

75 Tin

Tin is one of the earliest metals known and used mainly in bronze implements. It is a scarce element having an incidence of about 2 ppm in the earth's crust. Its unique combination of properties like non-toxic nature, high malleability, chemical inertness and ease with which it can form an amalgam and alloy with other metals, has given it a special status among non-ferrous metals. Pure tin is a silvery-white metal which is soft and malleable. It does not occur naturally as metal. By far, the most important tin mineral is cassiterite (SnO_2) which, in its purest form, contains 78.6% tin. The less common tin ore is stannite ($\text{Cu}_2\text{SnFeS}_4$). Tin is now used mostly for tin plating, soldering and in making bronze.

RESOURCES

Tin occurs in primary as well as secondary (alluvial or placer) forms. Occurrences of tin in primary as well as secondary forms have been reported from Bihar, Chhattisgarh, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Orissa, Rajasthan and West Bengal. However, the only workable economic deposits in the form of alluvial or placer deposits occur in Bastar and Dantewada districts of Chhattisgarh. Tin in primary form as disseminations in the gneisses and schists of Koraput district, Orissa is another source of economic importance.

The total resources of tin ore in the country as per UNFC system, as on 1.4.2005 are placed at 86.55 million tonnes containing about 101,237 tonnes metal. About 249,497 tonnes ore containing 134 tonnes metal are placed under reserves category and the bulk i.e. about 86.3 million tonnes containing about 101,103 tonnes metal are placed under remaining resources category. Of the ore reserves, about 95% are located in Chhattisgarh and 5% in Orissa. However, 62% ore resources are located in Haryana and 38% in Chhattisgarh while nominal resources are estimated in Orissa (Table-1).

PRODUCTION & STOCKS

Concentrates

Chhattisgarh was the only producer of tin concentrates. The production of tin concentrates in 2007-08 was at 61,522 kg as against 1,00,835 kg in the preceding year. Five mines, one in public sector and four in private sector, all located in Dantewada district of Chhattisgarh reported production in 2007-08.

The mine-head stocks of tin concentrates were 5,385 kg at the beginning of the year as against 3,002 kg at the end of the year.

The Chhattisgarh Mineral Development Corporation Limited (CMDC) purchases tin concentrates from local tribals, allowing them to collect it from the lease area. Hence, no labour was reported to have been employed in the mine owned by the CMDC, whereas Precious Minerals and Smelting Ltd, employed 54 workers in the mines during the year (Tables - 2 to 5). Prices of tin concentrates are furnished in Table - 6.

Metal

No production of tin metal was reported in both the years, i.e., 2006-07 and 2007-08.

**Table - 2 : Producers of Tin Concentrates
2007-08**

Name & Address of the producer	Location of the mine	
	State	District
Chhattisgarh State Mineral Dev. Corp. Ltd, 27/520, New Shanti Nagar, Shankar Nagar Road, Raipur, Chhattisgarh.	Chhattisgarh	Dantewada
Precious Minerals and Smelting Ltd, Semi Urban Industrial Estate, Frezerpur, Jagdalpur-494 001, Chhattisgarh.	Chhattisgarh	Dantewada

**Table -1 : Reserves/Resources of Tin as on 1.4.2005
(By Grades/States)**

Grade/State	Reserves				Remaining resources				Total resources (A+B)		
	Proved	Probable	Total	Feasibility	Pre-feasibility	Measured	Indicated	Inferred		Total	
	STD111	STD122	(A)	STD211	STD221	STD222	STD331	STD332		STD333	(B)
All India : Total											
Ore	200828	48669	249497	22580000	2518093	31330101	168326	595914	29110378	86302812	86552310
Metal	107.68	26.4	134.08	32187.8	892	13240.7	662.49	213.6	53906.43	101103.02	101237.1
By States											
Chhattisgarh											
Ore	188136	48669	236805	-	2516392	-	168326	595914	29109378	32390010	32626816
Metal	73.05	26.4	99.45	-	369.92	-	662.49	213.6	13103.43	14349.44	14448.89
Haryana											
Ore	-	-	-	22580000	-	31330000	-	-	-	53910000	53910000
Metal	-	-	-	32187.8	-	54032.8	-	-	-	86220.6	86220.6
Orissa											
Ore	12692	-	12692	-	1701	101	-	-	1000	2802	15494
Metal	34.63	-	34.63	-	522.08	0.9	-	-	10	532.98	567.61

Figures rounded off.

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**Table - 3 : Production of Tin Concentrates, 2005-06 to 2007-08
(By State)**

(Quantity in kg; value in Rs. '000)

State	2005-06		2006-07		2007-08(p)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	98734	14838	100835	18362	61522	13723
Chhattisgarh	98734	14838	100835	18362	61522	13723

**Table - 4 : Production of Tin Concentrates, 2006-07 and 2007-08
(By Sectors/State/District)**

(Quantity in kg; value in Rs. '000)

State	2005-06			2006-07(p)		
	No. of mines	Quantity	Value	No. of mines	Quantity	Value
India	3	100835	18362	5	61522	13723
Public sector	1	74406	14451	1	47051	11581
Private sector	2	26427	3911	4	14471	2142
Chhattisgarh	3	100835	18362	5	61522	13723
Dantewada	3	100835	18362	5	61522	13723

**Table - 5 : Mine - head Stocks of Tin Concentrates, 2007-08(p)
(By State)**

(In kg)

State	Stocks at the	
	beginning of the year	end of the year
India	5385	3002
Chhattisgarh	5385	3002

**Table - 6 : Prices of Tin Concentrates, 2005-06 to 2007-08
(Domestic Markets)**

(In Rs. per tonne)

Grade	Market	2005-06	2006-07	2007-08(p)
68% SnO ₂	Ex-stock Dantewada (Chhattisgarh)	190	278.41	314.75

MINING

In Govindpal-Tongpal area in Dantewada, district, Chhattisgarh, tin in the form of cassiterite is being mined from the sediments deposited in the streams. The stream sediments are dug up manually with conventional implements. Subsequent panning of these sediments helps in separating the lighter gangue minerals while the heavier part is recovered as cassiterite. Chhattisgarh Mineral Development Corporation Ltd (CMDC) purchases cassiterite concentrate at mutually agreed rates.

The tin ore or cassiterite concentrate is converted into tin metal in the smelters situated at Raipur and Jagdalpur. However, no production of metal was reported during the year.

INDUSTRY

Metal production has not been reported from M/s Dravya Industrial Chemicals Ltd from its plant located in Raipur district since 1999-2000. Similarly, production has not been reported by the lone public sector plant of CMDC in Raipur district.

Under private sector, HAMCO Mining and Smelting Ltd, Mumbai, has a tin plant at Silvassa, Dadra & Nagar Haveli. The plant uses imported concentrates. It has a production capacity of 3,000 tpy. However, the plant has not reported production. The other plant at Choudhwar, Cuttack district, Orissa owned by Sartin Alloys Private Ltd has 300 tpy capacity for unwrought tin and 1,000 tpy capacity for lead and tin alloys. This plant is designed to process domestic as well as imported ores. This plant has also not reported any production since 2002-03.

Hindustan Tin Works Ltd has planned to set up 350 million cans per annum capacity plant at Taloja in Maharashtra which will substitute the imports of cans meant mainly for beer and beverage/soft drinks.

USES & SPECIFICATIONS

Tin, as a metal, is the most preferred and environment-friendly packing material. Tin plates are used both in packaging food products like processed food, vanaspati ghee, etc. and in battery jackets and pesticide cans. The tin plate is manufactured by depositing tin on iron plate of thickness ranging from 0.17 mm to 0.60 mm. The amount of tin coating on tin plate is to be carried out as per BIS specification IS:597-1978 (Second Revision) for pack-rolled tin plate and pack-rolled black plate. The minimum amount of pure tin per square metre shall be 105 g for Grade I, 85 g for Grade II and 55 g for BC grade. The specifications for tin ingot which is to be used for various purposes is as per IS: 26 - 1992 (Fourth Revision). There shall be two grades of tin ingot; viz, Sn 99.85% and 99.75%.

Tin readily forms alloys with other metals to create useful materials, such as solders, bronzes, and fusible alloys.

Tin with lead forms an excellent alloy which melts at very low temperature and is used as solders in electronics or as a seal in plumbing. Tin is used in making fusible alloys to be used in safety devices, such as fire sprinklers, pressure cookers, boiler plugs and electrical fuses.

Powder containing 60% silver, 27% tin and 13% copper when mixed with appropriate quantity of mercury forms excellent dental amalgam to be used for filling dental cavities.

Tin is used in cast iron to improve the microstructure and it results in higher uniform hardness. Tin bronzes are used for making gears, tubing, springs and plumbing fitments and for making bearings. Tin is also used in making high tech alloys, such as zirconium-tin, used for cladding the fuel elements in thermal nuclear reactors and a niobium-tin-intermetallic compound used in certain high-performance superconducting fields, such as in high-energy physics.

Tin oxide-based catalysts are used in air purification system, gas sensors and CO₂ lasers. Organotin compounds are used in agrochemicals

and antifouling paints in seafaring vessels. Pure tin in molten form is used to provide a flat surface as well as fire-polish on both sides of float glass which solidifies on it. In glass industry, a very thin film of tin is applied on glassware for imparting strength. It is also used in the production of lead crystal glass. Tin oxide films thicker than 1 mm on glass, produce a transparent, yet electrically conductive layer. This layer is used in de-icing windscreen, antistatic glassware, security alarm, etc.

POLICY

As per the Foreign Trade Policy, 2004-09, there are no restrictions on the export and import of tin ores and concentrates.

CONSUMPTION

The main consumers in India are the tin plate industry and solder industry. The latter advancing to become the biggest single end-use over the last decade. The fastest growth rate is also expected in future. Tin plate companies; namely, Tin Plate Company of India Ltd and SAIL's Rourkela Steel Plant use tin metal in appreciable quantities for the manufacture of tin plate. The domestic tin plate market which has a size of 3 lakh tonnes per annum is categorised broadly into three basic market segments: edible oil and cashew, processed food and non-food for packaging. Rourkela plant of SAIL consumed about 46 tonnes tin in 2006-07 and 41 tonnes in 2007-08. Production of tin plates in 2007-08 was 14,820 tonnes against 16,792 tonnes in 2006-07. The Tin Plate Company of India Ltd consumes tin at its Golmuri Works, Jamshedpur in East Singhbhum, Jharkhand. The present installed capacity of the electrolytic tinning plant of the company is 165,000 tpy. The company produced 157,423 tonnes and 165,144 tonnes electrolytic tin plates in 2006-07 and 2007-08, respectively, consuming about 664 tonnes and 703 tonnes tin, respectively.

Other industry which consumes tin in substantial quantities in the country is tin solder required by high tech and electronic sectors which have a positive impact on tin industry. The consumption in IT industry and in food/beverages packaging industry is increasing day by day.

SUBSTITUTES

The most important use of tin is in making packing materials, as it is environment-friendly. A number of materials can replace tin in its various applications; such as, tetrapack for liquid food items, plastic/polycontainers for solid, semi-solid food; aluminium, glass, tin-free steel can be used in place of tin cans and containers. For tin solders, new epoxy resins, for bronze-aluminium alloys, copper-base alloys, plastic for bearing metals, compounds of lead and sodium for some tin chemicals are the other substitutes now in use in place of tin.

WORLD REVIEW

About 80% world's tin deposits occur as unconsolidated secondary or placer deposits in river beds and valleys or on the floor of sea and the remaining 20% as primary hard rock veins or lodes in close association with silicic granites. Tin is found allied closely with granite from which it originates. The world resources of tin metal are estimated at 11 million tonnes, located mainly in China (32%), Brazil (23%), Malaysia (11%), Peru (9%) and Bolivia and Indonesia (8% each). The world resources of tin by principal countries are given in Table-7.

The top four tin metal producers, responsible for around 55% of primary tin metal output, are Minsur SA (Peru), Malaysia Smelting Corp (Malaysia), PT Tambang Timah (Indonesia) and Yunnan Tin Corp (China). Sufficient world resources, principally in western Africa, south-eastern Asia, Australia, Bolivia, Brazil, China and Russia are available to sustain recent annual production rates in the 21st century.

The world production of tin in 2007 increased to 303,000 tonnes from 300,000 tonnes in the previous year. China (45%), Indonesia (22%), Peru (13%) and Bolivia (5%) were the principal producing countries (Table - 8).

Australia

The reopened Renison tin mine in Tasmania, purchased by Bluestone Tin Ltd produced 22 thousand tonnes of concentrate averaging 1.8% Sn in the December quarter of 2004. Bluestone Tin aims

to produce around 500,000 tpy of concentrate, averaging 1.6 % Sn for mining of about 6,000 tpy of contained tin. Bluestone is also to produce around 3,000 tpy of tin-in-concentrates from its Collingwood tin mine in Queensland and the Mt Bischoff tin mine in Tasmania, where estimated mineral resource is at 1.9 million tonnes averaging 0.96% Sn based on a 0.5% Sn cut-off grade.

**Table - 7 : World Resources of Tin
(By Principal Countries)**

(In '000 tonnes of tin content)

Country	Reserve base
World : Total	11000
Australia	300
Bolivia	900
Brazil	2500
China	3500
Indonesia	900
Malaysia	1200
Peru	1000
Portugal	80
Russia	350
Thailand	200
USA	40
Other countries	200

Source: Mineral Commodity Summaries, 2008.

**Table - 8 : World Production of Tin
(By Principal Countries)**

(In tonnes of metal content)

Country	2005	2006	2007
World : Total	301000	300000	303000
Australia	2713	2783	2071
Bolivia	18639	17669	15972
Brazil	11739	9528	12596
China	121600	126300	136300
Congo, Dem. People's Rep.of	7600	7200	12000
Indonesia	78400	809000	66137
Malaysia	2857	2398	2263
Nigeria	1500 ^e	1423	2500 ^e
Peru [#]	42145	38470	39019
Russia [#]	2500	2600	2800
Vietnam ^e	5400	5400	5400
Other countries	5907	5329	5942

Source: World Mineral Production, 2003-2007.

[#] Recoverable.

Bolivia

Cia Minera del Colquiri, owned by Comsur in joint venture with the Commonwealth Development Corp, operates the Colquiri mine. The company is to install a tailings treatment plant there to recover tin from tailings, accumulated over a 40-year period prior to 1980.

Comsur's tin smelter, Empresa Metalúrgica Vinto (EMV), purchased from RBG Resources liquidators is expected to increase production by 25% through 2005-06 to 15,000 tpy from the earlier level of 12,000 tpy.

Brazil

Rocha Sa project to be operational in 2007 will boost Paranapanema's total tin-in-concentrates output to 12,000 tpy, including production from alluvial deposits.

Cesbra, Brazil's second largest tin producer, plans to double output at its mine at Itapua do Oeste, Rondonia state, to 2,500 tonnes in 2006 and 3,000 tonnes of tin-in-concentrates by 2007.

China

Yunnan Tin Group, China's largest tin producer, plans to developing new polymetallic deposits. The company also signed letters of intent to develop a tin-mining project in Indonesia and a smelter in Singapore. The Mineral Surveys Bureau announced a tin prospect in Chenzhou in southeast Hunan containing 700,000 tonnes of ore reserves.

Indonesia

PT Timah plans to maintain its annual tin output at around 35,000 tpy while developing reserves. The company plans to concentrate its business in offshore tin exploitation in Riau Islands province with onshore operations becoming complimentary. Offshore exploration in Riau Island province has added 40,000 tonnes of tin to earlier reserves. Measured resources reached about 340,000 tonnes, of which 220,000 tonnes are located offshore and the remaining 120,000 tonnes on land.

Timah's new smelter on Kundur in Riau province to be operational since 2005, was

expected to produce around 5,000 tonnes of tin metal .

Malaysia

Malaysia Smelting Corp's has signed mining co-operation agreements with three Indonesian companies to prospect for alluvial tin in their concession areas on the country's Bangka Island.

Peru

San Rafael is an underground mine of Peru's sole tin producer Minsur SA in the southern highland region of Puno. It is operating at 100% of its 2,500 tpd installed capacity. It has reserves of 15 million tonnes with an average grade of 5% Sn, making it one of the world's richest deposits. The mine has an estimated mine life of 15 years.

Russia

Russia's sole tin producer Novosibirsk Tin Combine (NOK) plans to more than double the tin concentrate production from 2004 to 2008 period to 9,000 tpy.

FOREIGN TRADE

Exports

Exports of tin & alloys including scrap (total) increased marginally in 2007-08 to 5,544 tonnes from 5,493 tonnes in the previous year. Out of total exports in 2007-08, tin and alloys comprised 4,476 tonnes, tin and alloys worked (NES) 800 tonnes and tin scrap 268 tonnes. Exports were mainly to UAE (52%), Bhutan (8%), Australia and Nepal (4% each) (Tables - 9 to 13).

Imports

Imports of tin ores and concentrates decreased to 702 tonnes in 2007-08 from 1,126 tonnes in the previous year. Imports in 2007-08 were mainly from Congo PR (80%) and Colombia (19%). Imports of tin and alloys including scrap increased to 6,061 tonnes in 2007-08 from 5,590 tonnes in the previous year. Out of total alloys and scrap imported in 2007-08 tin and alloys comprised 5,712 tonnes, tin and alloys (worked, NES) 229 tonnes and tin (scrap) 120 tonnes (Tables - 14 to 19).

**Table - 9 : Exports of Tin Ores & Conc.
(By Countries)**

Country	2006-07		2007-08	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	++	4	-	-
Maldives	++	4	-	-

**Table 10: Exports of Tin and Alloys incl. Scrap
(By Countries)**

Country	2006-07		2007-08	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	5493	800063	5544	813385
UAE	1360	287099	2890	600633
Bhutan	384	22188	453	27577
UK	88	16025	143	20557
Malaysia	493	222080	51	19247
Australia	231	46072	237	18137
Indonesia	377	14296	114	8484
Sri Lanka	237	18789	77	7965
Nepal	331	15378	212	6948
Nigeria	231	17668	47	4091
Thailand	387	18788	8	627
Other countries	1374	121680	1312	99119

**Table - 11 : Exports of Tin and Alloys
(By Countries)**

Country	2006-07		2007-08	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	4427	690685	4476	686068
UAE	1115	261000	2516	538266
Bhutan	384	22188	453	27577
Malaysia	463	219602	40	18120
Italy	1	75	325	17340
UK	13	6301	77	15692
Australia	172	34523	206	14124
Indonesia	377	14296	100	7851
Nepal	296	13244	68	2969
Nigeria	141	11635	27	2057
Thailand	387	18773	8	596
Other countries	1078	89048	656	41476

**Table - 12 : Exports of Tin and Alloys
Worked (NES)
(By Countries)**

Country	2006-07		2007-08	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	893	87820	800	96435
UAE	229	24520	800	96435
Sri Lanka	80	9853	66	6059
Australia	46	7471	30	3828
Nepal	32	1815	138	3806
Canada	5	911	30	3527
Nigeria	90	6033	20	2034
USA	78	5001	18	1705
Germany	67	4809	11	1372
South Africa	87	5538	4	732
Oman	50	4942	++	1
Other countries	129	16927	118	12178

**Table - 13 : Exports of Tin (Scrap)
(By Countries)**

Country	2006-07		2007-08	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	173	21558	268	30882
China	46	3498	40	5722
UK	55	6302	65	4686
USA	7	1989	32	4166
Germany	-	-	22	3992
France	-	-	23	3915
UAE	16	1579	9	1174
Malawi	4	431	18	1106
Kuwait	1	178	6	1026
Saudi Arabia	5	461	7	866
Australia	13	4078	1	185
Other countries	26	3042	45	4044

**Table - 14 : Imports of Tin Ores & Conc.
(By Countries)**

Country	2006-07		2007-08	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	1126	282248	702	253846
Congo, P. Rep.	854	241210	559	203683
Colombia	-	-	134	48170
Tanzania	-	-	9	1993
Kenya	22	330	-	-
South Africa	65	17691	-	-
Unspecified	185	23017	-	-

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**Table - 15 : Imports of Tin and Alloys Incl. Scrap
(By Countries)**

Country	2006-07		2007-08	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	5590	2546808	6061	3727352
Malaysia	2821	1290158	2404	1575528
Indonesia	622	302095	1088	697756
Belgium	807	395578	922	595276
Singapore	328	144933	556	293488
Thailand	202	79720	311	194472
Germany	169	92217	132	92550
Chinese Taipei/Taiwan	44	41307	80	89138
China	122	50154	156	55309
Australia	5	3537	130	48410
UAE	209	56177	-	-
Other countries	261	90932	282	85425

**Table - 16 : Imports of Tin & Alloys
(By Countries)**

Country	2006-07		2007-08	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	5355	2472254	5712	3682089
Malaysia	2820	1289373	2402	1573958
Indonesia	622	302057	1088	697756
Belgium	807	395578	922	595116
Singapore	328	144933	498	291450
Thailand	202	79720	311	194432
Germany	164	90034	126	88430
Chinese Taipei/Taiwan	44	41307	79	87649
Australia	4	3263	80	47362
China	87	42865	105	46558
UK	71	9915	46	28753
Other countries	206	73209	55	30625

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**Table - 17 : Imports of Tin & Alloys : Worked (NES)
(By Countries)**

Country	2006-07		2007-08	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	93	33625	229	40261
Japan	6	2626	136	15634
China	35	7289	36	6320
Germany	4	1486	5	3423
USA	2	740	9	2999
Sri Lanka	30	13595	13	1678
Malaysia	1	785	2	1570
Chinese Taipei/Taiwan	-	-	1	1489
Slovenia	3	1458	4	1427
Italy	1	574	4	1132
Spain	6	3302	-	-
Other countries	5	1770	19	4589

**Table - 18 : Imports of Tin (Scrap)
(By Countries)**

Country	2006-07		2007-08	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	142	40929	120	5002
China	-	-	15	2431
Australia	-	-	50	1024
Singapore	-	-	54	847
Germany	1	697	1	697
Norway	-	-	++	3
UAE	140	40063	-	-
UK	1	169	-	-

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**Table - 19 : Imports of Tin
(By Items)**

Country	2006-07		2007-08	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Items	5590	2546808	6061	3727352
Tin & alloys	5106	2362899	5497	3560814
Block tin	1074	459966	552	355458
Anode, cathode, etc. of tin unwrought	3916	1833822	4842	3101226
Tin base alloys, NES	71	40686	98	97934
Tin & alloys : worked (bars, rods, plates, etc.)	45	28425	5	6196
Tin & alloys : worked	249	109355	215	121275
Tin & alloys; worked, NES	93	33625	229	40261
Tin scrap	142	40929	120	5002

FUTURE OUTLOOK

According to the Indian Tin Plate Manufacturers' Association (ITMA), the demand of tin plate for packaging industry in the country is growing and the consumption is expected to grow at a moderate level of 5% per annum. The per capita consumption of tin plate in India is only 0.3 kg compared with 10 kg in USA, 8 kg in Japan and 0.8 kg in China. The consumption pattern of tin in the world is: solders 28%, tin plates 27%, alloys and alloy coating 16%, PVC stabilisers 7%, tinning 5% and others 17 percent.

The demand has historically been dominated by tin - plate and solders, with latter advancing to become the biggest single end-use over last decade. Demand is expected to continue to increase in all end-use sectors, but fastest growth rates will be in solder.

In view of the likely enforcement of ban on the use of lead, lead-free solder will find market for soldering of electronic and electrical devices in the future. In other development, motor vehicle industry is showing interest in tin-zinc coatings for fuel tanks to replace lead-based fuel tank coatings.