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ILMENITE AND RUTILE

(FINAL RELEASE)

GOVERNMENT OF INDIA
MINISTRY OF MINES
INDIAN BUREAU OF MINES

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27 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 Moti Daman-Umbrat coast (Gujarat) in the west to Odisha coast 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 Kanyakumari 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. So far, about 3,890 km coastal tract and 160.72 sq km inland areas in Tamil Nadu and West Bengal have been investigated for over six decades by AMD. The ilmenite resources estimation for the areas explored up to 2012 has been completed and the resources are up from 520.38 million tonnes to 593.50 million tonnes (including leucoxene), inclusive of indicated,

Table – 1 : Ilmenite Resources/Deposits in India

State/Deposit	Ilmenite reserve (In million tonnes)
Andhra Pradesh	
1. Bhavanapadu Hukumpet	10.18
2. Kakinada (Phase I-VIII)	13.84
3. Kalingapatnam	5.80
4. Narasapur	2.92
5. Nizampatnam	19.26
6. Srikurman (South)	8.60
7. Visakhapatnam (Bhimunipatnam)	2.88
8. Amalapuram (Phase I-III)	3.10
9. Pandurangapuram-Voderevu (Bapatla-Chirala coast)	10.39
10. Vetapalem Coast (Chirala coast)	5.31
	82.28
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
	94.83
Maharashtra	
Ratnagiri	3.68
Gujarat	
Moti Daman-Umbrat coast	2.77
Odisha	
1. Brahmagiri (Phase IV)	37.98
2. Chatrapur	26.72
3. Gopalpur (Phase I-IV)	6.39
	71.09
Tamil Nadu	
1. Kudiraimozhi	22.86
2. Ovari-Periyatalai-Manapadu (Teri)	24.01
3. Sattankulam Teris	41.26
4. Cuddalore-Pudupattuchavadi	4.67
5. Vayakallur (Block I-IV)	3.54
6. Manavalakurichi	2.04
7. Midalam	1.64
	100.02

Source: *Department of Atomic Energy, Mumbai.*

Table – 1 A : Resources of Ilmenite and Rutile

(In million tonnes)

State	Total in situ #
Ilmenite* : Total	**593.50**
Andhra Pradesh	163.05
Jharkhand/Bihar	0.73
Gujarat	2.77
Kerala	145.70
Maharashtra	3.74
Odisha	96.44
Tamil Nadu	179.02
West Bengal	2.05
Rutile : Total	**31.35**
Andhra Pradesh	10.25
Jharkhand/Bihar	0.01
Gujarat	0.02
Kerala	8.41
Odisha	4.47
Tamil Nadu	8.00
West Bengal	0.19

Source: *Department of Atomic Energy, Mumbai.*
 # Inclusive of indicated, inferred and speculative categories.
** Including leucoxene.*

inferred and speculative categories. Resource estimation for the areas explored during 2012-15 is under progress. The most significant deposits which are exploitable and that 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 30-35% is ilmenite. The overall statewise reserves of ilmenite and rutile which occur together in beach sand deposits are furnished in Table-1 A.

As per the NMI database, based on UNFC system as on 1.4.2015, the total resources of titanium minerals are placed at 413 million tonnes comprising ilmenite (354 million tonnes), rutile (14 million tonnes), leucoxene (0.96 million tonnes), anatase (3.34 million tonnes) and titaniferous magnetite (40.62 million tonnes).

EXPLORATION & DEVELOPMENT

IREL carried out exploration work at Chatrapur sand deposit, district Ganjam, Odisha for ilmenite & rutile, zircon, monazite, sillimanite and garnet. Commenced by AMD, DAE in the year 1969, a total of 2,464 hecters has been explored in the area. About 409 boreholes were drilled and mineralogical analysis of 2442 samples have been undertaken during the year 2014-15. Proposal to further drill 196 boreholes in 2015-16 is on the anvil. Furthermore, exploration work at the beach placer deposit of length 18 km along the coast of Bay of Bengal between River Rushikulya and Gopalpur with an average width of 1.4 km is under consideration.

GSI carried out exploration work for placer minerals in the terrritorial waters off north Bhuminipatnam, Andhra Pradesh for ilmenite, rutile, garnet, sillimanite and zircon. A total of 69 vibrocore seabed sediment samples varying in length from 0.13 m to 2.77 m with an average core length of 1.30 m were collected on grid of 1 km x 1 km within the water depth of 21 to 37 m. In territorial waters off Palur-Malud, Odisha 5 sand samples show dominance of heavy minerals like ilmenite, rutile, garnet, monazite and sillimanite.

In Kerala, GSI took up assessment of heavy minerals near the shore area of Attipara, near Thiruvananthapuram. The preliminary study shows that ilmenite is the major heavy mineral occurring in the sediments. Other minerals include zircon, sillimanite, garnet and monazite.

The survey and exploration carried out by AMD during 2008-09, 2009-10, 2010-11, 2011-12, 2012-13, 2013-14 and 2014-15 included parts of West Bengal, Odisha, Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Maharashtra and Gujarat. The details of exploration activities carried out by AMD during 2014-15 are furnished in Table-2.

Table – 2 : Exploration Activities by AMD for Ilmenite, Rutile, Monazite, Zircon and other Heavy Minerals, 2014-15

Location	Activity		Remark
	Reconnai-ssance survey (sq km)	Detailed survey (sq km)	
Parts of Odisha, Andhra Pradesh, Karnataka and Tamil Nadu	302.62 (Coastal tracts) Inland areas	14.4	Reconnaissance survey was undertaken to delineate potential heavy mineral concentrations along the coastal and inland tracts: (a) Bajrakot-Brahmapur tract, Ganjam District, Odisha recorded THM ranging from 0.67 to 56.27%. (b) Four inland red sediment occurrences exposed between Patsonapuram and Agastinuagan, Ganjam District, Odisha recorded THM ranging from 2.01% to 57.31%. (c) River Swanamukhi Confluence-Kothapatnam tract, SPSR, Nellore District recorded THM up to 1.55%. (d) Vaipar-Vembar-Naripaiyur tract, Thoothukudi and Ramanathapuram District, Tamil Nadu records very low THM of 5-15%. In addition to reconnaissance surveys, detailed survey was carried out in (i) Malikipuram, East Godavari district, Andhra Pradesh and (ii) Chavara, Kerala.

***Source**: Department of Atomic Energy, Mumbai.*

PRODUCTION AND PRICES

Ilmenite

The production of ilmenite at 522 thousand tonnes in 2015-16 decreased by 19% as compared to that in the preceding year. Tamil Nadu was the leading producer of ilmenite during the year under review, contributing 48% of the total production followed by Odisha 35% and Kerala 17 percent.

Rutile

The production of rutile at 17 thousand tonnes in 2015-16 registered increase by 7% as compared to that in the previous year. Odisha was the leading producer of rutile accounting for 44% of the total production followed by Tamil Nadu 33% and Kerala 23 percent.

Production and prices of ilmenite and rutile are furnished in Tables -3 to 5.

Table – 3 : Production of Ilmenite and Rutile 2013-14 to 2015-16 (By States)

(In tonnes)

State	2013-14	2014-15	2015-16 (P)
ILMENITE			
India : Total	**721959**	**643128**	**521801**
Kerala	95083	93059	88333
Odisha	146771	191680	183402
Tamil Nadu	480105	358389	250066
RUTILE			
India : Total	**13459**	**15617**	**16723**
Kerala	3468	3630	3795
Odisha	5759	7249	7403
Tamil Nadu	4232	4738	5525

Table – 4 : Prices of Rutile 2013-14 to 2015-16

(` per tonne)

Year	Grade	Price	Remarks
IREL			
2013-14	Q	73500 - 87000	Ex-works, Bagged
	MK	73500 - 87000	Ex-works, Bagged
	OR	73500 - 87000	Ex-works, Bagged
2014-15	Q	54800-73500	Ex-works, Bagged
	MK	54800-73500	Ex-works, Bagged
	OR	54800-73500	Ex-works, Bagged
2015-16	Q	50000-54800	Ex-works, Bagged
	MK	50000-54800	Ex-works, Bagged
	OR	50000-54800	Ex-works, Bagged
KMML			
2011-12	-	87085	-
2012-13	-	110833	-
2013-14	-	67375	-
2014-15		**NA**	
V.V. Mineral (Average)			
2013-14	NA	102340	Average
2014-15	NA	55618	Average
2015-16	-do-	49266	Average

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.*

Table – 5: Prices of Ilmenite 2013-14 to 2015-16

(` per tonne)

Period	Grade	Price	Remarks
IREL			
2013-14			
(Non SR/TiO_2)	Q	1700-22250	Ex-works, loose
	MK	1600-2100	Ex-works, loose
	OR	1500-17750	Ex-works, loose
(SR/TiO_2)	Q	10500-14150	Ex-works, loose
	MK	10050-13700	Ex-works, loose
	OR	8000-12200	Ex-works, loose
2014-15			
(Non SR/TiO_2)	Q	15120-17000	Ex-works, loose
	MK	14230-16000	Ex-works, loose
	OR	13340-15000	Ex-works, loose
(SR/TiO2)	Q	6370-10500	Ex-works, loose
	MK	6070-10050	Ex-works, loose
	OR	5440-9000	Ex-works, loose
2015-16			
(Non SR/TiO_2)	Q	11000-15120	Ex-works, loose
	MK	10000-14230	Ex-works, loose
	OR	9000-13340	Ex-works, loose
(SR/TiO_2)	Q	5850-6370	Ex-works, loose
	MK	5550-6070	Ex-works, loose
	OR	5000-5440	Ex-works, loose
KMML			
2011-12	12650	59.88% TiO_2	
2012-13	17900	59.88% TiO_2	
2013-14	NA		
2014-15	**NA**		
V.V. Mineral (Average)			
2013-14	NA	10562	
2014-15	NA	5916	
2015-16	NA	5096	
BMC			
2012-13	TiO_2 : 49-51%	8500 (US$140)	f.o.b.Thoothukudi
2013-14	TiO_2 : 49-51%	9475 (US$150)	f.o.b.Thoothukudi
2014-15	TiO_2 : 49-51%	8400 (US$140)	f.o.b.Thoothukudi
DCW Ltd			
2012-13	NA	20552	
2013-14	NA	17290	
2014-15	NA	10955	

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; KMML, a Kerala State Government Undertaking and two Private Sector producers viz, M/s V. V. Mineral, Thoothukudi (Tamil Nadu) and M/s Beach Minerals Co. Pvt. Ltd, Kuttam (Tamil Nadu). 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 Kanyakumari, 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).

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.

IREL carried out trial runs for expansion of capacity of ilmenite to 2,00,000 tonnes at Chavara plant in Kerala and has commissioned it successfully. The Company has plan to expand MSP capacity at OSCOM to produce 4.7 lakh tonnes of ilmenite and associated minerals by the end of 2017. Trimex Group is understood to be gearing up to begin its 2,00,000 tpy ilmenite, 6,000 tpy zircon, 60,000 tpy garnet and 50,000 tpy sillimanite along with rutile project in Srikakulam district, Andhra Pradesh.

Installed capacity and production of ilmenite, rutile and other associated heavy minerals by various separation plants are furnished in Table-6.

Table – 6 : Installed Capacity & Production of Ilmenite, Rutile and Other Heavy Minerals, 2013-14 to 2015-16

(In tonnes)

Company/ Location	Mineral	Specification	Installed capacity (tpy)	Production		
				2013-14	2014-15	2015-16
Indian Rare Earths Ltd						
Manavalakurichi,	Ilmenite	55% TiO_2 (min)	90000	208054	252976	242075
Distt. Kanyakumari,	Rutile	94% TiO_2 (min)	3500	7878	9501	8788
Tamil Nadu.	Zircon	65% ZrO_2+HfO_2 (min)	10000	7878	10673	10785
	Sillimanite	58% Al_2O_3	8778	16005	25254	18796
	Monazite	96% pure	6000	491	2825	-
	Garnet	97% pure (min)	10000	26010	29532	22515
Chavara,	Ilmenite	58% TiO_2 (min)	200000	32233	28009	-
Distt. Kollam,	Rutile	95% TiO_2 (min)	11400	1138	992	-
Kerala.	Zircon	65% ZrO_2+HfO_2 (min)	17500	2132	1738	-
	Rare Earths	–	4500*	-	-	-
	Sillimanite	58% Al_2O_3 (min)	7000	3840	6943	
	Leucoxene	–	–	-	-	
	Zirflour	-200 mesh	6000	34	19	507
	(includes	-300 mesh	500	595	848	
	Microzir)					
Orissa Sands Complex,	Ilmenite	50.25% TiO_2 (min)	220000	138115	200102	-
Distt. Ganjam,	Rutile	94.25% TiO_2 (min)	7400	5766	7249	-
Odisha.	Zircon	64.25% ZrO_2+HfO_2 (min)	5000	4576	5769	-
	Sillimanite	56.5% Al_2O_3 (min)	13000	11722	18311	-
	Garnet	93.5% garnet (min)	20000	19092	11999	-
Kerala Minerals & Metals Ltd						
Chavara,	Ilmenite	59.88% TiO_2	61600	45240	62850	-
Distt. Kollam.	Rutile	93.20% TiO_2	4400	1850	2330	-
Kerala.	Zircon	64.81% ZrO_2	6500	3960	3635	-
	Sillimanite	NA	3600	1265	1270	-
V.V. Mineral						
Distt. Thoothukudi,	Ilmenite	51.0-52.5% TiO_2	450000	211662	314917	318430
Tamil Nadu.	Rutile	95% TiO_2 (min)	12000	3580	2803	1505
	Zircon@	66% ZrO_2+HfO_2 (min)	18000	8205	8218	2306
	Zircon-sillimanite	NA	24000	6604	4707	0
	Garnet	NA	150000	_	-	-
Beach Minerals Co. Pvt. Ltd						
Kuttam,	Ilmenite	KU grade 49-51% TiO_2	150000	36500	49090	
Distt. Tirunelveli,						
Tamil Nadu.						

Source: *Department of Atomic Energy, Mumbai and IREL.*
** In terms of rare earths chloride.*
@ Besides, 4,600 tonnes, 11,500 tonnes and 6,640 tonnes production of zircon-sillimanite have also been reported during 2013-14, 2014-15 and 2015-16 respectively.

INDUSTRY

For manufacture of 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 Synthetic Rutile Plants 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. IREL intends to set up titanium slag plant based on OR ilmenite at Odisha and has signed an MoU with NALCO for this purpose. Depending upon feasibility, further value addition to TiO_2 pigment and Ti sponge shall be taken up, subsequently.

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 nano-titanium dioxide was commissioned. KMML has set up a plant for producing 500 tpa of Titanium sponge with technology from DMRL.

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 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.

NMDC has signed an MoU with KSIDC and IREL for setting up a synthetic rutile plant in Kerala. The Company has applied for prospecting licences in various areas in Odisha, Kerala and Tamil Nadu and sought Swedish technology for mineral separation plant. The Beach Minerals Co. Pvt. Ltd also has plans for production of synthetic rutile from ilmenite. Presently, it only has facility of pilot plant. M/s V. V. Mineral has plans to set-up a 5 lakh tpy titanium pigment plant. The project is at approval stage.

Present domestic titanium metal production is negligible. KMML has set-up 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 capacities & production of synthetic rutile and TiO_2 pigment from 2013-14 to 2015-16 are furnished in Table-7.

Table –7 : Installed Capacity and Production of Synthetic Rutile/Titanium dioxide Pigment, 2013-14 to 2015-16

(In tonnes)

Plant	Location	Specification	Installed capacity (tpy)	Production		
				2013-14	2014-15	2015-16
Total			**243000** (Synthetic rutile)	**59426** (Synthetic rutile)	-	**100000**
			74800 (TiO_2 Pigment)	**23459** (TiO_2 Pigment)	-	**60000**
IREL	Orissa Sands Complex, Distt. Ganjam, Odisha.	90.5% TiO_2 (min)	100000 (Synthetic rutile)	-	-	-
KMML	Chavara, Distt. Kollam, Kerala.	92%-93% TiO_2	50,000 (Synthetic rutile)			
			40000 (TiO_2 - Chloride Process)	-	-	-
DCW Ltd	Sahupuram, Distt. Thoothukudi, Tamil Nadu.	95% TiO_2	48,000 (Synthetic rutile)	40696	-	-
CMRL	Edayar, Distt. Ernakulam, Kerala.	96.5% TiO_2	45,000 (Synthetic rutile)	18730	-	-
TTPL	Kochuveli, Distt. Thiruvananthapuram, Kerala.	97.5% TiO_2	17,000 (TiO_2-Sulphate Process)	11550		-
VVTi Pigments Pvt. Ltd* (formerly Kilburn Chemicals)	Thoothukudi, Tamil Nadu.	98% TiO_2 (min)	13,000 (TiO_2-Sulphate Process)	12243	13118	14465
Kolmar Chemicals Ltd	Kalyani, Distt. Nadia, West Bengal.	NA	4,800 (TiO_2-Sulphate Process)	NA	-	-

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.*

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 ultra violet 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.

CONSUMPTION

The ilmenite consumption is placed at 196,300 tonnes in 2015-16 which is marginally higher as compared to present year. The bulk of ilmenite is consumed in the manufacture synthetic rutile (99%). Moderate proportions are consumed by welding electrode and ferro-alloys Industry. The consumption of rutile in 2015-16 was 30,900 tonnes compared to 28,300 tonnes in 2014-15. Bulk consumption was in Paint Industry (41%) followed by Electrode Industry (57%) (Table - 8).

Table – 8 : Consumption* of Ilmenite and Rutile 2013-14 to 2015-16 (By Industries)

(In tonnes)

Industry	2013-14 (R)	2014-15 (R)	2015-16 (P)
Ilmenite			
All Industries	**188600**	**195900**	**196300**
Chemicals	187000	194000	194000
Electrode	1200	1500	1900
Others (Ceramic, Ferro-alloys, Paint & Refractories)	400	400	400
Rutile			
All Industries	**26000**	**28300**	**30900**
Electrode	8800	11500	12600
Paint	16600	16200	17700
Others (Cosmetic, Electrical, Paper & Ferro-alloys)	600	600	600

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 percent.

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 the Foreign Trade Policy, 2015-2020 and the policy on exports and imports, titanium ores and concentrates under heading 2614 (comprising ilmenite unprocessed and upgraded, i.e., beneficiated ilmenite including ground ilmenite) and rutile sand can be imported/exported freely.

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 China (29%), Australia (19%), India (11%), South Africa (8%), Brazil (6%), Madagascar and Norway (5% each) and Mozambique (2%). The world reserves of rutile are 59 million tonnes in terms of TiO2 content. Major rutile reserves are located in Australia (50%), followed by Kenya (22%), South Africa (14%), India (13 %) and Ukraine (4%).

World production of ilmenite and rutile concentrates was 10.49 million and 0.78 million tonnes, respectively, in 2015. Canada contributed 18% of ilmenite production, followed by Australia (12%), China (15%) and South Africa (10%). Australia produced 38% of world rutile output, followed by South Africa (17%), Sierra Leone (16%) and Ukraine (13%). World reserves and production of titanium minerals, viz, ilmenite and rutile, are furnished in Tables - 9 to 11.

Table – 9 : World Reserves of Ilmenite and Rutile (By Principal Countries)

(In '000 tonnes of contained TiO_2)

Country	Reserves	
	Ilmenite	Rutile
World: Total (Ilmenite+Rutile) : 829000		
World: Total (Rounded)	**770000**	**59000**
Australia	150000	27000
Brazil	43000	-
Canada	31000	–
China	220000	–
India*	85000	7400
Kenya	54000	13000
Madagascar	40000	–
Mozambique	14000	-
Norway	37000	–
South Africa	63000	8300
Ukraine	5900	2500
USA**	2000	–
Vietnam	1600	–
Other countries	26000	400

***Source**: Mineral Commodity Summaries, 2017.*

** As per NMI database, based on UNFC System, the total resources of titanium minerals in India are estimated at about 413.62 million tonnes.*

*** Includes rutile*

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

(In '000 tonnes)

Country	2013	2014	2015
World: Total	**12335**	**11575**	**10496**
Australia Ilmenite	1314	1138	1005
Leucoxene	226	241	246
Canada (e)@	2800	2500	1900
China	1700	1600	1600
India	722	720e	720e
Korea, Rep. of	230	241	204
Madagascar	562	334	200
Mozambique	720	855	764
Norway	826	864	630
Russia	150	178	193
Senegal	0	101	428
South Africa(e)	1070	1105	1000
Ukraine(e)	600	600	600
USA(e)	200	100	100
Vietnam(e)	1026	558	282
Other countries	189	440	624

***Source**: World Mineral Production, 2011 & 2015.*

***Note**: Some ilmenite is converted to synthetic rutile in Australia, India, Japan, Taiwan and USA.*

@ Canada produces some ilmenite which is sold as such and not processed into slag, but tonnages are small.

Table – 11 : World Production of Rutile (By Principal Countries)

(In '000 tonnes)

Country	2013	2014	2015
World: Total (wt. of conc.)	**1261**	**795**	**778**
Australia	250	341	295
India	13	13e	13e
Kenya	0	52	79
Kazakhstan(e)	17	17	17
Sierra Leone	120	115	123e
South Africa	734	133	130
Ukraine(e)	100	100	100
Other countries	25	24	21

***Source**: World Mineral Production, 2011 & 2015.*

World production of TiO_2 contained in titanium mineral concentrates was 9.85 million tonnes in 2014, which reportedly decreased by 8% from that of 2013. The leading sources of world imports of titanium mineral concentrates were Australia, South Africa, China and Canada.

Metal

Commercial production of titanium metal involves the chlorination of titanium-containing mineral concentrates to produce titanium tetrachloride ($TiCl_4$), 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 TiO_2 pigment production capacity was estimated to be 5.7 million tonnes per year. TiO_2 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, TiO_2 pigment can exhibit a wide range of functional properties, including dispersion, durability, opacity and tinting.

FOREIGN TRADE

Exports

As per the data from DGCI & S, Kolkata, exports of titanium ores & conc. marginally increased to 0.78 million tonnes in 2015-16 as compared to 0.78 million tonnes in the preceding year. Exports in 2015-16 comprised ilmenite (783,656 tonnes), rutile (6,722 tonnes) and other titanium ores (111 tonnes). Main destinations were China (54%), Netherlands (21%) and Japan (13%).

Exports of titanium and alloys (including waste & scrap) were 171 tonnes in 2015-16 as compared to 174 tonnes in the previous year. Exports were mainly to USA (73%). Exports of titanium oxide and dioxide (total) increased to 40,820 tonnes in 2015-16 from 37,924 tonnes in 2014-15. Out of the total exports in 2015-16, those of titanium dioxide were 4,438 tonnes and exports of titanium oxides (other than titanium dioxides) were 36,382 tonnes (Tables-12 to 19).

Imports

As per the data from DGCI&S, imports of titanium ores & conc. increase to 106,422 tonnes in 2015-16 as compared to 51,991 tonnes in the preceding year. Out of the total imports of titanium ores & conc. in 2015-16, those of ilmenite were 90,991 tonnes, rutile 11,649 tonnes and other titanium ores were 3,782 tonnes. Main suppliers were Mozambique, Indonesia, Australia, South Africa and Sri Lanka.

Imports of titanium and alloys (including waste & scrap) were 1,869 tonnes in 2015-16 as compared to 2,007 tonnes in the previous year. Imports were mainly from Kazakhstan, China, USA and UK. Imports of titanium oxide and dioxide (total) were 17,192 tonnes in 2015-16 as compared to 19,178 tonnes in the preceding year. Imports were mainly from China (40%), Korea, Rep. of (15%) and Germany (14%). Bulk of these imports were of titanium dioxide (16,421 tonnes) and titanium oxides (other than Titanium Oxides) were 771 tonnes in 2015-16 (Tables - 20 to 27).

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

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**775192**	**6956324**	**783656**	**6302006**
China	411450	3414625	422913	2667402
Japan	93120	1349411	103596	1707574
Netherlands	137343	1070970	160786	121818
Malaysia	79354	715576	54166	405150
Korea, Rep. of	53900	405144	21500	128366
Germany	-	-	10000	75553
Mexico	-	-	468	4323
USA	-	-	78	4273
Bangladesh	19	540	80	2575
Other countries	6	58	69	2782

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

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (``'000)	Qty (t)	Value (``'000)
All Countries	**779598**	**7179648**	**790489**	**6644934**
China	411870	3435382	422913	2667402
Japan	95228	1447215	108222	1926431
Netherlands	137343	1070970	160890	1218911
Malaysia	79354	715577	54167	405206
Korea, Rep. of	53941	407479	21503	128585
Iran	1148	64153	1317	70576
Belgium	228	12489	240	12718
Bangladesh	160	9523	261	13831
Germany	++	4	10000	75553
Other countries	126	16856	976	35531

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

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (``'000)	Qty (t)	Value (``'000)
All Countries	**4332**	**217945**	**6722**	**336088**
Japan	2108	97804	4626	218857
Iran	1148	64153	1316	70542
Belgium	228	12489	234	12661
Indonesia	28	1453	141	7587
Bangladesh	108	6717	102	6608
Australia	-	-	40	6016
Netherlands	-	-	104	5093
Bulgaria	26	1599	39	2503
Ukrain	-	-	54	2417
Quatar	-	-	28	1606
Other countries	686	33730	38	2198

Table – 15 : Exports of Titanium Ores & Conc. (Others) (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (``'000)	Qty (t)	Value (``'000)
All Countries	**74**	**5379**	**111**	**6840**
Bangladesh	33	2266	79	4648
Kenya	35	2809	24	1551
Pakistan	-	38	6	491
Ireland	-	-	1	76
Malaysia	++	-	1	56
Brazil	-	-	++	18
Maldives	4	142	-	-
Indonesia	1	119	-	-
Other countries	++	4	-	18

Table – 16 : Exports of Titanium & Alloys (Incl. Waste & Scrap) (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (``'000)	Qty (t)	Value (``'000)
All Countries	**174**	**197302**	**171**	**195613**
USA	121	46371	124	43628
Italy	3	18664	++	6233
Senegal	-	-	24	41956
Saudi Arabia	3	11130	2	7562
Israel	++	115	1	21330
Singapore	++	1580	3	7006
UAE	1	3777	4	6203
UK	29	25293	3	30766
Switzerland	-	-	2	6003
Japan	-	-	5	4151
Other countries	17	90372	3	20775

Table – 17 : Exports of Titanium oxide & Dioxide : Total (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (``'000)	Qty (t)	Value (``'000)
All Countries	**37924**	**2286503**	**40820**	**2296618**
Japan	23980	1204302	33664	1563366
Italy	1894	267505	1159	175933
USA	1456	182155	1498	166132
Malaysia	1092	63590	2656	157973
Thailand	153	16099	320	32578
Sri Lanka	68	10319	209	26108
Nigeria	498	70220	190	24618
Indonesia	-	-	165	19731
UAE	220	23925	139	18826
Saudi Arabia	2	423	155	17650
Other countries	8561	447964	665	93703

Table – 18 : Exports of Titanium dioxide (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**5157**	**710758**	**4438**	**558233**
USA	1291	171091	1258	149365
Italy	1768	239796	977	132273
Japan	523	65426	496	55831
Thailand	153	15962	320	32495
Sri Lanka	68	10319	204	25600
Nigeria	379	58079	142	21741
Indonesia	-	-	163	19296
UAE	220	23906	138	18315
Saudi Arabia	2	423	155	17650
Turkey	103	13895	102	14169
Other countries	650	111861	483	71498

Table – 19 : Exports of Titanium oxide (Other than Titanium Dioxide) (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**32767**	**1575745**	**36382**	**1738385**
Japan	23457	1138877	33168	1507535
Malaysia	1092	63590	2652	157535
Italy	126	27709	182	43660
USA	165	11064	240	16767
Morocco	22	4497	22	3871
Turkey	18	1397	42	3020
Nigeria	119	12141	48	2877
Nepal	7	253	16	943
Bangladesh	5	960	2	511
UAE	++	19	1	511
Other countries	7756	315238	9	1155

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

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**51991**	**971521**	**106422**	**1637171**
Mozambique	32567	322152	72777	702208
Australia	5660	292110	10017	401529
Sri Lanka	1609	81833	6463	137216
South Africa	3522	172263	2660	122150
Macao	-	-	10423	100276
Thailand	-	-	1500	62246
Ukraine	106	4885	908	48122
Sierra Leone	24	1442	364	20083
Senegal	-	-	478	17640
Malaysia	20	200	462	8939
Other countries	8483	96634	370	16762

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

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**40894**	**408590**	**90991**	**916147**
Mozambique	32567	322151	72777	702209
Macao	-	-	10423	100276
Sri Lanka	25	212	5540	88310
Indonesia	8252	85157	-	-
Australia	-	-	1910	21652
Ukraine	28	624	-	-
Germany	2	246	4	493
Malaysia	20	200	337	3207

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

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**8736**	**447124**	**11649**	**557798**
Australia	4550	237323	6477	303975
Sri Lanka	1134	60063	923	48906
South Africa	2898	141147	2548	117065
Ukraine	78	4262	908	48122
China	52	2887	124	6266
Sierra Leone	24	1442	364	20083
Malaysia	-	-	125	5732
Austria	-	-	130	5437
Vietnam	-	-	50	2212

Table – 23 : Imports of Titanium Ores & Conc. (Others) (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**2361**	**115807**	**3782**	**163226**
Australia	1110	54787	1630	75902
South Africa	624	31116	112	5085
Sri Lanka	450	21558	-	-
Vietnam	125	5548	-	-
Chinese Tapei/Taiwan	-	-	++	68
UAE	-	-	60	2226
UK	-	-	1	36
USA	-	-	-	23
Senegal	-	-	478	17640
Thailand	-	-	1500	62246
Other countries	52	2798	-	-

Table – 24 : Imports of Titanium & Alloys (Incl. Waste & Scrap) (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**2007**	**3360378**	**1869**	**306279**
USA	278	766774	538	85250
China	343	466447	514	57468
UK	164	440201	169	36223
Italy	137	307203	81	22247
Ukraine	91	173251	123	26862
Japan	165	172428	171	16330
France	37	171375	43	11610
Russia	81	154257	65	10250
Germany	123	133041	63	14970
Romania	46	66669	40	6294
Other countries	542	508732	62	18752

Table – 25 : Imports of Titanium oxide & Dioxide : Total (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**19178**	**3029044**	**17192**	**2768564**
China	6072	788308	6804	894413
Korea, Rep. of	4481	674238	2580	408698
Germany	1934	452877	2398	505965
USA	1389	265207	1157	204659
Japan	996	241829	944	232371
Czech Republic	1520	206615	1700	200964
France	14	9606	422	134393
Ukraine	1700	196505	460	49772
Chinese Tapei/Taiwan	112	20957	247	43091
Saudi Arabia	60	10084	120	17020
Other countries	900	162819	360	77218

Table – 26 : Imports of Titanium dioxide (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**17574**	**2824279**	**16421**	**2570933**
China	4786	671137	6491	856721
Germany	1769	411692	2382	500827
Korea, Rep. of	4481	674193	2540	404758
USA	1370	261673	1157	203977
Japan	972	230982	922	221219
Ukraine	1700	196505	460	49772
Czech Republic	1520	206615	1700	200724
Chinese Taipei/Taiwan	112	20957	237	41331
France	14	8380	148	18389
Malaysia	100	17129	100	16505
Other countries	750	125016	284	56710

Table – 27 : Imports of Titanium oxides (Other than Titanium Dioxides) (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**1604**	**204765**	**771**	**197631**
China	1286	117171	313	37692
Japan	24	10847	22	11152
Germany	165	41185	16	5138
Italy	40	8989	40	9466
Saudi Arabia	60	10084	40	5566
Finland	-	-	1	1710
France	++	1226	274	116004
Korea, Rep. of	++	45	40	3940
Belgium	++	118	10	1760
Chinese Tapei/Taiwan	-	-	10	1710
Other countries	29	15100	5	3079

FUTURE OUTLOOK

The major chunk of consumption of ilmenite is for the manufacture of synthetic rutile. The future demand of ilmenite during the 12th Plan Period at the GDP growth rate of 8%, 9% and 10% is estimated at 3.19 lakh, 3.27 lakh and 3.35 lakh tonnes, respectively, as per the Report of Working Group on Mineral Exploration and Development (other than coal & lignite) for the 12th Five Year Plan (2012-17), Planning Commission of India.

The demand for titanium in India would be approximately 1000 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 Technology Information, Forecasting & Assessment: Technology Vision 2035.

As per data available for the defence, atomic energy and space research allocations, the critical sector are given encouragement to increase communication set-up, safeguard India's security with modern arms, ammunitions and control and a three fold increase in power generation. 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. The present capacity of this titanium sponge plant is 500 tpa. However, with the successful commissioning of the titanium sponge plant, India has joined the elit club of seven countries capable of producing aerospace grade titanium sponge. The plant has the basic infrastructure for increasing the capacity of 1000 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.