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ILMENITE AND RUTILE

(ADVANCE RELEASE)

GOVERNMENT OF INDIA
MINISTRY OF MINES
INDIAN BUREAU OF MINES

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15 Ilmenite & Rutile

India is endowed with large resources of heavy minerals which occur mainly along coastal stretches of the country and also in inland placers. Heavy mineral sands comprise a group of seven minerals, viz, ilmenite, leucoxene (brown ilmenite), rutile, zircon, sillimanite, garnet and monazite. Ilmenite ($FeO.TiO_2$) and rutile (TiO_2) are the two chief minerals of titanium. Titanium dioxide occurs in polymorphic forms as rutile, anatase (octahedrite) and brookite. Though brookite is not found on a large-scale in nature, it is an alteration product of other titanium minerals. Leucoxene is an alteration product of ilmenite and is usually found associated with ilmenite.

RESOURCES

Ilmenite and rutile along with other heavy minerals are important constituents of beach sand deposits found right from Saurashtra coast (Gujarat) in the west to Digha coast, West Bengal in the east. These minerals are concentrated in five well-defined zones:

* Over a stretch of 22 km between Neendakara and Kayamkulam, Kollam district, Kerala (known as 'Chavara' deposit after the main mining centre).
* Over a stretch of 6 km from the mouth of River Valliyar to Colachal, Manavalakurichi and little beyond in Kanniyakumari district, Tamil Nadu (known as MK deposit).
* On Chatrapur coast stretching to about 18 km between Rushikulya river mouth and Gopalpur lighthouse with an average width of 1.4 km in Ganjam district, Odisha (known as 'OSCOM' deposit after IREL's Orissa Sands Complex).
* Brahmagiri deposit stretches for 30 km from Girala nala to Village Bhabunia with an average width of 1.91 km in Puri district, Odisha.
* Bhavanapadu coast between Nilarevu and Sandipeta with 25 km length and 700 m average width in Srikakulam district, Andhra Pradesh.

The AMD of the Department of Atomic Energy has been carrying out exploration of these mineral deposits. Of the total coastal length of 5,921 km spread in Odisha, Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Maharashtra, Goa, Gujarat and West Bengal about 451 km, 1,873 km, and 112 km have been covered by detailed exploration, general exploration and preliminary exploration respectively. A coastal length of 2,272 km have not been covered due to various reasons viz., mangrove, port activity etc., leaving an unexplored coastal length of 1,214 km. The distribution of area coverage (sq km) in different geological domains are Beach & Dune (1845), Inland Sand Body (180), Terrace sediments (368), River Channel (32), Inland alluvium (646) and Lake & Sea Beds (38). The ilmenite resource estimation for the areas explored up to year 2016 has been completed and the resources are up from 539.50 million tonnes (including leucoxene) in the year 2012 to 629.57 million tonnes in year 2016. The resources include measured, indicated and inferred categories. The most significant deposits which are exploitable and which could attract the attention of Industry for large-scale operations are listed out in Table-1.

The average grade of total heavy minerals in these deposits is 10-25% of which 30-40% is ilmenite. The overall Statewise reserves of ilmenite and rutile which occur together in beach sand deposits are furnished in Table-1 A.

EXPLORATION & DEVELOPMENT

The exploration and development details, if any, are covered in the Review on "Exploration and Development" under "General Reviews".

Table – 1 : Ilmenite Reserves, Resources/Deposits in India

State/Deposit	Ilmenite reserve (In million tonnes)
Andhra Pradesh	
1. Bhavanapadu	10.18
2. Kakinada (Phase I-VIII)	13.81
3. Kalingapatnam	7.03
4. Narasapur	2.92
5. Nizampatnam	19.26
6. Srikurman (South)	8.60
7. Visakhapatnam (Bhimunipatnam)	2.88
8. Amalapuram (Phase I-IV)	4.72
9. Pandurangapuram-Voderevu (Bapatla-Chirala coast)	10.38
10. Vetapalem Coast (Chirala coast)	5.31
Kerala	
1. Chavara Barrier beach	13.17
2. Chavara Eastern Extension (Phase-I)	17.02
3. Chavara Eastern Extension (Phase-II)	49.26
4. Trikkunnapuzha-Thotapally Beach & Eastern Extension	9.50
5. Alapuzha-Kochi	5.88
Maharashtra	
Ratnagiri	3.68
Munge-Achra-Malvan	1.12
Vijayadura-Mithbav	0.70
Gujarat	
Moti Daman-Umbrat coast	2.77
Odisha	
1. Brahmagiri (Phase I-V and NW extension)	86.04
2. Chatrapur	26.72
3. Gopalpur	6.42
Tamil Nadu	
1. Kudiraimozhi	22.86
2. Ovari-Periyatalai-Manapadu (Teri)	24.01
3. Sattankulam Teris	41.26
4. Cuddalore-Pudupattuchavadi (beach sand)	4.67
5. Vayakallur (beach sand)	4.52
6. Manavalakurichi (beach sand)	3.07
7. Midalam	1.64

Source: *As per letter received from Department of Atomic Energy dated 26/07/2018.*

Table – 1 A : Resources of Ilmenite and Rutile

(In million tonnes)

State	Total in situ #
Ilmenite* : Total	**629.57**
Andhra Pradesh	156.17
Jharkhand	0.73
Gujarat	2.77
Kerala	144.02
Maharashtra	5.50
Odisha	150.62
Tamil Nadu	167.70
West Bengal	2.06
Rutile : Total	**33.95**
Andhra Pradesh	10.55
Jharkhand	0.01
Gujarat	0.02
Kerala	8.74
Maharashtra	0.01
Odisha	6.58
Tamil Nadu	7.85
West Bengal	0.19

Source: *As per letter received from Department of Atomic Energy dated 26/07/2018. The resources of beach sand minerals (BSM) viz. Ilmenite, Rutile, Zircon, Garnet, leucoxene, monazite and Sillimanite were last updated in the year 2016 by AMD.* *# Inclusive of indicated, inferred and speculative categories.* ** Including leucoxene.*

PRODUCTION AND PRICES

Ilmenite

The production of ilmenite was 266 thousand tonnes in 2018-19.

Rutile

The production of rutile was 11.04 thousand tonnes in 2018-19.

Production and prices of ilmenite and rutile are furnished in Tables -2 to 4.

Table – 2 : Production of Ilmenite and Rutile (By States)

(In tonnes)

State	2016-17	2017-18	2018-19* (P)
ILMENITE			
India : Total	**594978**	**284667**	**265931**
Kerala	113323	100010	48694
Odisha	183015	184657	191492
Tamil Nadu	298640	-	25745
RUTILE			
India : Total	**14898**	**11829**	**11045**
Kerala	4724	3969	1723
Odisha	7372	7860	8384
Tamil Nadu	2803	-	938

Source: *Department of Atomic Energy, Mumbai.*
** Data is incomplete as IREL production figures are only available*

Table – 3 : Prices of Rutile 2016-17 to 2018-19

(₹ per tonne)

Year	Grade	Price	Remarks
IREL			
2016-17	Q	50000-52000	Ex-works, Bagged
	MK	50000-52000	Ex-works, Bagged
	OR	50000-52000	Ex-works, Bagged
2017-18	Q	55000-64500	Ex-works, Bagged
	MK	55000-64500	Ex-works, Bagged
	OR	55000-64500	Ex-works, Bagged
2018-19	Q	66500-94500	Ex-works, Bagged
	MK	66500-94500	Ex-works, Bagged
	OR	66500-94500	Ex-works, Bagged
KMML			
2016-17	-	52083	Average
2017-18	-	66916	Average
2018-19	-	NA	-
V.V. Mineral			
2016-17	-	45782	Average
2017-18	-	-	-
2018-19	-	-	-

Source: *Department of Atomic Energy, Mumbai.*
Note*: Q: Quilon; MK: Manavalakurichi; OR: Odisha*

Table – 4: Prices of Ilmenite 2016-17 to 2018-19

(₹ per tonne)

Period	Grade	Price	Remarks
IREL			
2016-17			
(Non-slag/SR/TiO_2)	Q	11500-13000	Ex-works, loose
	MK	10500-12000	Ex-works, loose
	OR	9500-11000	Ex-works, loose
(Slag/SR/TiO_2)	Q	7400-8100	Ex-works, loose
	MK	7050-7900	Ex-works, loose
	OR	6350-7725	Ex-works, loose
2017-18			
(Non-slag/SR/TiO_2)	Q	15000-18200	Ex-works, loose
	MK	14000-17200	Ex-works, loose
	OR	13000-16200	Ex-works, loose
(Slag/SR/TiO_2)	Q	9975-12375	Ex-works, loose
	MK	9775-12125	Ex-works, loose
	OR	9600-11950	Ex-works, loose
2018-19			
(Non-slag/SR/TiO_2)	Q	19400-19400	Ex-works, loose
	MK	18400-18400	Ex-works, loose
	OR	17400-17400	Ex-works, loose
(Slag/SR/TiO_2)	Q	13530-13530	Ex-works, loose
	MK	13075-13075	Ex-works, loose
	OR	9600-9600	Ex-works, loose
KMML			
2016-17		NA	
2017-18		NA	
2018-19		NA	
V.V. Mineral			
2016-17	-	5241	-
2017-18	-	-	-
2018-19	-	-	-
BMC			
2016-17		NA	
2017-18		NA	
2018-19		NA	
DCW Ltd			
2016-17	-	8423	
2017-18	-	14489	
2018-19	-	15265	

Source: *Department of Atomic Energy, Mumbai.*
Note*: Q: Quilon; MK: Manavalakurichi; OR: Odisha*
Ilmenite is usually sold on NAW (naked at works) basis from all production center.

MINING & PROCESSING

Mining and processing of beach sand is carried out by the IREL, a Government of India Undertaking and KMML, a Kerala State Government Undertaking. Exploitation work of beach sand deposits located at Chavara in Kerala, Gopalpur in Odisha and Manavalakurichi in Tamil Nadu by IREL is under progress.

At IREL, Chavara, Beach Sand was collected over a stretch of 22 km between Neendakara and Kayamkulam in Kerala and was transported to plant site. The unit has adopted wet mining operations involving use of two Dredge and Wet Concentrator (DWC) of 100 tph capacity each to exploit the inland deposits away from the beaches. Chavara ilmenite is the richest in TiO_2 content (75.8% TiO_2) and has great demand in India and abroad for manufacture of pigments.

At Manavalakurichi, the deposit is spread over 300 hectares at Thuthoor-Ezudesam villages, Vilavancode tehsil, district Kanniyakumari, Tamil Nadu. All the raw sand required for the mineral separation plant to operate to its full capacity is collected from nearby beaches. Deposits are also exploited by DWC of 100 tph capacity. Manavalakurichi is next to Chavara in terms of TiO_2 content which is more than 55%.

The sand deposits of OSCOM at Chatrapur in district Ganjam extend along the coast of Bay of Bengal with an average width of 1.4 km and average depth of 7.5 m. Mining operations involve suction dredging to 6 m depth below water level on a much larger scale (500 tph) augmented by a smaller sized (100 tph) supplementary. The ilmenite from OSCOM is inferior in grade in terms of TiO_2 content (50%) in comparison to Chavara and Manavalakurichi. The Synthetic Rutile Plant of OSCOM is presently not working. As a result, the majority of OSCOM ilmenite produced of late is routed to the international market as feedstock for production of both slag grade and anatase grade pigment.

In dry mining, beach washings laden with 40-70% Heavy Minerals (HM) are collected through front-end loaders and bulldozers for further concentration to 90% HM at land-based concentrators. Though dry mining is very simple and economic, there is considerable opposition by local people for this form of mining for reasons that removal of sand would expose the land area to sea erosion. Therefore, collection of beach washings has reduced significantly in recent past.

As an alternate approach, IREL has adopted wet mining involving dredging and wet concentration (DWC) from inland areas away from the beach lines. In this mode, an artificial pond is created, the sand bed is cut and the slurry is pumped to spiral concentrator for removal of quartz. Manavalakurichi was the first plant to install a DWC (100 tph) followed by one (500 tph) at OSCOM and two (each 100 tph) at Chavara. The concentrate (90% HM) of beach washing plant from DWC is further upgraded to 97% HM grade at a Concentrate Upgradation Plant (CUP) before sending it to Mineral Separation Plant (MSP).

Execution of Supplimentary Mining Lease deed for OSCOM Mines till a period up to the year 2047 has been completed under the provision of AMCR 2016. Communication on precious area of the Bramhagiri Mineral Sands Deposit in Puri District under AMCR 2016 is in the final stages of issuance by Govt of Odisha.

After much persuasion, the precise area communication over an extent of 855 ha out of the identified area of 1,817 ha in Kanniyakumari district is also expected to be issued by Govt of Tamil Nadu. The Government is showing keen interest in exploiting the resources through a joint venture between IREL and TAMIN, a State PSU. This initiative would be a breather for MK operations as the mineable land within the mining leasehold areas are on the verge of exhaustion. Further, it will also pave way for formation of a new subsidiary of IREL in the same line as that of IREL and IDCOL.

KMML collects seasonal accretions of heavy mineral sand from the beach front. The pit so formed gets filled by fresh accretions of heavy mineral sand. The mineral sand is collected using bulldozers and wheel loaders and transported in tippers to Mineral Separation Plant.

The mineral separation plants use variety of equipment, such as, gravity concentrators, high tension electrostatic separators and magnetic separators. Making use of difference in physical properties like electrical conductivity, magnetic susceptibility and difference in specific gravity, etc., individual minerals like ilmenite, rutile, zircon, sillimanite and garnet are separated. The mined beach sands are pre-concentrated and dried after sieving (30-mesh) to separate the heavies from rejects. The heavy minerals are passed through electrostatic separators where conducting minerals – ilmenite and rutile – are separated from other non-conducting minerals. Ilmenite and rutile are further subjected to low-intensity magnetic separators where magnetic fraction - ilmenite is separated from rutile. Similarly, non-conducting fractions are subjected to high-intensity magnetic separators where weak magnetic fraction (monazite and garnet) is separated from non-magnetic fraction (zircon and sillimanite). The fractions are further processed on wind tables to separate garnet from monazite and sillimanite from zircon.

Installed capacity and production of ilmenite, rutile and other associated heavy minerals by various separation plants are furnished in Table-5.

Table – 5 : Installed Capacity & Production of Ilmenite, Rutile and Other Heavy Minerals, 2016-17 to 2018-19

(In tonnes)

Company/ Location	Mineral/ Product	Installed capacity (tpy)	Production		
			2016-17	2017-18	2018-19
Indian Rare Earths Ltd					
Manavalakurichi,#	Ilmenite	90000	29032	-	25745
Distt Kanniyakumari,	Rutile	3500	951	-	938
Tamil Nadu.	Zircon	10000	2606	-	2190
	Sillimanite	8778	-	-	-
	Monazite	6000	-	-	-
	Garnet	10000	10618	-	7425
Chavara,	Ilmenite	200000	57919	43253	48694
Distt Kollam,	Rutile	11400	2319	1515	1723
Kerala.	Zircon	17500	4502	2649	3072
	Rare Earths	4500*	-	-	-
	Sillimanite	10000	8654	6826	7953
Orissa Sands Complex,	Ilmenite	220000	183015	184657	191492
Distt Ganjam,	Rutile	7400	7372	7860	8384
Odisha.	Zircon	5000	5696	6458	6694
	Sillimanite	13000	15435	16698	17930
	Garnet	20000	17405	34170	31332
Kerala Minerals & Metals Ltd					
Chavara,	Ilmenite	61600	55404	56757	26140
Distt Kollam.	Rutile	4400	2405	2454	1548
Kerala.	Zircon	6500	4784	4844	4762
	Sillimanite	3600	600	701	271
V.V. Mineral					
Distt Thoothukudi,	Ilmenite	450000	269608	-	-
Tamil Nadu.	Rutile	12000	1852	-	-
	Zircon	18000	12763	-	-
	Zircon-sillimanite	24000	-	-	-
Beach Minerals Co. Pvt. Ltd					
Kuttam, Distt Tirunelveli, Tamil Nadu.	Ilmenite	150000	-	-	-
V.V. Titanium Pigments Pvt. Ltd Distt Thoothukudi Tamil Nadu.	Titanium Dioxide	18000	16064	13801	11902

Source: *Department of Atomic Energy, Mumbai and IREL.*
** In terms of rare earths chloride. '-' Not Available # During the year 2017-18, Manavalkurichi Plant was non-operating from Jan 2017 because of non-availability of environmental clearence (EC). V.V.Mineral mine is not in operation since 2017-18.*

INDUSTRY

For manufacturing titanium dioxide pigment, ilmenite is first treated chemically to obtain upgraded ilmenite, commonly called as synthetic rutile. There are two major pigment production processes, namely, chloride process and sulphate process depending on different operating characteristics and feedstock requirements. Plants employing chloride process consume high TiO_2 content feedstocks like synthetic rutile and chloride slag. On the other hand, plants employing the sulphate process use lower-grade ilmenite and sulphate slags.

Ilmenite obtained from Mineral Separation Plant (MSP) is chemically treated to remove impurities, such as, iron to obtain synthetic rutile (90% TiO_2) in Synthetic Rutile Plant (SRP). Indian SRP are based on reduction roasting followed by acid leaching with or without generation of hydrochloric acid. Plants of IREL (OSCOM) and KMML depend on acid regeneration from the leach liquor while those of Cochin Minerals & Rutile Ltd (CMRL) and DCW use fresh acid and recover ferric chloride from the leach liquor for its use in water purification.

At OSCOM plant of IREL, reduction-roasting of ilmenite with coal is followed by leaching with HCL to separate iron as soluble ferrous chloride. The leached ilmenite is calcined to yield synthetic rutile and the acidic leach liquor is treated in an acid regeneration plant to recover HCL for recycling with iron oxide as waste. The unit stopped production in 1997 as it was not viable economically. Against the Request for Proposal floated to set up titanium slag plant under Build-Own-Operate (BOO) model, a CPSE has shown keen interest and based on their request, the due date of submission has been extended. Considering the formidable investment and difficulties in sourcing technology in the field, the progress, though slow is in the right direction.

Environment Clearence for setting up nano titania/zirconia facilities have been received. However, in consideration of the stringent norms of Zero Effluent Discharge, work has been taken up to use alternate feed material to meet the stipulations. The KMML is manufacturing rutile grade titanium dioxide pigment by chloride route at its Sankaramangalam plant near Chavara in Kerala. The project for the production of one lakh tonnes of TiO_2 in a phased manner is under implementation. The Company also has plans to enhance pigment capacity to 60,000 tpy for which detailed project report is under preparation. In 2009, the Company had developed Nano Titanium Dioxide particles on laboratory scale and in July 2011, India's first commercial plant for synthesis of Nanotitanium Dioxide was commissioned.

The V.V. Mineral is the only company in India with a 40 km stretch of beach area under a mining lease for 30 years and another 440 acres for 30 years and 26 fully-owned patta lands. In addition to this, V.V. Mineral owns multiple mining leases. The geological characteristics of the Gulf of Mannar like typical wind and wave action and beach structure make it a highly valuable zone for continuous deposition of heavy minerals, viz. Garnet, Ilmenite, Rutile, Zircon and Sillimanite. This ensures a continuous deposition of placer minerals from Gulf of Mannar. V.V. Mineral inland deposits also add to its total output of 70,000 tonnes of heavy minerals.

As the leading mining company of India their mining process revolves around scientific and eco-friendly methodology. Manual mining in beaches ushers in job facilities to the downtrodden and sophisticated equipment employed in inland mining make the process outstanding. The proximity of the wet processing units to the sea shore makes transport easy and reliable. V.V. Mineral is the only Indian beach mining company to have obtained environment clearance from Government of India.

There are 9 wet plants situated close to the mining areas for upgrading the mining ore in mining area itself. There are 8 dry plants situated close to the mining areas and equipped with state-of-the-art machinery.

V.V. Mineral have separate washing unit to enrich the quality and purity of Super Garnet near warehouse, dedicated to fix the quality in general and purity in particular. Water for the washing process is taken from the river and converted to pure water using reverse osmosis process. These Super Garnet is washed with great care to make it chloride and silica free. The washing unit ensures below 25 ppm chloride and 1000 TSS after the process.

The DCW Ltd procures ilmenite from Manavalakurichi which is then roasted with coke fines to convert Fe_2O_3 into FeO. The reduced ore is leached with concentrated hydrochloric acid to remove oxides of iron and other metals. The leached ore is washed and calcined to get upgraded ilmenite which contains more than 95% TiO_2. The upgraded ilmenite is micronised to 2 microns by using high-pressure steam. This is marketed as Titox. The liquor from ilmenite leaching process contains fine TiO_2 particles and chlorides. The TiO_2 recovered by filtration & washing in filter process is marketed as Utox. The Company has plans to increase the plant capacity to 48,000 tpy and also to install facilities for the manufacture of ferrite grade iron oxide from the effluent of the ilmenite plant.

Cochin Minerals and Rutile Ltd (CMRL), which began production at its 10,000 tpy synthetic rutile plant in Kerala in 1990 as a 100% EOU, has gradually raised the production capacity to around 45,000 tpy since 2008-09 for exports. It also has ferric chloride & ferrous chloride plants having capacities of 24,000 tpy & 72,000 tpy, respectively.

The Travancore Titanium Products Ltd (TTPL), a Kerala State Govt Undertaking, manufactures titanium dioxide pigment by sulphate process at its plant at Kochuveli, Thiruvananthapuram. Ilmenite is reacted with sulphuric acid in digesters and a porous cake is formed. The mass in the solid form is dissolved in dilute sulphuric acid to get titanium in solution as titanium oxysulphate along with other metallic ingredients in ilmenite as their sulphate. The liquor is reduced using scrap iron, when ferric iron gets completely reduced to the ferrous state. The liquor is clarified, concentrated and boiled to precipitate the titanium content as hydrated titania which is then filtered by vacuum filters and calcined. Sulphuric acid required for captive consumption is produced at site using elemental sulphur. Till recently, TTPL was the only unit producing anatase grade titanium dioxide pigment in India. TTPL has capacity to produce 17,000 tpy of titanium dioxide, and with plans to modernise and diversify in stages, the Company has chalked out targets to produce both anatase and rutile grades titanium dioxide pigment.

Tata Steel has proposed a project to produce 1,00,000 tonnes per year titanium dioxide from ilmenite mined from beach sands of Tirunelveli and Thoothukudi districts in southern Tamil Nadu.

Present domestic titanium metal production is negligible. KMML has setup a 500 tpy titanium sponge plant with Defence Metallurgical Research Laboratory (DMRL) technology and first batch of titanium was delivered in September 2011. The plant will be further expanded to 1,000 tpy. IREL is to set up a 10,000 tpy titanium sponge plant at OSCOM for which proposals have been invited on "build, operate and own" basis. IREL intends to set-up titanium slag plant based on ilmenite from OSCOM, Odisha and has signed an MoU with NALCO for this purpose. Depending upon feasibility, further value addition to TiO_2 pigment and titanium sponge will be taken up, subsequently. Titanium sponge is imported by Mishra Dhatu Nigam Ltd (MIDHANI) for further processing in the country.

The available data on plantwise installed capacities of synthetic rutile and TiO_2 pigment from 2016-17 to 2018-19 are furnished in Table-6.

USES

About 90% of the world's titanium mineral production is used in the manufacturing of white titanium dioxide pigment. The unique combination of superior properties of high refractive index, low specific gravity, high hiding power and opacity and non-toxicity enable titanium dioxide in its application in the manufacture of all types of white and pastle shades of paints, white-walled tyres, glazed papers, plastics, printed fabrics, flooring materials like linoleum, pharmaceuticals, soaps, face powders and other cosmetic products. Besides, its non-toxic nature facilitate its use in cosmetics, pharmaceuticals, and even in foodstuffs as well as in toothpastes. Titanium dioxide is used in the manufacture of many sunscreen lotions and creams because of its non-toxicity and ultraviolet absorption properties. Synthetic rutile is used for coating welding electrodes as flux component and for manufacture of titanium tetrachloride which in turn is used in making titanium sponge. Synthetic rutile is also used as ingredient of special abrasives. Titanium metal is a versatile material with exceptional characteristics. The lightness, strength and durability of the metal make it an essential metal for the Aerospace Industry. It is also used in desalination and power generation plants and corrosive chemical industries because of its inertness and resistance to corrosion and high thermal conductivity. Its non-reactive property makes titanium metal one of the few materials that can be used in the human body for orthopaedic use and in pacemakers.

Table –6 : Installed Capacity of Synthetic Rutile/Titanium dioxide Pigment,

(In tonnes)

Plant	Location	Specification	Installed capacity (tpy)
IREL	Orissa Sands Complex, Distt Ganjam, Odisha.	90.5% TiO_2 (min)	100000 (Synthetic rutile)
KMML Kerala.	Chavara, Distt Kollam,	92%-93% TiO_2	55,000 (Synthetic rutile) 60000 (TiO_2 - Chloride Process)
DCW Ltd	Sahupuram, Distt Thoothukudi, Tamil Nadu.	95% TiO_2	42,000 (Synthetic rutile)
CMRL	Edayar, Distt Ernakulam, Kerala.	96.5% TiO_2	50,000 (Synthetic rutile)
TTPL	Kochuveli, Distt Thiruvananthapuram, Kerala.	97.5% TiO_2	17,000 (TiO_2-Sulphate Process)
VVTi Pigments Pvt. Ltd* (formerly Kilburn Chemicals)	Thoothukudi, Tamil Nadu.	98% TiO_2 (min)	18,000 (TiO_2-Sulphate Process)
Kolmark Chemicals Ltd	Kalyani, Distt Nadia, West Bengal.	NA	4,800 (TiO_2-Sulphate Process)

Source: *Department of Atomic Energy, Mumbai and individual companies.*
Note: *KMML captively consumes synthetic rutile while CMRL and DCW export synthetic rutile.*
* *Including Kilburn Chemicals.*

CONSUMPTION

The ilmenite consumption is placed at 2,77,900 tonnes in 2018-19 which is marginally lower as compared to previous year. The bulk of ilmenite is consumed in the manufacture of synthetic rutile (99 %). Moderate proportions are consumed by welding electrode and Ferroalloys Industry. The consumption of rutile in 2018-19 was 10,500 tonnes as compared to 9,700 tonnes in 2017-18. The entire consumption was reported from electrode Industry since last two years (Table-7).

Table – 7 : Consumption* of Ilmenite and Rutile 2016-17 to 2018-19 (By Industries)

(In tonnes)

Industry	2016-17	2017-18 (R)	2018-19 (P)
Ilmenite			
All Industries	**241100**	**295000**	**277900**
Chemicals	240200	294100	277100
Electrode	900	800	700
Others (Ceramic, Ferroalloys)	-	100	100
Rutile			
All Industries	**7500**	**9700**	**10500**
Electrode	6200	9700	10500
Paint	1300	-	-

Figures rounded off.
** Includes actual reported consumption and/or estimates made wherever required.Paucity of data, hence, the consumption may not be complete.*

POLICY

The Government of India had notified in October 1998, a policy on exploitation of beach sand minerals in the country, which inter alia allows participation of the Private Sector with or without foreign companies subject to conditions stipulated. This will encourage further exploitation of mineral deposits through a judicious mix of Public & Private Sector participation including foreign collaboration. The ceiling on FDI on mining of titanium minerals has been raised to 100 per cent.

Joint ventures with foreign participation were being pursued by IREL for production of value-added products, keeping in view the Beach Sand Mineral Policy of the Government.

The minerals, ilmenite and rutile, were grouped as 'prescribed substances' as per notifications issued under the Atomic Energy Act, 1962. However, as per the revised list of Prescribed Substances, Prescribed Equipment and Technology notified by Department of Atomic Energy vide S.O.No.61(E), dated 20.1.2006, the titanium ore minerals like ilmenite, rutile and leucoxene have been delisted as prescribed substances by the Department of Atomic Energy subject to the note as below:

"These minerals shall remain prescribed substances only till such time the policy on Exploration of Beach Sand Minerals notified vide Resolution No.8/1(1)/97-PSU/1422, dated 6.10.1998, is adopted/revised/modified by the Ministry of Mines or till 1.1.2007, whichever occurs earlier and shall cease to be so thereafter".

As per notification No 26/2015-2020, the export of Beach Sand Minerals have been brought under State Trading Enterprise (STE) and shall be canalised through Indian Rare Earths Limited (IREL). Beach Sand Minerals, permitted anywhere in the export policy under Sl No 98A of Chapter 26 of schedule 2 Export Policy.

As per Gazette Notification No : GSR.134 (E) dated 20.2.2019, the particulars of threshold values for atomic minerals in respect pf Beach Sand Minerals (BSM) shall be regulated as Schedule A [Rule 2(1)(m) and Rule 36] (Table 7A).

Table - 7 A : Particulars of Threshold Value for Atomic Minerals
[See Rule 2 (1)(m) and Rule 36]

Uranium-bearing tailings left over from ores after extraction of copper and gold, ilmenite and other titanium ores.	60 ppm U_3O_8 and/or 250 ppm ThO_2.
Zirconium-bearing minerals and ores including zircon.	All cases of zirconium-bearing minerals occurring in Beach Sand Minerals and other placer deposits in association with monazite are notified as above threshold (i.e. the threshold is 0.00% monazite in Total Heavy Minerals), irrespective of monazite grade. In other cases, zircon containing less than 2000 ppm of Hafnium.
Beach Sand Minerals, i.e., economic heavy minerals found in the teri or beach sand, which include ilmenite, rutile, leucoxene, garnet, monazite, zircon and sillimanite.	All cases of Beach Sand Minerals and other placer deposits in association with monazite are notified as above threshold (i.e., the threshold is 0.00% monazite in Total Heavy Minerals), irrespective of monazite grade.

SUBSTITUTES

There are no cost-effective substitutes for titanium dioxide pigments. Synthetic rutile made from ilmenite can be substituted for natural rutile. Nickel steels, stainless steels and some non-ferrous metal alloys can sometimes replace titanium alloys in industrial uses although at the expense of performance or economics. Tungsten carbide competes with titanium carbide for surface cutting machine tools. Titanium slag competes with ilmenite and rutile.

Environmental awareness indicates that titanium dioxide plants are likely to use chloride technology in future as it produces much less quantity of waste products. Synthetic rutile or slag (made from ilmenite) is likely to be used as feed in increasing amount. There is also a strong pressure to reduce the radioactive content of feedstocks because it affects the marketability of beach sand ilmenite. Titanium alloys could be replaced in aerospace applications by lithium-aluminium alloys or carbon-epoxy composites.

WORLD REVIEW

World resources of anatase, ilmenite and rutile are more than 2 billion tonnes. World reserves of ilmenite are estimated at 770 million tonnes in terms of TiO_2 content. Major reserves are in Australia (32%), China (30%), India (11%), Brazil (6%) , South Africa & Norway (5% each), Canada (4%) , Mozambique (2%) and Madagascar (1%). The world reserves of rutile are 47 million tonnes in terms of TiO_2 content. Major rutile reserves are located in Australia (62%), followed by India (16%), South Africa (13%) and Ukraine (5%).

World production of ilmenite and rutile concentrates was 8.8 million tonnes and 0.70 million tonnes, respectively, in 2018. Canada and China contributed 23% and 16% of ilmenite production, followed by Mozambique (11%), Ukraine (8%), Norway & India (7% each), South Africa (6%). Australia produced 29% of world rutile output, followed by Ukraine (15%) and Kenya (14%). World reserves and production of ilmenite and rutile, are furnished in Tables - 8 to 10.

Table – 8 : World Reserves of Ilmenite and Rutile (By Principal Countries)

(In '000 tonnes of contained TiO_2)

Country	Reserves	
	Ilmenite	Rutile
World: Total (Ilmenite+Rutile) : 817000		
World: Total (Rounded)[a]	**770000**	**47000**
Australia	250000[c]	29000
Brazil	43000	-
Canada	31000	-
China	230000	-
India	85000	7400
Kenya	850	380
Madagascar	8600	-
Mozambique	14000	880
Norway	37000	-
Senegal	-	NA
South Africa	35000	6100
Ukraine	5900	2500
USA[a][b]	2000	-
Vietnam	1600	-
Other countries	26000	400

Source: USGS, Mineral Commodity Summaries, 2020.
a:US rutile reserves data are included with ilmenite.
b:Rounded to nearest 1,00,000 tonnes to avoid disclosing company proprietary data.
c:Joint Ore Reserves Committee- compliant reserves were 57 million tonnes.

Table – 9 : World Production of Ilmenite[1] (By Principal Countries)

(In '000 tonnes)

Country	2016	2017	2018
World: Total	**9300**	**9700**	**8800**
Canada*[a][b]	1800	2300	2000
China*	1400	1400	1400
Mozambique	903	998	959
Ukraine	500*	500*	745
Norway*	630	630	630
India[d]	595	580*	580*
Australia[c]	765	694	543
Australia[c]Leucoxene	73	57	69
Senegal	416	492	507
Senegal[m]Leucoxene	10	10	10
South Africa*[b]	1020	550	500
Kenya	360	491	463
Madagascar	268	430	382
Vietnam	211	225	210
Korea, Rep. of	167	167*	167*
USA*	100	100	100
Other countries	199	194*	202

***Source**: BGS, World Mineral Production,2014-2018.*
*:*Estimate*
a:Canada produces some ilmenite which is sold as such and not processed into slag, but tonnages are small.
b:It is believed that the majority of this is processed in to slag.
c:Years ended 30 June of that stated.
d:Years ended 31 March following that stated,
m:Including natural rutile.

Table – 10 : World Production of Rutile (By Principal Countries)

(In '000 tonnes)

Country	2016	2017	2018
World: Total (wt of conc)	**700**	**700**	**700**
Australia[c]	285	227	205
Sierra Leone	149	165	108
Ukraine	90[e]	90[e]	107
South Africa[e]	67	95	100
Kenya	70	87	98
India[d]	15	150[e]	150[e]
Mozambique	8	9	8
Malaysia	4	5	5
Madagascar[e]	5	5	5
Brazil	3	3	3
Sri Lanka	2	2	2

***Source :** BGS, World Mineral Production,2014-18.*
c: Years ended 30 June of that stated.
d: Years ended 31 March following that stated.
e : Estimated

Metal

Commercial production of titanium metal involves the chlorination of titanium-containing mineral concentrates to produce titanium tetrachloride (TiCl4), which is reduced with magnesium (Kroll process) or sodium (Hunter process) to produce a commercially pure form of titanium metal. The metal formed has a porous appearance and is referred to as sponge. Titanium ingot and slab are produced by melting titanium sponge or scrap or a combination of both, usually with various other alloying elements.

Pigment

Global TiO2 pigment production capacity was estimated to be 5.7 million tonnes per year. TiO2 pigment produced is categorised by crystal form as either anatase or rutile. Rutile pigment is less reactive with the binders in paint when exposed to sunlight than the anatase pigment and is preferred substance in outdoor paints. Anatase pigment has a bluer tone than rutile, is somewhat softer and is used mainly in indoor paints and in paper manufacturing. Depending on the manner in which it is produced and subsequently finished, TiO2 pigment can exhibit a wide range of functional properties, including dispersion, durability, opacity and tinting.

FOREIGN TRADE

Exports

Exports of titanium ores & conc. increased slightly by 1% to 0.36 million tonnes from 0.35 million tonnes in the preceding year. Exports were mainly from China (46%), Japan (22%), Republic of Korea (12%), Germany (10%), Belgium (6%) and Malaysia (4%). Out of the total exports in 2018-19 the contribution of ilmenite was 0.36 million tonnes rutile (1,847 tonnes) and others (100 tonnes).

Exports of titanium and alloys (including waste & scrap) were 319 tonnes which increased marginally by 17% from 273 tonnes in the previous year. Exports were mainly to USA (34%), UK(18%), China (16%), Republic of Korea (8%) and Malaysia (6%). Exports of titanium oxide and dioxide (total) decreased to 37,089 tonnes in 2018-19 from 38,676 tonnes in 2017-18. Out of the total exports in 2018-19, those of titanium dioxide were 7,345 tonnes and exports of titanium oxides (other than titanium dioxides) were 29,744 tonnes (Tables-11 to 18).

Imports

Imports of titanium ores & conc. decreased drastically by 41% to 97,307 tonnes in 2018-19 from 1,63,690 tonnes in the preceding year. Imports were mainly from Mozambique (62%), Australia (12%), China ((9%) and South Africa & Thailand (3% each). Out of the total imports of titanium ores & conc. in 2018-19, those of ilmenite were 70,275 tonnes, rutile 20,825 tonnes and other titanium ores were 6,207 tonnes.

Imports of titanium and alloys (including waste & scrap) were 7,654 tonnes in 2018-19 as compared to 4,394 tonnes in the previous year. Imports were mainly from USA (26%), China (18%), Japan (13%) and Singapore (8%). Imports of titanium oxide and dioxide (total) were 14,649 tonnes in 2018-19 as compared to 13,787 tonnes in the preceding year. Imports were mainly from China (41%), Republic of Korea (33%), Belgium (8%) and Japan & Netherlands (5% each). Bulk of these imports were of titanium dioxide (14,544 tonnes) and titanium oxides (other than titanium oxides) were 104 tonnes in 2018-19 (Tables - 19 to 26).

Table – 11 : Exports of Titanium Ores & Conc.
(By Countries)

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**355475**	**6010132**	**359974**	**6566846**
China	179698	2758165	163924	2264780
Japan	75334	1783481	77735	2075944
Korea, Rep. of	22073	301772	44025	593918
Germany	62500	763000	35000	560039
Belgium	156	9882	23078	513058
Malaysia	14422	323680	15122	494640
Iran	588	33756	268	23271
Netherlands	192	5078	560	21717
Pakistan	33	2671	44	3672
Indonesia	218	13773	51	3531
Other countries	261	14874	167	12276

Figures rounded off

Table – 12 : Exports of Titanium Ores & Conc. (Ilmenite) (By Countries)

Country	2017-18 (R) Qty (t)	2017-18 (R) Value (₹'000)	2018-19 (P) Qty (t)	2018-19 (P) Value (₹'000)
All Countries	**353384**	**5889529**	**358027**	**6438829**
China	178914	2716512	162916	2209240
Japan	75233	1777491	77715	2074615
Korea, Rep. of	22000	297143	44000	592301
Germany	62500	763000	35000	590039
Belgium	-	-	22902	499955
Malaysia	14422	323680	15122	494640
Netherlands	140	2601	364	7752
Bangladesh	13	491	6	232
Kenya	-	-	2	37
Oman	-	-	++	10
Other countries	162	8612	++	8

Figures rounded off

Table – 13 : Exports of Titanium Ores & Conc. (Rutile) (By Countries)

Country	2017-18 (R) Qty (t)	2017-18 (R) Value (₹'000)	2018-19 (P) Qty (t)	2018-19 (P) Value (₹'000)
All Countries	**2038**	**118114**	**1847**	**120257**
China	784	41653	1008	55540
Iran	588	33756	268	23271
Netherlands	-	-	196	13965
Belgium	156	9882	78	5422
Pakistan	33	2663	44	3672
Indonesia	218	13773	51	3480
Thailand	-	-	28	2171
Oman	-	-	27	1966
Korea, Rep. of	73	4629	25	1617
Sweden	48	3007	25	1584
Other countries	138	8752	97	7570

Figures rounded off

Table – 14 : Exports of Titanium Ores & Conc. (Others) (By Countries)

Country	2017-18 (R) Qty (t)	2017-18 (R) Value (₹'000)	2018-19 (P) Qty (t)	2018-19 (P) Value (₹'000)
All Countries	**52**	**2489**	**100**	**7759**
Belgium	-	-	98	7981
Indonesia	-	-	1	51
Nepal	-	-	1	17
Malawi	-	-	1	11
Netherlands	52	2477	-	-
Pakistan	++	8	-	-
Japan	++	3	-	-
China	++	++	-	-

Figures rounded off

Table – 15 : Exports of Titanium & Alloys (Incl. Waste & Scrap) (By Countries)

Country	2017-18 (R) Qty (t)	2017-18 (R) Value (₹'000)	2018-19 (P) Qty (t)	2018-19 (P) Value (₹'000)
All Countries	**273**	**371053**	**319**	**272937**
USA	183	196231	109	110276
Korea, Rep. of	19	21135	27	26477
France	1	1414	2	19873
UK	1	2954	59	15159
Singapore	8	5927	28	12759
Saudi Arabia	++	2067	3	12530
China	++	731	51	11564
Israel	++	13401	++	8860
Malaysia	3	3657	22	8658
Germany	3	8895	3	6052
Other countries	56	114639	14	40729

Figures rounded off

Table – 16 : Exports of Titanium Oxide & Dioxide : Total (By Countries)

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**38676**	**2945095**	**37089**	**3255387**
Japan	19196	952831	27277	1941610
USA	3749	570132	2745	479320
Italy	1508	286171	1200	226773
Taiwan	4007	189787	2021	100009
Spain	911	163623	518	72809
Malaysia	1338	76894	868	53761
Indonesia	300	36404	323	52183
Brazil	138	14755	541	38571
Egypt	93	20731	147	37321
UAE	330	51189	156	29328
Other countries	7106	582580	1293	223702

Figures rounded off

Table – 17 : Exports of Titanium dioxide (By Countries)

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**9560**	**1537658**	**7345**	**1274279**
USA	3693	566025	2637	470891
Italy	1428	267579	1200	226773
Japan	721	99276	1117	180384
Spain	911	163623	518	72742
Indonesia	295	35406	322	51914
UAE	330	51189	156	29328
Sri Lanka	173	27079	159	28107
Thailand	224	27683	190	27071
Nigeria	269	43374	171	21281
Egypt	57	6769	100	14901
Other countries	1459	249656	774	150887

Figures rounded off

Table – 18 : Exports of Titanium Oxide (Other than Titanium Dioxide) (By Countries)

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**29115**	**1407437**	**29744**	**1981107**
Japan	18475	853555	26160	1761227
Taiwan	4000	188671	2000	96254
Malaysia	1326	75779	868	53761
Brazil	28	1775	481	28581
Egypt	36	13961	47	22420
USA	55	4108	108	8429
Nepal	2	230	21	3306
Bangladesh	10	2188	13	3047
Canada	-	-	40	2327
Turkey	72	3509	5	975
Other countries	5112	263660	2	781

Figures rounded off

Table – 19 : Imports of Titanium Ores & Conc. : Total (By Countries)

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**163690**	3297464	**97307**	3013233
Mozambique	104702	1539413	60162	1090697
China	916	50358	8918	638679
Australia	5796	300599	11529	317145
South Africa	5390	257836	3248	219736
Thailand	2620	137475	3100	202242
Ukraine	2019	118054	1787	143201
Sri Lanka	33135	468945	2123	132345
Netherlands	26	1475	2306	101817
Senegal	1740	68605	1820	89171
Belgium	-	-	1554	31470
Other countries	7346	354704	760	46730

Figures rounded off

Table – 20 : Imports of Titanium Ores & Conc. (Ilmenite)
(By Countries)

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**135224**	**1923741**	**70275**	**1250833**
Mozambique	104602	1533784	60084	1083791
Australia	-	-	9338	147292
Sri Lanka	30566	388750	630	16349
Malaysia	-	-	169	2219
Ukraine	56	1163	54	1139
USA	-	-	++	43
South Africa	-	40	-	-
Sweden	-	4	-	-

Figures rounded off

Table – 21 : Imports of Titanium Ores & Conc. (Rutile)
(By Countries)

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**21049**	**1132193**	**20825**	**1500945**
China	864	47809	7579	554128
South Africa	4842	230229	3248	219736
Thailand	2590	127755	3100	202242
Ukraine	1782	106518	1621	132576
Sri Lanka	1074	62346	1493	115996
Australia	4054	218131	1307	111142
Netherlands	9	1475	837	75916
Senegal	500	18840	1140	54375
Malaysia	193	8484	318	18124
Mozambique	100	5629	78	6906
Other countries	5023	304977	104	9804

Figures rounded off

Table – 22 : Imports of Titanium Ores & Conc. (Others) (By Countries)

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**7417**	**241532**	**6207**	**261455**
China	52	2549	1339	84552
Australia	1742	82469	884	58710
Senegal	1240	49765	680	34796
Belgium	-	-	1502	26709
Netherlands	-	-	1469	25902
Singapore	-	-	80	17280
Ukraine	181	10374	112	9486
Malaysia	25	1133	96	2000
Vietnam	-	-	24	1247
Germany	1542	26856	21	759
Other countries	2635	68386	++	14

Figures rounded off

Table – 23 : Imports of Titanium & Alloys (Incl. Waste & Scrap) (By Countries)

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**4394**	**4466982**	**7654**	**7031699**
China	665	814763	1375	1811839
USA	1473	1167313	1987	1377465
Japan	317	311716	987	1077137
UK	159	344884	215	668770
Germany	162	326114	207	480465
France	47	164213	90	344083
Italy	108	116816	320	246403
Singapore	266	91336	632	174173
Korea, Rep. of	17	22965	542	154187
Ukraine	439	345031	220	126805
Other countries	741	761831	1079	570372

Figures rounded off

Table – 24 : Imports of Titanium oxide & Dioxide : Total (By Countries)

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**13787**	**2520427**	**14649**	**2907346**
China	5700	878366	5970	1017189
Korea, Rep. of	2500	409158	4820	818335
Belgium	236	47263	1109	285154
Japan	1254	282616	668	208853
Netherlands	-	-	694	181920
Germany	2452	558720	475	126788
Canada	80	24930	160	52658
France	181	68087	87	49498
USA	510	88169	97	40289
Russia	160	24818	120	21009
Other countries	714	138270	449	105653

Figures rounded off

Table – 25 : Imports of Titanium dioxide (By Countries)

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**13699**	**2477077**	**14544**	**2868634**
China	5632	865991	5887	1000489
Korea, Rep. of	2500	409158	4820	818335
Belgium	235	46986	1108	284812
Japan	1248	274508	661	204003
Netherlands	-	-	694	181920
Germany	2447	546767	474	121786
Canada	80	24930	160	52658
France	179	63403	78	43758
USA	509	87020	97	38954
Russia	160	24848	120	21009
Other countries	709	133466	445	100910

Figures rounded off

Table – 26 : Imports of Titanium oxides (Other than Titanium Dioxides) (By Countries)

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**84**	**43348**	**104**	**38711**
China	68	12374	83	16700
France	2	4684	9	5740
Germany	5	11953	1	5002
Japan	6	8108	7	4850
Thailand	1	634	1	1797
Hong Kong	++	26	2	1520
USA	++	1149	++	1335
UK	1	447	++	610
Singapore	-	-	++	573
Belgium	1	277	1	342
Other countries	1	3697	++	242

Figures rounded off

FUTURE OUTLOOK

As per Technology Vision Document 2035, the demand for titanium in India would be approximately 1,000 tonnes by 2035. The contribution by Space Sector (100 tonnes), General Engineering (50 tonnes), Atomic Energy (125 tonnes), Aeronautical (50 tonnes), Power Generation (150 tonnes), Petroleum Refinery (50 tonnes) and Chemical Industry (475 tonnes).

As per data available the defence, atomic energy and space research which are critical sectors have been assigned targets to increase communication set-up, safeguard India's security with modern arms, ammunitions & control and to increase power generation by three-fold. For meeting these targets, Indian engineering Industry is dependent on input materials like titanium sponge, which was not available in India till 2012. The first ever commercially indigenously made Ti-sponge was released as late as 2013 at KMML, Kerala, with the support of ISRO. However, with the successful commissioning of the titanium sponge plant, India has joined the elite club of seven countries capable of producing aerospace - grade titanium sponge. The plant has the basic infrastructure for increasing the capacity to 1,000 tpa in future with sponge to metal yield at 35%, the requirement of titanium sponge on a conservative estimate would be 2,500 tpa for India. The gap, therefore, will remain. The plant capacity now will be just sufficient to serve Strategic Industry like the indigenous space & defence programmes.

Global demand growth for TiO_2 is expected to trend with the prospects of economic growth and production of paint, paper and plastics.

Aerospace, defence and industrial uses are expected to strongly influence the consumption of titanium metal in the near future.

The impetus by the Government for renewal energy and infrastructure however augers well for demand for steel and that for IREL's rutile which finds application in production of welding electrodes.