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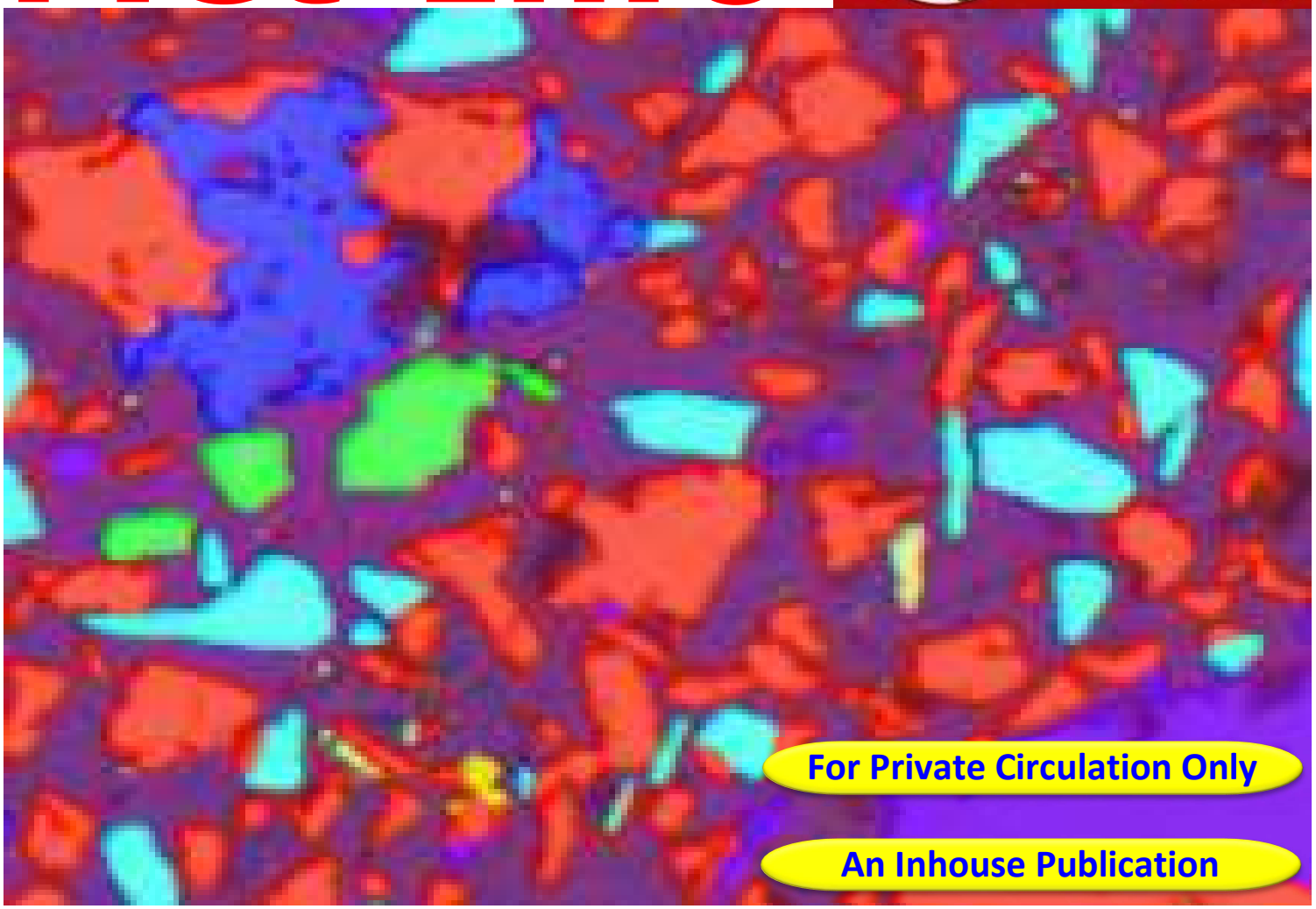

The Indian Institute of Metals
Delhi Chapter

Jawahar Dhatu Bhawan
39, Tughlakabad Institutional Area, M B Road
Near Batra Hospital, New Delhi-110062

E-mail: iim.delhi@gmail.com

Visit Us: www.iim-delhi.com

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Editor-in-Chief: S C Suri
Associate Editor: S.K. Varshney

IIM Delhi Chapter Executive Committee: 2024-25

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Executive Committee Members: Contact Details

Name / Designation	Affiliation	Contact No /E-Mail
Shri R K Vijayavergia ***Chairman***	Consultant Steel Research & Technology Mission of India	9650155544 rkv.sail@gmail.com
Shri Deepak Jain ***Vice Chairman***	Former Dy. Director General (W) BIS	9868640986, 8368622619 deepakjain7177@gmail.com
Shri K R Krishnakumar ***Hon. Secretary***	Consultant Ministry of Mines	9818277840; 01202773861 kuduvak059@gmail.com
Shri Ramesh Kumar Narang ***Hon. Treasurer***	Consultant Odisha Coal & Power Ltd	9899298857 rknarang62@gmail.com
Shri M P Sharma ***Hon. Jt. Secretary***	Scientific & Technical Consultant Aluminium Industries	9212202084; 9818508300 aluminiumconsultant@yahoo.com aflmps@rediffmail.com
Shri B D Jethra ***Member***	Former Adviser Planning Commission	9818326878 jethra@yahoo.com
Shri K L Mehrotra ***Member***	Ex CMD MOIL	9810203544;klm91048@gmail.com klmehrotra48@gmail.com
Shri K K Mehrotra ***Member***	Ex CMD MECON Limited	9868112514; 01203645267 kishorekmehrotra@gmail.com
Shri Manoranjan Ram ***Member***	Vice President, Head of Sales & Marketing Danieli Group	99100149989 manoranjanram@yahoo.com m.ram@danieli.com
Shri N K Kakkar ***Member***	Former Vice President Somani Kuttner India Pvt. Ltd.	9871008505 nirmalkakkar@gmail.com
Dr. Ramen Datta ***Member***	Consultant Steel Research & Technology Mission of India	9958084110 dattaramen@gmail.com
Shri N Vijayan ***Member***	Director Technotherma India Pvt. Ltd.	9818695690 technothermaindia@gmail.com
Shri G I S Chauhan ***Member***	Former ED I/c, RDCIS, SAIL	9717302437; 7048993116 gisc.delhi@gmail.com
Shri Ram Gopal ***Member***	Former ED SAIL	9968605059 ramgopal.sail@gmail.com
Dr. Rahul Sharma ***Member***	Director India International Zinc Association	9910299297 rsharma@zinc.org
Shri Anil Kumar ***Member***	Ex Tata Steel	7763807077 kvsa2009@gmail.com
Prof. Nitya Nand Gosvami ***Member***	Associate Professor Dept. of Materials Science & Engineering, IIT Delhi	9958887964 ngosvami@iitd.ac.in
Prof. Suddhasatwa Basu ***Special Invitee***	FIPI Chair Professor IIT Delhi	7838134181 drsbasu@gmail.com
Dr. Mukesh Kumar ***Special Invitee***	Sr. Adviser JSP Group	9650080849; 9584032329 drmukeshkumar@gmail.com
Shri R K Sinha ***Special Invitee***	Ex Director (Operations) Modern Steels Ltd	8968684955 rksinha555@gmail.com
Shri R K Singhal ***Invitee***	Consultant Steel Research & Technology Mission of India	9910055630 rksh.singhal@gmail.com
Er Sushil Kumar Varshney ***Invitee***	Director/CEO Academy of Industrial Management Delhi	9312672831 acadim@gmail.com
Shri B R Jain ***Invitee***	Sr. Adviser Engineering Council of India	9313190011 jainbinay@gmail.com
Shri Ashok Kumar Khatri ***Invitee***	Director Technotherma India Pvt. Ltd.	9818695689 ashokkhatri10@gmail.com

Lanthanide Metals: Definition, Properties, Uses, and Types

The lanthanides are a particularly important group of materials, constituting the f-block of the periodic table. They're often referred to loosely as ***rare-earth metals***.

Lutetium is often included in the group, despite being a d-block transition metal, as it has common properties with the lanthanides. Thus there are either 14 or 15 members of the group, depending on definitions, with atomic numbers ranging from 57 to 71.

Key properties of lanthanides include: ***elevated melting points, unusual blends of magnetic properties, and remarkable luminescence*** that finds various scientific and industrial uses. These elements are exploited for purposes like: electronics, catalysis, and renewable energy technologies.

This article discusses lanthanide metals to include their properties, uses, types, advantages, and disadvantages.

What Are Lanthanides Metals?

Lanthanides are a group of metals with their characteristics critical to a range of high-tech applications. Much of the commonality stems from the lanthanide elements' common electron configurations, resulting in shared chemical behaviours. Their high melting points, useful magnetic properties, and notable luminescence make them crucial across many technical sectors. They find applications in electronics, catalysis, and renewable-energy-related technologies.

Properties of Lanthanide Metals

Lanthanides possess distinctive properties. Listed below are some of the most significant:

1. High Melting Points

Lanthanides exhibit notably high melting points, ranging from around 700 °C for cerium to over 1900 °C for lutetium. This behavior stems from their unusually strong metallic bonds which require substantial energy input to overcome. The melting points vary within the lanthanide series based on specific atomic size, electron configuration, and crystal structure. This makes lanthanides suitable for

applications that must withstand high temperatures, such as in aerospace, nuclear reactors, and high-temperature manufacturing processes.

2. Metallic Conductivity

Most lanthanides exhibit relatively poor electrical conductivity compared to other metals. Their partially filled f-orbits hinder the free mobility of electrons. However, the conductivity of cerium and europium can be tuned under certain conditions, such as in specific atomic lattice structures or the presence of dopant impurities. This variability in conductivity across the series makes them valuable for specialized applications in electronics, magnetic devices, and lighting technologies.

3. Stable +3 Oxidation State

The stable +3 oxidation state is a generalized feature of the group resulting from the covalent satisfaction of their 4f orbitals. The +3 oxidation state arises due to the loss of three valence electrons, resulting in a very stable electron orbit configuration. This stability makes lanthanides valuable as organic reaction catalysts, it facilitates fluorescence in some electric lights, and it is related to the ferromagnetic behavior of neodymium and samarium.

4. Lanthanide Contraction Influences Atomic Sizes

“Lanthanide contraction” is a phenomenon that dictates the atomic sizes of elements in the series. Electrons in the 4f orbital shield the nuclear charge less than other orbitals. It causes the overall atom to be more compact than you might otherwise expect based on trends within the periodic table. Despite the addition of more electrons as the atomic number increases, the increasing nuclear charge pulls the outer electrons closer to the nucleus. This phenomenon greatly affects lanthanide elements’ reactivity, coordination chemistry, and bonding behavior.

5. Uniform Atomic Radii

Contrary to the typical trend of atomic radii increasing as the atomic number rises, lanthanides exhibit nearly uniform atomic radii across the whole group. This occurs as a direct result of the filling of 4f orbitals, which have poor shielding effects. The consequence of this is that their atomic size barely increases across the series. This effect is distinct from all other elements on the periodic table.

6. Varied Magnetic Properties

The unusual electron configurations of lanthanides make for a wide-ranging set of magnetic properties. Gadolinium exhibits strong paramagnetism, while cerium and praseodymium possess weak paramagnetism. On the other hand, dysprosium and neodymium display strong ferromagnetic behavior, particularly at low temperatures. These variations stem from the complex interactions between the electron spin configurations of lanthanide atoms. The range of behaviors means lanthanide materials get used for many different purposes in devices like magnetic storage devices and magnetic resonance imaging (MRI) systems.

7. Luminescence in Europium and Terbium

Europium and terbium are particularly important for their luminescent properties, in the form of phosphors. Europium emits red luminescence, while terbium emits green — both when excited by ultraviolet light. These elements are extensively utilized in applications such as: fluorescent lamps, cathode ray tubes, and television screens. Their luminescent properties enable efficient lighting devices. Additionally, they are crucial components in the production of luminescent materials for use in security features, optical devices, and biomedical imaging.

8. Diverse Applications Due to Unique Electronic Configurations

The many uses for lanthanides stem from their unique electronic configurations, which equip them with a wide range of behaviors and properties. Lanthanides' partially filled f-orbitals allow for complex interactions with electromagnetic fields and ligands. This characteristic leads to their utilization in fields such as: magnets used for data storage and electric motors, phosphors for fluorescent lamps, LEDs, CRT screens, catalysts in numerous chemical reactions, and MRI scans.

Distinctive Chemical Properties of Lanthanide Metals

The distinctive chemical properties of lanthanide metals include:

1. They all have related outer electron configurations. This results in generally comparable chemical behaviors.

2. They tend to form coordination compounds (useful for dies, pigments, and catalysts) with high coordination numbers. This is due to the elevated

availability of their valence f-electrons for bonding and high affinity for ligands.

3. They commonly exhibit stable +3 oxidation states, resulting in the formation of trivalent compounds.

4. Many lanthanides are paramagnetic, meaning they are weakly attracted to magnetic fields due to the magnetically polarizing effect of their unpaired electrons.

Lanthanides Often Found in Low Concentration in the Earth's Crust

Yes, lanthanides are typically found in relatively low concentrations, though they're more widely distributed in the Earth's crust than many other elements. Despite falling into the category known as rare-earth elements, they are not particularly rare. However, their wide dispersal and generally low concentrations make their extraction and purification challenging and costly. Large volumes of low-grade ore must be processed to acquire reasonable amounts of the elements. Lanthanides are primarily obtained from rare-earth mineral ores, which require extensive processing to isolate the sought-after elements.

Uses of Lanthanide Metals

Lanthanide metals find diverse applications due to their unique mix of properties.

1. They serve as catalysts in a wide range of industrially important chemical reactions, enhancing reaction rates and selectivity in high-value processes.

2. These metals, particularly neodymium and samarium, are critical in the production of high-strength permanent magnets used in motors, generators, and magnetic resonance imaging (MRI) machines.

3. Lanthanides form phosphors that are useful in fluorescent lamps, LEDs, and various other lighting applications. They produce specific colors more efficiently than other materials. This includes the neodymium in **NdYAG lasers**.

4. They are added to glass and ceramic materials to improve both transparency and strength. They can also improve IR absorption and alkali resistance.

5. Some lanthanide isotopes are used in nuclear reactors for neutron capture and shielding purposes, absorbing larger numbers of neutrons per unit area than most other potential shield materials.

6. Lanthanides are utilized in electronics, including: lasers, semiconductors, and superconductors, to enhance performance and efficiency in both electrical and optical emission characteristics.

What Industry Uses Lanthanides Metals?

Some industries that use lanthanide metals are:

1. Electronics
2. Automotive
3. Catalysis
4. Lighting
5. Renewable energy
6. Glass and ceramics
7. Aerospace
8. Defense
9. Medical devices
10. Telecommunications

Can Lanthanides and Ferrous Metals Serve the Same Industrial Purposes?

Yes, both lanthanides and ferrous metals show up in thousands of processes and products. There is nearly zero overlap in applications, however. The only area in which there is some degree of interchangeability between the two groups is in advanced magnetic applications, where some lanthanides' magnetic properties can complement those of ferrous metals.

Different Type of Lanthanide Metals

The different types of lanthanide metals are listed and discussed below:

1. Cerium (Ce)

Cerium is a chemical element with the symbol Ce and atomic number 58. It is a soft, silvery metal and is the most abundant of the rare-earth elements. Cerium is widely used in catalytic converters, glass manufacturing, and as a polishing agent in various industries.

2. Europium (Eu)

Europium is a chemical element with the symbol Eu and atomic number 63. It is a rare-earth metal with a silvery-white appearance. Europium is notable for its ability to emit red fluorescence under certain conditions, making it a useful phosphor for fluorescent lamps and television screens, as well as in security features for banknotes.

3. Neodymium (Nd)

Neodymium is a chemical element with the symbol Nd and atomic number 60. It is a rare-earth metal that is commonly used in powerful permanent magnets, particularly in applications such as: electric motors, headphones, speakers, and magnetic resonance imaging (MRI) machines. Neodymium magnets are known for their exceptional strength and stability.

4. Ytterbium (Yb)

Ytterbium, with the symbol Yb and atomic number 70, is a rare-earth metal used in various applications, including: laser technology, atomic clocks, and medical imaging. Its unique properties, such as its ability to absorb and emit light, make it valuable in telecommunications, research, and industrial processes. Ytterbium compounds also have potential pharmaceutical applications.

5. Terbium (Tb)

Terbium — symbol Tb and atomic number 65 — is a rare-earth metal used in green phosphors for CRT screens and energy-efficient fluorescent lamps. It's also utilized in solid-state devices, lasers, and nuclear reactors. Terbium compounds have applications in magneto-optical recording, sensors, and as dopants in materials for electronic devices.

6. Praseodymium (Pr)

Praseodymium — symbol Pr and atomic number 59 — is a rare-earth metal used in high-strength magnets — particularly in hybrid vehicle motors and wind turbines. It's also employed in carbon arc lighting, as a component in rare-earth alloys for improved strength, and in certain types of glass for optical filters.

7. Dysprosium (Dy)

Dysprosium, with the symbol Dy and atomic number 66, is a rare-earth element used in permanent magnets for electric vehicles and wind turbines due to its high magnetic strength and stability at high temperatures. It's also used in nuclear reactor control rods, lighting applications, and as a component in certain alloys.

8. Gadolinium (Gd)

Gadolinium is a rare-earth element withthe symbol Gd and atomic number 64. Its unique magnetic properties make it valuable in magnetic resonance imaging (MRI) contrast agents. Additionally, gadolinium is used in electronics and as a neutron absorber in nuclear power plants for controlling the rate of fission reactions.

9. Erbium (Er)

Erbium — symbol Er and atomic number 68 — is a lanthanide metal primarily used in optical fiber amplifiers for telecommunications. Its ability to efficiently amplify light signals in optical communication systems is crucial for long-distance transmission. Erbium-doped fiber amplifiers (EDFAs) are vital components in modern telecommunications networks, enhancing signal strength in fiber-optic communication systems.

10. Holmium (Ho)

Holmium — symbol Ho and atomic number 67 — is a lanthanide metal that's used in nuclear control rods due to its high neutron-absorbing capacity. Additionally, holmium finds use in medical lasers for surgical procedures and as a component in certain magnetic alloys for electronic devices.

11. Lutetium (Lu)

Lutetium — symbol Lu and atomic number 71 — is the heaviest member of the lanthanide series. It's utilized in various applications, including medical imaging and cancer therapy due to its ability to emit gamma rays. Lutetium compounds are also employed in catalysts and as dopants in phosphors for LED lighting and displays.

12. Promethium (Pm)

Promethium, with atomic number 61 and symbol Pm, is the only lanthanide without stable isotopes. Due to its radioactivity, it finds niche applications in nuclear batteries, thickness measurement devices, and luminous paint. However, its scarcity and radioactivity limit widespread use, relegating it primarily to specialized fields like aerospace and military applications.

13. Samarium (Sm)

Samarium has the atomic number 62 and symbol Sm. Its compounds are employed in magnets, lasers, and nuclear reactors. Samarium-cobalt magnets are notable for their high magnetic strength and resistance to demagnetization, making them valuable in the aerospace, automotive, and electronics industries. Additionally, samarium is used in cancer treatment and as a neutron absorber in nuclear reactors.

14. Thulium (Tm)

Thulium — atomic number 69 and symbol Tm — is a lanthanide metal used primarily in research and specialized applications. Its compounds are employed in laser systems for medical and industrial purposes, such as medical imaging and material processing. Thulium-doped fibers are also used to amplify optical signals in long-distance communication networks.

15. Lanthanum

Lanthanum is a soft, silvery-white metallic element of atomic number 57 and the periodic table symbol La. It belongs to the lanthanide series of the periodic table and is one of the rare earth elements. Lanthanum has various industrial applications, including rechargeable batteries, catalysts, and optical spectrum lenses as a minor component (along with others) that improves optical clarity.

How To Choose Which Type of Lanthanides Metals To Use

The proper type of lanthanide for an application depends heavily on the project's specific requirements. Some typical steps to follow are:

1. Assess and understand the characteristic properties of each lanthanide element, such as: melting point, density, reactivity, and magnetic behavior, to determine which fits best with your application's demands.

2. Consider the availability and cost-effectiveness of the lanthanide metal. Some are considerably more affordable than others which may rule out otherwise attractive options.

3. Consider the chosen material's environmental impact, including extraction, processing, and disposal, to minimize the overall environmental footprint.

4. Ensure compatibility with other materials and components used in the application to avoid adverse reactions or secondary issues affecting performance.

5. Verify compliance with any relevant regulations and standards governing the use of lanthanide metal.

What Type of Lanthanides Metals Are Used for Magnets?

Neodymium and samarium are the two lanthanides used in high-strength, rare-earth magnets. While neodymium magnets are stronger, they corrode very easily, so their uses are limited. Samarium-cobalt magnets have 30% lower magnetic strength than neodymium types, but they are highly corrosion-resistant and offer better high-temperature performance.

What Type of Lanthanides Metals Are Used for LED Lighting?

Lanthanum, cerium, terbium, and europium are widely employed in LEDs. Cerium and terbium are additionally exploited as phosphors that enhance color rendering and brightness. Europium goes into red phosphors, while lanthanum is used in blue and green sources. They can all efficiently convert electrical energy into visible light, putting them at the heart of LED lighting technology.

What Type of Lanthanides Metals Are Used for Catalysts for Petroleum Refining?

Cerium and lanthanum are commonly used as catalysts for petroleum refining. Cerium-based catalysts aid in various refining processes such as fluid catalytic cracking (FCC) and hydrocracking. Lanthanum-based catalysts are also utilized in FCC units to improve the selectivity and efficiency of the cracking reactions. They serve pivotal roles in the production of high-quality fuels and petrochemicals through these catalytic processes.

Advantage of Using Lanthanide Metals

The specific advantages of lanthanide use depend on the purpose and the particular element. As a general rule, lanthanides possess unique electronic configurations that make them valuable in technological applications such as: electronics, optics, and catalysis. Secondly, their distinct chemical properties make many of them notable: luminescence, magnetism, and catalytic activity. Additionally, lanthanide metals are crucial components in the development of advanced materials and technologies due to their exceptional performance under extreme conditions. Moreover, the difficulty in sourcing and refining these elements highlights their importance as strategic resources, driving efforts to optimize their extraction, recycling, and utilization for sustainable development.

Disadvantage of Using Lanthanide Metals

A major disadvantage of using lanthanides is their limited availability and complicated extraction. Recovering and refining these elements is expensive and creates significant pollution. Some lanthanides also exhibit toxicity risks if not properly handled, requiring careful management in manufacturing and disposal processes.

Do Transition Metals Also Have Magnetic Properties Like Lanthanide Metals?

Yes, many transition metals also exhibit magnetic properties, but these properties widely vary between elements based on their electronic configuration. Some transition metals, such as: iron, cobalt, and nickel, are well-known for their magnetic properties. Cobalt is used in cooperation with samarium in one type of high-strength magnet, while neodymium is paired with iron and boron for an even stronger one.

What Distinguishes Lanthanide Metals From Other Types of Metals?

Lanthanide metals are distinguished from other types of metals primarily by their electron configuration, which results in unique thermal, chemical, and magnetic properties. They belong to the f-block of the periodic table, so their 4f electron orbitals are not full. It gives them unique magnetic, luminescent, and other chemical properties.

Additionally, lanthanides exhibit lanthanide contraction, wherein the atomic radii decrease as the atomic number rises within the series. This contraction influences their chemical behavior and contributes to their distinct characteristics, setting them apart from other metal groups.

Are Lanthanides the Same as Actinides?

No, lanthanides and actinides are two distinct groups of elements on the periodic table. Lanthanides form a subgroup within the f-block of the periodic table, from lanthanum (La) to lutetium (Lu). Actinides are also found in the f-block but are located below the lanthanides, from actinium (Ac) to lawrencium (Lr).

While lanthanides and actinides share some similarities in their electronic configurations and properties, they are distinct subgroups with a considerable diversity of characteristics and applications.

Difference Between Heavy Metals and Lanthanide Metals

The primary differences between **heavy metals** and lanthanide metals are listed below:

1. Heavy metals are characterized by high atomic weights and densities. Examples include: lead, mercury, cadmium, arsenic, and chromium. Lanthanides specifically refer to the metallic elements in the lanthanide series of the periodic table, from lanthanum to lutetium.

2. Heavy metals are distributed across various groups on the periodic table, primarily in the transition metals and post-transition metals. Lanthanides are solely located in the f-block of the periodic table.

3. Heavy metals are often toxic to living organisms, both in metallic and reaction byproduct forms. They tend to concentrate in fatty tissues (including the central nervous system) and have insidious long-term effects on health, cognitive ability, and life expectancy. Lanthanide metals were classically not considered toxic and remain common in various industrial, medical, and technological applications. A range of toxic effects are now suspected, however, and this is a matter of current research.

Source: Xometry, April 26, 2024

DRI-fed EAF Route: Capitalizing HDRI Energy Value with the Ecobelt® DRI Conveyor

Achieving net-zero emissions in the steel industry requires bold innovation and fundamentally reshaping steelmaking processes. The DRI-fed EAFs route is emerging as a promising solution for reducing emissions and meeting the growing demand for top-tier steel products. Magaldi, leveraging its expertise in challenging, high-temperature applications, has developed a viable and environmentally sound alternative to traditional technologies for transporting hot DRI (HDRI) from the reactor discharge to the melt shop, capitalizing on the energy value of the HDRI in the EAF.

A sustainable future through the DRI-fed EAF route

While increasing the use of steel scrap can help decarbonize current crude-steel production routes, it falls short of a comprehensive solution. Steel demand continues to outstrip recycled supply, and available scrap may not meet industry standards. To bridge this gap sustainably, many steel companies are turning to DRI and electric melters.

Steel producers have two main options for integrating reduced iron into their processes: sending hot DRI directly to the EAF or feeding the melters with briquetted iron. However, briquettes require more energy per ton to melt compared to HDRI – about 100 to 150 additional kWh/tLS. Therefore, the integrated HDRI process stands out for its cost-efficiency and higher productivity. This suggests that an increase in DRI production is expected to be a key trend driving the growth of the global EAFs market.

The Ecobelt® DRI conveyor for integrated HDRI process

In recent years, reductions in CO_2 emissions have come largely from the quest for more sustainable energy sources, primarily green hydrogen, to produce DRI. However, there are further opportunities for efficiency improvements connected to the DRI handling process.

Driven by its commitment to innovation and backed by extensive experience in handling hot materials under challenging conditions, Magaldi has developed a

viable alternative to conventional technologies for transporting and charging HDRI.

The Ecobelt® DRI conveyor is the only fully enclosed conveyor of its kind for HDRI transportation from the direct reduction furnace to downstream processes, including the cooling station, briquetting machine, or EAF meltshop. Equipped with a thermally insulated cover, the conveyor system operates under an inert gas atmosphere that helps maintain the DRI's integrity during transportation while improving the downstream melting process and overall EAF productivity. In particular, the Ecobelt® DRI conveyor offers:

- **HIGH DEPENDABILITY AND UPTIME**

  The redundant patented mesh system ensures continuous trouble-free transportation of HDRI, eliminating the risk of interruption or delay that could result in a loss of quality and efficiency for the entire plant.

- **HIGH-TEMPERATURE RESISTANCE**

  Designed to withstand temperatures of up to 1100 °C (2,012 °F) without warping or deforming, the Ecobelt® DRI conveyor remains robust even when conveying DRI at temperatures ranging from 700 °C to 950 °C (1,292 °F to 1,742 °F). This eliminates the risk of equipment damage or costly process shutdowns due to hot spots in the DRI on the conveyor belt.

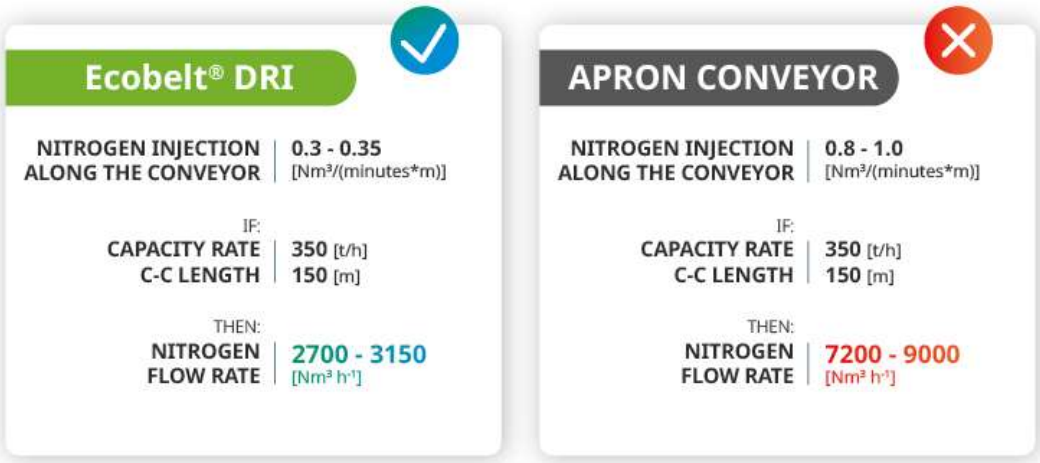
- **LOW THERMAL DROP**

  With the Ecobelt® DRI conveyor, HDRI can be transported and charged to the EAF at up to 700 °C (1292 °F), capitalizing on sensible heat. Hot charging helps reduce the cost per ton of liquid steel by lowering power and electrode consumption, and tap-to-tap cycles while boosting EAF productivity.

- **NO REOXIDATION AND EXTREMELY LOW NITROGEN REQUIREMENTS**

  The air seal provided by the full enclosure with an integrated inert gas system ensures that oxygen is kept out. This minimizes the risk of re-oxidation and preserves the high metallization level of the conveyed

material, thereby enhancing product quality and energy efficiency. But what sets the Ecobelt® DRI apart from conventional technologies is its lower nitrogen injection along the conveyor: just one-third of the requirements of conventional technologies.



- **EFFECTIVE DUST CONTAINMENT**

  Unlike pneumatic transport systems, the Ecobelt® DRI conveyor greatly reduces HDRI fines generation. The high velocity and resultant turbulence in pneumatic systems can cause significant breakage and erosion of the HDRI, resulting in fines generation of up to 8-10%. Moving slowly and smoothly, the Ecobelt® DRI conveyor overcomes such drawbacks while the full enclosure ensures that no dust is emitted from the conveyor and no spillage is generated underneath.

- **LOW MAINTENANCE**

  Designed for low maintenance requirements, the Ecobelt® DRI conveyor is devoid of chains, wheels, or sprockets. Only the head and tail pulley bearings and return idler bearings require lubrication. The upper idlers and rollers are lubricated for life, and other elements are designed for continuous operation, allowing for preventive maintenance on a multi-year

schedule.

- **GREAT FLEXIBILITY**

  The Ecobelt® DRI is available as a pan plate or bucket conveyor to address challenging geometries of up to 75 degrees while transporting materials ranging from fine-grained to lumpy. This adaptability makes it suitable for various process requirements.

The Ecobelt® DRI conveyor represents a leap forward in sustainable steelmaking within the DRI-fed EAF route, offering a robust solution to the challenges posed by this pathway. With its array of benefits and innovative design, it paves the way for a greener, more efficient future in the steel industry.

Source: Weekly news from Steel Times International May 15, 2024,

Steel Prices Trade at 3-year Lows on Increased Supplies

Steel prices in India have plummeted to a three-year low, with hot rolled coils and cold rolled coils trading significantly lower than their April 2022 peaks. This drop has been primarily attributed to a 68% increase in imports during the April-June quarter. Industry players have raised concerns with the government for protective measures.

HRC coils prices have fallen to Rs 51,000 a tonne from a peak of Rs 76,000 a tonne in April 2022.

he rate of cold rolled coils (CRC) is trading at Rs 58,200 a tonne from the peak of Rs 86,300 a tonne in April 2022 (excluding the 18 per cent GST).

According to the data, imports during the April-June quarter surged by 68 per cent to 1.93 million tonnes (MT) from 1.15 MT in the same period of 2023-24. Steel imports rose by 38 per cent to 8.319 MT in 2023-24, making India a net importer of the commodity.

Source: Economic Times Whatsapp channel

India Steel Production to Cross 300MT by 2030

Domestic steel production is likely to cross 300 million tonnes by 2030. Steel Ministry does not foresee any hurdles in capacity addition due to decarbonisation efforts in the steel sector and will soon release a draft roadmap seeking public opinion to reduce carbon foot print in the steel sector, which accounts for 12 per cent of total emissions.

The current steel demand remains strong with infrastructure push from the government and expecting a growth of about 10 per cent. The GDP is also growing robustly, and with continued emphasis on infrastructure from both government and private sectors, steel demand will continue to stay strong.

From January to April 2024, steel production was 49.5 million tonnes, a jump of 8.5 per cent.

Finished steel output during 2023-24 was 138.5 million tonnes, up 12.4 per cent year-on-year. To achieve 300 million tonnes of installed capacity, a CAGR of 12 per cent would be required.

Some steel makers were not reporting production and sales data accurately, and the ministry feels there are gaps. The steel makers complain of several headwinds like iron ore shortage, cheap steel imports and policy shortcomings.

The government had set up 14 task forces on this and, after inter-ministerial discussions, the report will be released for public feedback soon. The roadmap focuses on increased hydrogen use in the steel industry and carbon capture, among others. The short-term target for the government aims at about a 20 per cent reduction in carbon intensity. Currently, the average carbon intensity is 2.5 tonnes per tonne of steel production.

A consortium has been planned with labs, IITs, primary and secondary steel makers, and equipment makers to develop indigenous green technology.

Jindal Stainless to Supply High-end Stainless Steel to BrahMos Aerospace

Jindal Stainless announced that it will produce customized stainless steel and specialty low-alloy steel sheets for BrahMos Aerospace's defence projects. The company has been accredited as a qualified vendor for manufacturing and supplying steel plates from its Hisar plant in Haryana. Jindal Stainless MD Abhyuday Jindal emphasized the company's commitment to making India self-reliant in its defence sector.

Jindal Stainless has previously supplied materials for key projects under the **DRDO** and **Isro**, including India's lunar mission Chandrayaan, PSLV, GSLV Mk3, nuclear submarine missile system, missile canisters for various missile programmes, and exhaust units in rockets.

The company recently developed and supplied 3 mm special alloy steel sheets for the Supersonic Missile-Assisted Release of Torpedo (SMART) system.

Source: Economic Times Whatsapp channel

JSW Steel Boosts Global Footprint with $120 million Deal for 66.67% Economic Interest in Australian Mining

In a significant move to bolster its international presence, JSW Steel Limited announced a strategic investment in the Australian mining sector. The company's Board of Directors, in a meeting held in August, 2024, approved the acquisition of up to 66.67% economic interest in M Res NSW HCC Pty Ltd The investment, amounting to US$ 120 million, will be executed through JSW Steel's wholly-owned subsidiary, JSW Steel (Netherlands) B.V., Securing raw materials and optimising costs are critical strategic priorities for JSW Steel, and this acquisition marks a significant step toward achieving these goals.

Res NSW, holds a 30% stake in Golden M NSW Pty Ltd ("Golden M"). these mines are key assets, with total marketable reserves of approximately 99 million tons

Source: Economic Times Whatsapp channel

ArcelorMittal Trials New Carbon Dioxide Conversion Technology

ArcelorMittal and Mitsubishi Heavy Industries (MHI) are working with D-CRBN, a climate tech company, to trial a new technology to convert carbon dioxide (CO_2) captured at ArcelorMittal's plant in Gent, Belgium into carbon monoxide which can be used in steel and Chemical Production.

According to ArcelorMittal, this is the first industrial testing of D-CRBN's plasma technology, making ArcelorMittal Gent the first steel plant in the world to trial the process, which has been designed to reduce CO_2 emissions.

The new trial expands the current multi-year carbon capture pilot taking place at the site to test the feasibility of full-scale deployment of MHI's carbon capture technology (the Advanced KM CDR Process).

D-CRBN is an Antwerp-based company that has developed a technology using plasma to convert carbon dioxide into carbon monoxide. Using renewable electricity, the plasma is used to break the carbon-oxygen bond, thereby converting CO_2 into carbon monoxide, which can be used as a reductant in the steelmaking process – replacing part of the coke or metallurgical coal used in the blast furnace – or as a basic ingredient in Gent's Steelanol plant, for chemicals or alternative fuel production.

The D-CRBN process requires high-purity CO_2, which can be provided by MHI's carbon capture unit, currently being used to capture blast furnace off-gases, and off-gases from the hot strip mill reheating furnace, in Gent.

A pipeline between MHI's carbon capture unit and D-CRBN's unit was connected on 1st July, to test the feasibility of using the CO_2 captured by the MHI technology as a feedstock for D-CRBN. The industrial pilot is an important stage of testing D-CRBN's technology, to make sure that any impurities that accompany the CO_2 produced during steelmaking do not have a detrimental effect on the process and product gas.

ArcelorMittal is pursuing a number of decarbonization routes in order to achieve its climate targets, which include a 35% reduction in CO_2 emissions from ArcelorMittal Europe, by 2030. One of these routes is Smart Carbon steelmaking,

which uses circular carbon in the blast furnace, carbon capture and storage (CCS) or utilization (CCU).

This is unique carbon capture and usage trial in Gent, which is part of our strategy to develop the Smart Carbon steelmaking route in ArcelorMittal Belgium. ArcelorMittal Belgium team of engineers has worked hard with our partners to reach this stage – and we are thrilled that our new partner, D-CRBN, have created this new CCU technology here in Belgium."

Electrifying steel production is challenging, but D-CRBN's process, which recycles CO_2 emissions back into CO, offers a cost-effective and scalable solution. Our technology can electrify and decarbonize existing blast furnaces and significantly reduce their coal use. The conversion of CO_2 back into CO for steel production will limit the need for green hydrogen in the future and reduce the costs of emission-free products. Moreover, some of the CO produced can be supplied to neighboring chemical companies as feedstock.

CCUS will play a critical role in decarbonizing existing assets in the steel industry our collaboration with ArcelorMittal and D-CRBN in Belgium provides another tool for the industry to reduce its carbon footprint – capturing emissions, converting them into a valuable feedstock, and feeding them back into the process. This initiative demonstrates our commitment to sustainable practices and innovative solutions for a greener future.

ArcelorMittal, MHI, BHP and Mitsubishi Development Pty Ltd (Mitsubishi Development) announced in May 2024 that they had successfully started operating a pilot carbon capture unit on the blast furnace off-gas at ArcelorMittal Gent in Belgium. In October 2022, the four parties announced their collaboration on a multi-year trial of MHI's carbon capture technology (Advanced KM CDR Process) at multiple CO_2 emission points, starting at the Gent steelmaking site.

Source: Weekly news from Steel Times International, July 8, 2024

Tata Steel Meramandali Implements Coke Oven Gas Injection Technology in Blast Furnace

Tata Steel Meramandali, Odisha, India, has taken a significant step in its journey towards decarbonization by placing an order with SMS group for the implementation of Paul Wurth Coke Oven Gas (COG) Injection Technology at their Blast Furnace (BF) #1. Coke oven gas is a byproduct that forms during the production of coke from coal in coke ovens. This order marks a significant milestone, setting a precedent for the industry's move towards sustainable steel production.

aul Wurth COG Injection Technology is a breakthrough innovation that aims to reduce the coke rate and consequently the carbon footprint of the blast furnace operation. By utilizing the chemical potential of COG, the process can save around 0.65 kilogram of coke for each kilogram of COG injected, which considerably reduces the OPEX cost and significantly improves the CO_2 footprint. Paul Wurth's COG injection technology is designed to ensure the safe and reliable injection of the highly toxic and explosive COG into the blast furnace through the tuyeres using specialized lances.

The comprehensive scope of supply for this project includes plant engineering, supply of all process equipment including compressor station, electrics and automation ensuring an integrated approach to the implementation of this technology.

To optimize the supply of gas to the blast furnace, selection of adequate compressor technology as well as the control of the temperature range are crucial success factors to guarantee smooth operation of the plant. The advanced Paul Wurth automation system assures this smooth operation and at the same time, guarantees plant safety implementing for each injection line fully automatic flushing, flow monitoring and lance cooling.

The project is expected to be commissioned by Q1 2026 and will be completed within 25 months.

The implementation of this technology is not only a record-setting achievement for India but also a strategic move towards meeting the country's goal of net zero by 2070. As we lay the groundwork for a greener future, this collaboration with SMS group is not just a milestone for us but a beacon for the entire Indian steel industry. By adopting cutting-edge technologies like COG injection, we are not only reducing our carbon footprint but also setting a new standard in environmental stewardship while enhancing our operational efficiency and competitiveness in the global market."

Source: Green Steel World News Update, 13 June 2024

Vedanta Puts Steel Business Sale On Hold

Vedanta Ltd. has put a plan to sell its steel business on hold after a $1 billion share sale gave the company more breathing room with its finances, and as environmental and regulatory concerns deter potential bidders, according to people familiar with the matter.

Mumbai-headquartered Vedanta had been working with advisers on a sale of the business, which includes iron-ore and manganese mines, to raise about $2.5 billion to help reduce the group's debt load.

Vedanta's billion-dollar fundraising through a share placement last month has eased some of the debt pressure and reduced the need to sell. The company may revisit a sale later, without disclosing any specific environmental or regulatory concerns surrounding the steel business.

Vedanta entered the steel business in 2018 when it bought a 90% stake in ESL Steel Ltd., which has operations in Bokaro, in eastern India's Jharkhand state. Its products include pig iron, billets, TMT bars, wire rods and ductile iron pipes, the company's website shows.

Considerations for a sale followed Vedanta's board approving a plan last year to split the conglomerate into six different companies. Vedanta said at the time the demerger should be completed this financial year through March 2025.

Vedanta's net debt was 613.2 billion rupees ($7.3 billion) as of the end of June, up 8.8% from the previous quarter. For its steel business, saleable production was up

10% from a year earlier at 356 kilotons thanks to improved efficiency, the company said. Overall net profit easily beat estimates.

Source: Economic Times Whatsapp channel

UK Govt Open to Investing More If Tata Steel Builds Assets

Tata Steel UK's CEO, TV Narendran, revealed that the British government is willing to provide further funding if Tata Steel opens additional product lines to mitigate job losses. The company and government had previously agreed on a £1.25 billion investment to transition to an electric arc furnace, with the government contributing £500 million. The transition could make about 2,800 jobs redundant. Tata Steel is exploring additional investments in downstream operations, such as a steel galvanizing line or a scrap processing unit, which could be supported by the government to preserve jobs.

The government has been very positive, they are keen to get more investment and increase steel consumption in the UK.

Tata Steel and the UK govt had jointly agreed to transition to an electric arc furnace for an investment of 1.25 billion, for which the government would provide a grant of 500 million, with the rest being borne by the company. This transition is expected to make around 2,800 jobs redundant.

Ten Commandments for IIM Membership Development-Actions & Strategies

L. Pugazhenthy
Past President, The Indian Institute of Metals

1. From a membership level of 11071 during 2014-2015, the IIM Membership at present stands at 8412. What a decline for a 78 years old metals professional body, especially when the Indian metals sector has grown by leaps & bounds over the years.

2. IIM needs a greater visibility among the metals industry, including the downstream units. Therefore IIM needs immediately a massive, collective

outreach by all – President, Vice Presidents, Council Members, Chapter office bearers assisted by the IIM HQs. Anyone employed in the metals industry (Civil, Elect, Mech, Chemical Engg. etc.) can become a member of IIM and benefit from its activities and strategies.

3. From my personal experience, IIM Chapter office bearers and members always like to meet the President and the three Vice Presidents at the chapter levels too (besides meeting them at ATM and Council Meetings). Therefore as and when the four of them go to any Indian city or town for official or personnel reasons, it will be nice if they can spare some time to meet the local chapter office bearers over a lunch, dinner or coffee for mutual interactions. (I used to practice this during my Vice Presidentship as well as Presidentship and visited many chapters including Srinagar, Surathkal, Khetri Nagar, Coimbatore etc). This action will certainly motivate the Chapter office bearers a great deal for membership development and increased activities.

4. IIM President should also advise the Council Members to meet as many Chapter office bearers locally as well as nearby chapter office bearers as possible for bridging a meaningful relationship between the Council and the Chapters.

5. IIM HQrs should have a closer rapport with all the Chapters. IIM Secretary General should hold periodic video conferences with different Zonal Chapter office bearers so as to understand their genuine concerns for addressing them and also for extending supportive measures.

6. On their part, the Chapter office bearers should visit as many nearby Engg. Colleges, Research Labs, Schools etc. to inform them about IIM, its activities & services. (I have addressed students of Class 11 & 12 in several schools in and around Delhi to propagate our objectives and to encourage them to choose Metallurgy or Materials Engg. as a future career option).

7. From now on, Council should set an achievable membership target for the next 3 years alongwith appropriate strategies for achieving that target; periodic review is also required for fine tuning, if any.

8. The Joint Secy. attached to the President as well as the JSW team should persuade the downstream steel units in India for Donor Membership or Sustaining Membership. At the moment, the downstream steel sector is absent in IIM and hence this imperative action. Vice President (Non-ferrous) should also persuade nonferrous downstream units to join the IIM fraternity. These steps will also bring in more revenue to the IIM as a whole.

9. We need to bridge the IIM-industry gap at the MSME level at the earliest. Chapter office bearers should visit and interact with the local MSME units involved in foundry, die casting, rolling, secondary steel production etc. for any technical assistance or support.

10. Every year IIM gives away several prestigious awards and unfortunately these awards are not at all known to many in the metals industry. Only well-known public and private companies attached to IIM for long keep getting the awards again and again. These awards are also given to many students and we need to communicate these awards among many colleges & technical institutions in the country.

Zero Duty to Boost Critical Minerals for Renewables

India has upped the ante in its critical minerals play, with government announcing full exemption of customs duty on 25 critical minerals, including lithium, cobalt, and rare earths, among others. The first-ever offshore mineral block auctions will also be undertaken.

Duty rates for several critical minerals like graphite, silicon quartz and silicon dioxide have also been slashed from 5-7.5 per cent to 2.5 per cent.

Critical minerals, the lynchpin of renewable energy and clean technologies, remain an elusive resource in India's transition to a low-carbon future.

Besides lithium and cobalt, antimony, beryllium, bismuth, gallium, germanium, hafnium, indium, molybdenum, niobium, nickel, potash, rhenium, strontium, tantalum, tellurium, tin, tungsten, vanadium, zirconium, selenium, cadmium and silicon (other than quartz and silicon dioxide) will attract zero custom duty.

This is expected to augment the availability of critical minerals by providing a fillip to the processing and refining sector.

Minerals such as lithium, copper, cobalt and rare earth elements are critical for sectors like nuclear energy, renewable energy, space, defence, telecommunications, and high-tech electronics. "I propose to fully exempt customs duties on 25 critical minerals and reduce BCD (basic custom duty) on two of them. This will provide a major fillip to the processing and refining of such minerals and help secure their availability for these strategic and important sectors.

Sustainability-focused organisation's 2023 report had highlighted the vulnerabilities and opportunities in the global critical minerals supply chain. "Indigenising and overseas acquisition of mining and building domestic capabilities (for process and recycle) will secure the supply chain for the domestic manufacturing ecosystem, especially for clean energy sectors such as solar, wind, EV and batteries.

Source: The Hindu Businessline, July 23, 2024

Recycling and a Treasure Trove of Critical Minerals

With auctions of critical mineral blocks in India having met with a lukewarm response, will recyclers prove to be a crucial set of urban miners who will help meet the demand for cobalt, lithium, and nickel in the country?

It is learnt that a legislation is in the pipeline to address the serious shortage of critical minerals for the manufacture of Lithium-ion (Li-ion) batteries and other electronic devices. In all likelihood, the move will take the form of a productivity linked investment (PLI) scheme for the recycling of critical minerals in the country.

This will help create a circular economy and give a fresh incentive to recyclers to extract the maximum secondary metals from end-of-life lithium-ion batteries.

The Global E-waste Monitor 2024 has cited figures which should serve as an eyeopener. In 2022, as much as 900 million primary ore extraction from the earth was avoided globally by reclaiming materials through documented recycling. The value of metals embedded in 2022 e-waste included $19 billion worth of copper, $15 billion in gold and $16 billion in iron. The value of secondary raw materials

reclaimed from e-waste was $28 billion. In addition to this, 93 million tonnes of CO_2 emissions were avoided by formal e-waste management. And all this, when only 23 percent of the global e-waste was formally recycled.

PLI Scheme

Closer home, India's PLI scheme may well boost the extraction from end-of-life batteries and reduce its need to import critical minerals. "India does not have reserves of critical minerals, and this is a step in the right direction. Why pay taxpayers money for importing?".

Recycling as a methodology has a larger agenda and that incentives should be given to companies that have good efficiency and a rate of extraction that is 90 percent or so. Attero's patented technology gives it an extraction efficiency of 98 percent. "The companies must be technologies advanced and be able to match the top quality. Besides, those who have developed the extraction technology in India must be given more brownie points.

Energy-Efficiency

Bengaluru-based MiniMines, a fledgling start-up, is one that has also developed its own technology. The founders hope that with an extraction efficiency of 96 percent, they too will be covered.

They have developed a water and energy-efficiency hybrid hydrometallurgy process to extract rare metals like lithium, cobalt, nickel and manganese from Li-ion battery waste. We have developed the technology from scratch and have taken it from lab unit to pilot unit and have been evaluated by Oil India Ltd and the United Nations Industrial Development Organisation. They hope that small players like them who cannot match the financials of large companies but have the efficiency also get a chance.

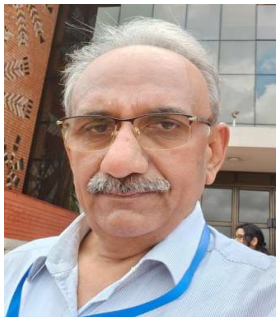
If companies are required to provide balance sheets for many years and show massive investments, we will not be able to fulfil the criteria. The incentive scheme should be fair to all.

MiniMines recently received a grant of $100,000 from ACT, a non-profit Indian venture philanthropy platform which is supporting ground-breaking, cutting-edge clean tech solutions and helping start-ups scale up. They apply venture capital principles to our grants and our investment committee does strict evaluation and due diligence before awarding a grant.

Meanwhile, experts feel that besides a PLI scheme, it would be pertinent for the government to consider mandating EV battery manufacturers under its Battery Waste Management Rules to use a percentage of secondary raw minerals in their new batteries and incentivise them for the same. This would be a further boost for recyclers and ensure that critical minerals extracted in India do not find their way into other countries, while India imports raw material. That would, no doubt, be a prudent move.

Source: The Hindu Businessline, July 21, 2024

Know Your Members



Shri Ram Gopal

Education profile

- Bachelor of Engineering from University of Roorkee (Now IIT , Roorkee) in 1981 in Metallurgical Engg.
- LLB in 2013 and LLM in 2019.
- Executive Program in Business and Corporate laws from IIM Kolkata in 2023

Work and Professional Experience

- Has about 39 year experience with SAIL, a Maharatna PSU in different plants/units.
- Has experience in various areas like Raw materials security including mines expansion , quality improvement and new mines opening projects.
- Has experience in production planning, logistics and services management, safety , Contract management. -Worked for commissioning, ramping up production and stabilization of new Units /Plants at ISP, Burnpur.
- Has been Chief Executive of CFP, the Ferroalloys production plant of SAIL at Chandrapur, Maharashtra.
- As Head of Materials Management at Corporate office at SAIL had experience in policy making and implementation, inventory management etc .
- For 28 years worked at Bokaro Steel plant in the area of Raw materials , logistics, technical support/services and contract management.
- About 3 years on Raw Materials Security of SAIL at corporate office and secured critical Environment clearances.
- About 4 years at IISCO Steel plant, Burnpur (WB) where we commissioned and stabilized the new units of most modern Steel Plant of SAIL.
- For 2 years. On expediting the projects of SAIL at corporate office planning projects and sorting out technical and commercial issues.
- Has been Director on Board at NSPCL, a joint venture company of SAIL and NTPC.
- Life member of Indian Institute of Metals , and
  Life member of Indian Institute of Materials Management and National Councilor.
- Member of Supreme Court Bar Association, and Member of Delhi High Court Bar Association

Contact details

Mob. No. 9968605059
E-mail: ramgopal@gmail.com