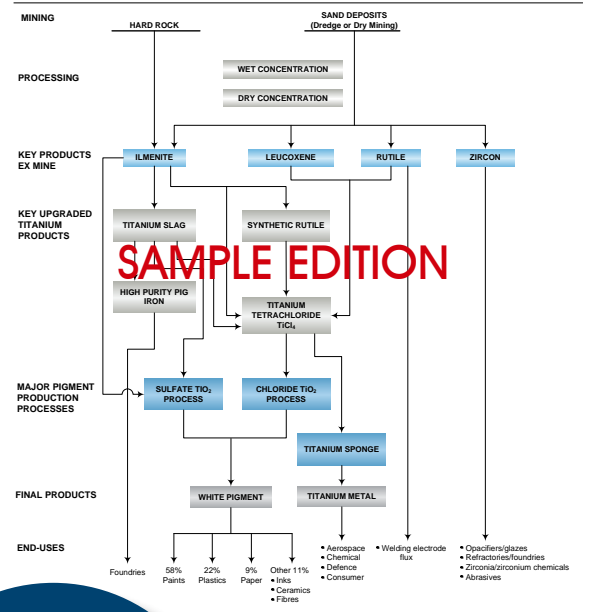
## Executive summary

### Introduction

The titanium industry involves key mineral sands commonly referred to as titanium feedstocks. These raw materials are used primarily in the production of titanium dioxide (TiO<sub>2</sub>) pigment and, in smaller quantities, in the production of titanium metal and welding fluxes. The most common mineral sands products are ilmenite, rutile and, to a lesser extent, leucocoxene and zircon.

The following figure shows the steps involved from mining through to major end-uses.

### Titanium feedstock flowsheet



## SAMPLE EDITION

TITANIUM FEEDSTOCK ANNUAL REVIEW 2013

Titanium feedstocks are mainly used in the production of pigment, which accounts for more than xxx% of the world's consumption of titanium minerals. The remainder is used in the production of titanium metal and fluxes for welding rods, and as a metallurgical flux in iron and steel making. Demand for titanium feedstocks has, therefore, been historically linked with that of TiO<sub>2</sub> pigment, an industry discussed in detail in the *TiO<sub>2</sub> Pigment Annual Review 2013*.

Only a small number of large mining companies or groups are involved in the production of titanium feedstocks, and these are dominated by close relationships between producers (miners) and consumers (predominately pigment producers). In 2012, the industry experienced the impact of slowing demand throughout the value chain as well as a number of strategic moves within the industry to curtail costs and maintain security of supply.

The largest feedstock producers are based in Africa and Australia. Xxx is the biggest producer of titanium feedstock in the world. The second-biggest feedstock producer is xxx. Xxx is the world's third-largest feedstock producer as a result of xxx.

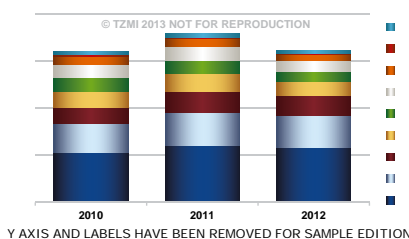
### Feedstock demand and pricing

The sector has been negatively impacted by the debt crisis surrounding the Euro Zone and the economic slowdown experienced in China. Following a year of considerable demand growth, the titanium feedstock market in 2012 was influenced by a significant de-stocking phase among pigment producers. Demand for titanium dioxide (TiO<sub>2</sub>) pigment appeared to be strong at the beginning of 2012, as it rebounded slightly from the dramatic declines experienced in Q4 2011. However, as the year progressed, declining sales of TiO<sub>2</sub> pigment resulted in high inventory levels; reaching 120 day sales of inventory (DSI) for certain plants at one point in time.

In addition, the sector has been negatively impacted by the debt crisis surrounding the Euro Zone and the economic slowdown experienced in China.

During 2012, demand for titanium feedstocks declined significantly to xxx million TiO<sub>2</sub> units; down approximately xxx% year-on-year. Demand for feedstock by product type is shown in the following figure.

### Demand for feedstock by product type: 2010-2012



REF 8716

A decline in feedstock consumption was seen across all feedstock types and wide-scale production curtailment by pigment producers took place, particularly in chloride markets. Demand for chloride-grade feedstock fell substantially, down almost xxx% year-on-year, as major chloride pigment plants dramatically scaled back TiO<sub>2</sub> production, while demand for sulfate-grade feedstocks only declined by xxx% year-on-year.

Global demand for titanium feedstocks continues to be dominated by pigment manufacture, which accounted for xxx% of total consumption in 2012, while titanium metal and other uses each accounted for xxx%. Demand for pigment feedstocks is estimated at xxx million TiO<sub>2</sub> units in 2012, much lower than that for 2011, and this directly correlates with a decline in global pigment production.

Based on TZMI's forecasts, a total increase in feedstock demand of xxx TiO<sub>2</sub> units is expected during the period to 2014; more than xxx% of which is likely to be influenced by demand growth in pigment manufacture.

### Feedstock demand by market: 2010-2014

'000 TiO<sub>2</sub> units

	2010	2011	2012	2013 <sup>f</sup>	2014 <sup>f</sup>	Change in demand 2012-2014 <sup>f</sup>
Pigment						
Ti metal						
Other uses						
<b>Total feedstock demand</b>						

<sup>f</sup>-forecast

Following several consecutive price increases in 2011, feedstock pricing appeared strong at the beginning of 2012. However, signs of market softening in the downstream TiO<sub>2</sub> pigment sector began to emerge in late Q2 2012.

Many pigment producers cut back on production, which in turn, reduced their requirement for titanium feedstocks and prices for several feedstock types fell substantially as a consequence. Prices have also been influenced by the pricing mechanism moving away from an annual basis to quarterly, or even spot prices, for most feedstocks.

### Feedstock supply

At the start of 2012, supply for most feedstock products, in particular high-grade titanium dioxide (TiO<sub>2</sub>), remained tight. However, as the year progressed, it became clear that the economic deterioration in Europe and slowdown in China, together with a looming 'fiscal cliff' in the US, had profoundly impacted global feedstock offtake. Some feedstock producers scaled back production at their mines in an effort to bring the feedstock supply/demand ratio closer to balance and reduce costs.

TZMI has estimated the global supply of titanium feedstock in 2012 at xxx million TiO<sub>2</sub> units; down xxx from 2011 levels.

The relative market share of the feedstock types for 2012 remains largely consistent with 2011. Sulfate ilmenite accounts for the largest share (xxx%) of global titanium feedstock supply in terms of TiO<sub>2</sub> units. Chloride slag comprises the second largest share of feedstock type supplied, accounting for around xxx% of global supply in 2012, and is the base load feedstock for chloride route pigment manufacture.