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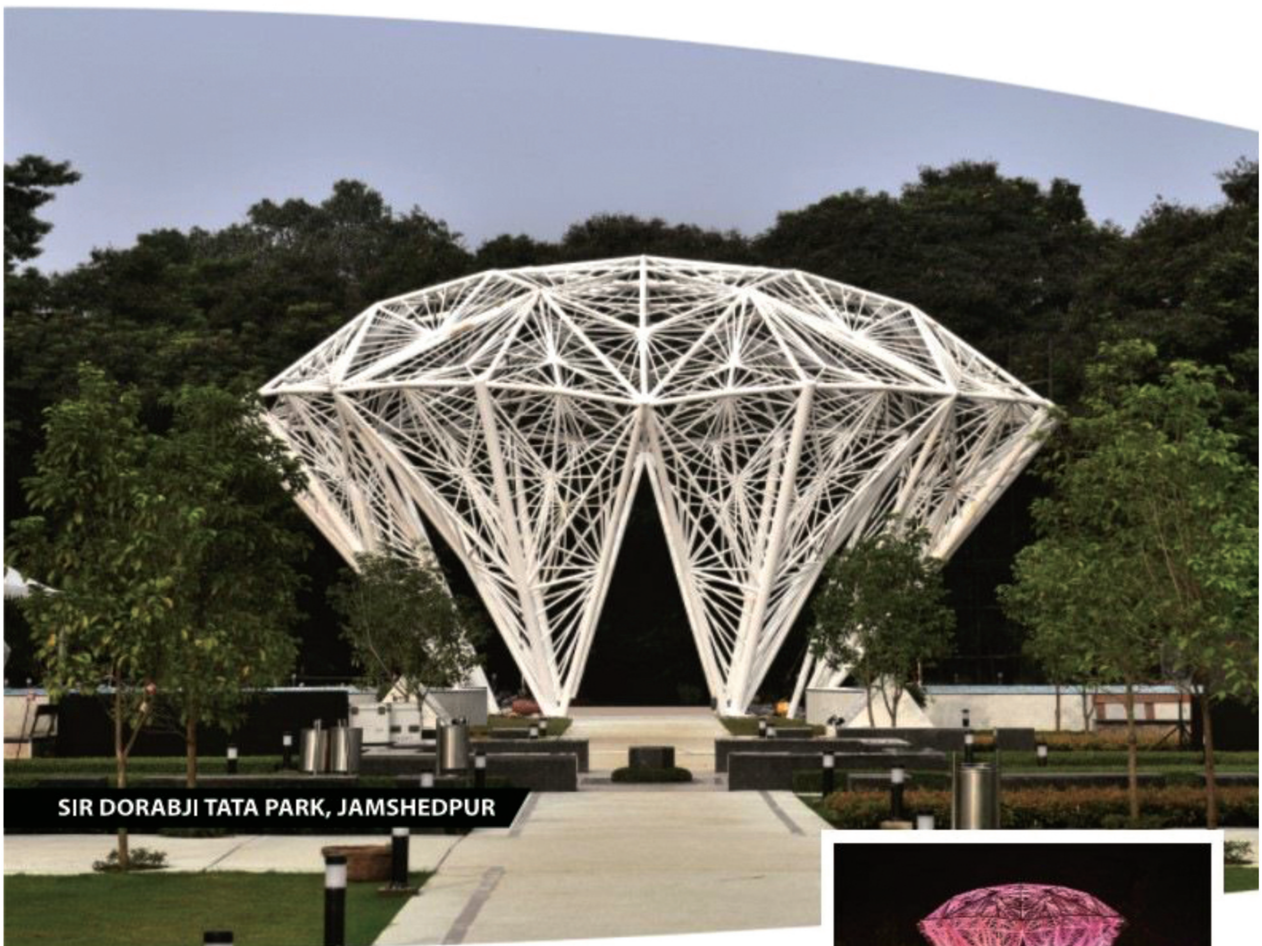
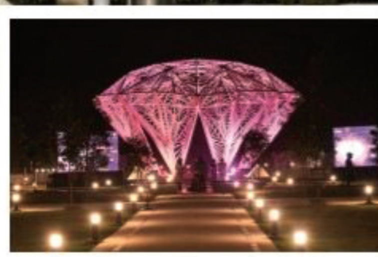
IIM METAL NEWS

A monthly publication of The Indian Institute of Metals

TATA STEEL
#WeAlsoMakeTomorrow

TATA





A JEWEL CRAFTED IN STEEL, BUILT FOR TOMORROW

The Jubilee Diamond sculpture is fabricated from 45MT of Tata Structura steel hollow sections. The superior strength-to-weight ratio of Tata Structura makes it flexible enough to craft imaginative designs in steel - a material of choice for architects who shape tomorrow. The open plan architecture of this stunning monument allows visitors an immersive experience. The sculpture celebrates the contribution of Sir Dorabji Tata and his wife Lady Meherbai Tata to the Company in the 1920s. Sure, we make steel.

But **#WeAlsoMakeTomorrow**.

Building today's monuments for a more beautiful tomorrow

Jubilee Diamond, Jamshedpur

Crude Steel production by region

	Apr 2023 (Mt)	% change Apr 23/22	Jan-Apr 2023 (Mt)	% change Jan-Apr 23/22
Africa	1.3	4.8	5.0	-0.8
Asia and Oceania	121.1	-1.5	467.5	2.3
EU (27)	11.1	-11.7	44.4	-10.2
Europe, Other	3.5	-17.3	12.9	-18.8
Middle East	4.2	4.2	14.3	1.9
North America	9.2	-4.6	36.2	-3.8
Russia & other CIS + Ukraine	7.5	5.9	28.9	-7.9
South America	3.6	-2.2	13.6	-5.6
Total 63 countries	**161.4**	**-2.4**	**622.7**	**-0.3**

The 63 countries included in this table accounted for approximately 97% of total world crude steel production in 2022. Regions and countries covered by the table:

- **Africa:** Egypt, Libya, South Africa, Tunisia
- **Asia and Oceania:** Australia, China, India, Japan, Mongolia, New Zealand, Pakistan, South Korea, Taiwan (China), Thailand, Viet Nam
- **European Union (27)**
- **Europe, Other:** Macedonia, Norway, Serbia, Türkiye, United Kingdom
- **Middle East:** Iran, Qatar, Saudi Arabia, United Arab Emirates
- **North America:** Canada, Cuba, El Salvador, Guatemala, Mexico, United States
- **Russia & other CIS + Ukraine:** Belarus, Kazakhstan, Russia, Ukraine
- **South America:** Argentina, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela

Top 10 steel-producing countries

	Apr 2023 (Mt)	% change Apr 23/22	Jan-Apr 2023 (Mt)	% change Jan-Apr 23/22
China	92.6	-1.5	354.4	4.1
India	10.7	3.2	43.9	3.0
Japan	7.2	-3.1	28.9	-5.3
United States	6.6	-5.3	26.1	-4.1
Russia	6.4 e	1.9	25.1	-0.6
South Korea	5.7	3.0	22.4	-0.4
Germany	3.2	-3.8	12.4	-5.9
Brazil	2.8	-5.9	10.6	-8.8
Türkiye	2.7	-20.6	10.1	-21.3
Iran	3.1	5.9	9.7	0.1

e - estimated. Ranking of top 10 producing countries is based on year-to-date aggregate

Source : worldsteel.org

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Dr K Bhanu Sankara Rao

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E-mail: thesecretarygeneral.iim@gmail.com, iimmetalnews@yahoo.com
Phone: 033-2367 9768 / 2367 5004
Website: www.iim-india.net
Fax: (033) 2367 5335
Facebook - https://www.facebook.com TheIndianInstituteofMetals/
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Prof. U. Kamachi Mudali, Former President, IIM and formerly Vice Chancellor of VIT Bhopal University & Chairman and Chief Executive of Heavy Water Board, has taken over as the Vice Chancellor of HBNI, from May 11, 2023 for a period of 5 years

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1950-52	Late Phiroz Kutar	1979-80	Late P L Agrawal	1994-95	Dr S K Gupta	2009-10	Dr Sanak Mishra
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1954-56	Late M S Thacker	1981-82	Late C V Sundaram	1996-97	Late P Rodriguez	2011-12	Mr M Narayana Rao
1956-58	Late K S Krishnan	1982-83	Late Samarpungavan	1997-98	Late S Das Gupta	2012-13	Mr H M Nerurkar
1958-60	Late S K Nanavati	1983-84	Late J Marwaha	1998-99	Dr C G K Nair	2013-14	Prof K Chattopadhyay
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1967-70	Late M N Dastur	1987-88	Dr V S Arunachalam	2002-03	Late P Ramachandra Rao	2017-18	Dr Biswajit Basu
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1958-67	Mr R D Lalkaka	1986-97	Late S S Das Gupta	2006-13	*Mr J C Marwah	2015-18	*Mr Sadhan Kumar Roy
1968-76	Dr M N Parthasarathi					2018-23	*Mr Kushal Saha

Interview Dr. S.K. Jha, Chairman and Managing Director of MIDHANI

Dr. S. K. Jha
C & MD, MIDHANI

Glorious journey of MIDHANI towards Atamanirbhar Bharat

1. Many people do not know how the name MIDHANI was derived, could you please explain very briefly about this acronym?

India witnessed a frenzy of industrial activities after Independence. Immediate priority was given to the setting up integrated steel plants- "the temples of Modern India" for the commercial production of steel in large quantity, and the extraction of essential metals such as Aluminium, Copper, Zinc, and others. Then emerged the strategic industries that included nuclear power, thermal power, space, aeronautical, chemicals, electronics, telecommunication, defence production and general engineering. These strategic sectors demanded not only commonly available metals and alloys, but also advanced alloys, albeit small in quantity, which were not available at that time in the country and were therefore forced to depend totally on imports. An absolute necessity was felt for the indigenous production of these critical alloys. It is in this scenario, the Government of India decided to set up an integrated manufacturing plant for the critical range of special metals and alloys needed for the country, and thus Mishra Dhatu Nigam Limited - Superalloy Project as it was known initially came into existence. The translation of the name into Hindi is that 'Mishra' means mixture, 'Dhatu' denotes for metal/ alloy and 'Nigam stands for entity or corporation. To facilitate efficient delivery of telegraphic messages the term 'MIDHANI' (derived from the letters underlined in each word in the name of the company "Mishra Dhatu Nigam" in Devanagri script) was adopted. Mishra Dhatu Nigam Limited was incorporated under the Companies Act as a Public Sector Undertaking (PSU) under the Defence Ministry on November 20, 1973, at Hyderabad.

2. What was the main objective behind establishing MIDHANI in 1973 and how far these objectives have been fulfilled?

The major objective of setting up MIDHANI was to develop technology to produce various grades of strategic materials in different product forms and meet the requirement of materials projected by space, missile, nuclear power reactors, etc., with a combination of stringent chemical composition control, microstructure, physical and mechanical properties. Over the period MIDHANI has not only met the requirements of strategic sectors but also participated in various national level projects in developing new alloys and made country self-reliant in several sectors. MIDHANI played a key role in supporting several strategic programs of the country, where it was not possible to import special metals and alloys due to embargo. Over the years, it has developed expertise in producing wide range of high-performance materials, including Titanium alloys, Special steels, Super alloys, and other advanced materials. MIDHANI has also successfully undertaken several research and development activities in the field of metallurgy, materials science, and engineering.

3. What are the significant contributions made by MIDHANI for the advancement of strategic sectors in India?

The crowning glory of MIDHANI started with the development of maraging steel for space and nuclear applications in collaboration with VSSC, Trivandrum and BARC, Trombay. MIDHANI emerged as a technology leader with successful development and manufacture of maraging steel grade 250 plates and rings as structural elements of the first stage rocket motor casings for the Polar Satellite Launch Vehicle (PSLV) and Geosynchronous Satellite Launch (GSLV) vehicles. MIDHANI established a full-pledged production facilities to melt this steel in vacuum with demonstration of commercial production in1979. MIDHANI has supplied various special metals and alloys for Indian space missions, including various grades of titanium alloys, superalloys, and special steels for rocket engines, fuel tanks, and structural components. MIDHANI's contributions of superalloys and titanium castings along with high performance superalloys have been instrumental in the success of Cryogenic engines. Critical space missions, such as the Chandrayaan, Mars Orbiter Mission, Gaganyaan have provided MIDHANI team to develop many technologies and products with very high-quality standards. Technology developed in these areas have also been given opportunity to export materials for USA space program for qualification. MIDHANI has developed the melting and processing technology to produce Niobium-Hafnium-Titanium (Nb-Hf-Ti) refractory alloy, equivalent to C-103 for space application.

MIDHANI has supplied high-strength steels, nickel-based superalloys, and titanium alloys for various Indian missile programs, including development of Agni, Prithvi, and Brahmos missile systems. At present MIDHANI is continuously supplying materials for Akash Missiles, ASTRA Missiles, Rudram, and other programs of defence. These materials are used in critical components such as missile bodies, propulsion systems, and guidance systems. MIDHANI provided materials such as armour grade steels, titanium alloys, and nickel-based superalloys for various defence applications, including armoured vehicles, naval vessels, and fighter aircraft. Many of these materials have been proven to withstand high temperatures, remarkable fatigue resistance, and corrosion resistance.

MIDHANI in collaboration with nuclear establishments in India carried out extensive research work for the development of materials that can withstand radiation damage, fatigue, creep, and creep-fatigue interaction at elevated temperatures. The materials supplied to Fast Breeder Reactor technology program include 316 SS, Alloy D, Modified versions of Alloy D9, Nitrogen alloyed 316L steels, 9Cr1Mo and its modified version P91, and P92 steels. In case of pressurised heavy water reactors and associated fuel cycle technologies, MIDHANI provided materials such as modified stainless steels, precipitation hardened steels, duplex steels, nickel-based alloys, maraging steels etc. India is one of the few countries associated with the development and testing of the Test Blanket Modules for International Thermonuclear Experimental Reactor (ITER). MIDHANI has developed Reduced Activation Ferritic-Martensitic Steel -called INRAFM (Indian RAFM), in the form of hot rolled plates of various thicknesses. This is the cleanest steel ever produced in the country with very low ductile-to-brittle transition temperature surpassing the efforts made by other partner countries of ITER mission.

The coal-fired Advanced Ultra-Super Critical (A-USC) Thermal Power Plants, aimed at reducing emission of carbon dioxide operate with steam temperatures at 700-760 ^{0}C and at about 300 bar pressure. The AUSC plants require most demanding high temperature materials in the generator, critical steam piping and steam turbine. As a part of the National Mission for development of India’s first 800-MW AUSC plant, MIDHANI has developed 617 and 740 grade nickel-based superalloys and 304H Cu special austenitic stainless steel.

Overall, MIDHANI's contributions to aerospace, nuclear and defence sectors have been acknowledged as critical for building up India's strategic capabilities, and the company's implementation has been through a combination of establishing advanced facilities, collaborative R&D, and customer-centric approach to meet their specific requirements. MIDHANI's products have been used in several critical defence and aerospace programs in India, including the Light Combat Aircraft, T-72/90 tanks, Armour products, MiG series of alloys, Missiles of different variants, the Sukhoi-30 MKI fighter aircraft, BrahMos missiles, strategic platforms for Indian Navy and Space launch vehicle, Cryo-engines etc. The pay loads for Vikram moon lander for Chandrayaan 2 are made with titanium rings, bars and blocks manufactured by MIDHANI; it developed and supplied materials for Cryogenic Engine of LVM3, a three-stage heavy lift launch vehicle, for launch of the Chandrayaan-2 spacecraft. Specially developed cobalt base alloys, special nickel alloys, specific purpose stainless steel and precipitation hardened steel, and titanium alloys have gone into several areas such as liquid engine, thrusters, nozzles for liquid stages, gas bottles, cryogenic upper stage components of the LVM3.

4. What are the efforts undertaken very recently to develop new materials and Indigenization of materials and processing technologies?

MIDHANI has been indigenising alloys and manufacturing processes for various applications on continuous basis; during last year the following products have been indigenised:

(i) Development of PT 1M Seamless Pipes for Defence sector

(ii) Development of Titanium alloys for NIOT Project for space sector

(iii) Development of Zircalloy tubes for nuclear reactor

(iv) Development of Borated zirconium strip of 1mm x 10mm X 1000mm for nuclear reactor

(v) Development of 'Fluid End Component'- MDN 16-5-1, Super Martensitic Stainless Steel for Oil and Gas Sector

(vi) Development and manufacturing of 6mm hot rolled sheet of alloy C 276 for thermal power sector

(vii) Development of 3-meter-wide plates for armouring of vehicle

(viii) Development of Rolled Homogenous Armour (RHA) Steel for 'Ballistic Penetration testing' of missiles.

(ix) Development of Monel K 500 forged and hot rolled bars for components carrying high pressure oxygen inside Gaganyaan Crew Module's cabin pressurization and control system

(x) Superfer 909 for Health care equipment's

(xi) Titan26A disc and Superni 115 blades for aeroengine applications

(xii) Superfer600 blades for Uranium Corporation of India Ltd.

Under the Atmanirbhar Bharat many sub systems, platforms, etc. are being indigenized by industries involved in aero, space, and defence sectors. These systems require alloys in various forms that need to be developed and subsequently manufactured with in the country (which otherwise would have to be imported). MIDHANI will actively involve in identifying such needs and develop the metallic materials in the required forms at the earliest. MIDHANI has played a critical role in developing technology for high end steels thereby reducing India's dependence on imports of high-performance steels. In recent past MIDHANI has developed special grades of Titanium alloys for AMCA, Adour Engine, MIG aircraft and other strategic programmes of aerospace.

5. What is the status of MIDHANI with respect to the initially stated objectives and various measures taken to make it as growth-oriented establishment?

MIDHANI continued to work towards achieving its stated objectives of producing high-quality special metals and alloys for strategic sectors and promoting domestic production and R&D in this field. The company has expanded its product range and capabilities to meet the evolving needs of its customers and has been successful in establishing itself as a reliable supplier of critical materials to the defence, aerospace, and nuclear sectors. R & D engineers of MIDHANI have not only indigenised many alloys as import substitute but also developed new alloys for overseas customers and made presence in countries like, USA, Sweden, Germany, Poland, Middle east etc. MIDHANI has also collaborated with various institutions and industries in India and abroad to develop new technologies and products and has invested in R&D initiatives to improve its existing products and processes. The company has established a Technology Centre for Advanced Materials (TCAM) to carry out R&D activities in the field of advanced materials and has also signed MoUs with various academic institutions and research organizations to promote collaboration and knowledge exchange.

In addition to its core business of producing special metals and alloys, MIDHANI has also diversified into new areas such as high-performance materials for medical applications, axles for Indian railways, Titanium castings, fasteners for high end applications and production of Titanium and superalloys powders for additive manufacturing (3D printing). Company has also established technology for production of Armoured vehicles, light weight bullet proof jackets and composites for other armoured products. MIDHANI entered in international market for the supply of special materials and semi-finished products. Company is also working with a mission to achieve growth by increasing domestic and export sales of advanced materials and diversification of business and expansion of client base. There is a plan to increase value addition by manufacturing of finished/semifinished products. Continuous efforts are being made in up-gradation and modernization of existing manufacturing facilities to reduce cost of production and bring excellence in operation. MIDHANI has been engaged in the development of special materials for Kaveri derivative engines, Adour Engine, MIG aircraft and other strategic programme of defence. MIDHANI is also supporting in development of special steels, Titanium alloys and superalloys for India's all ongoing Missile development and production plan such as ASTRA, Rudram, NAG etc.

6. Where does MIDHANI stand today comparing to similar establishments gearing to the needs of strategic sector?

MIDHANI is in stronger position today in comparison to similar organizations since it has strong base of know-how in technology to process niche materials. MIDHANI is not only having qualified and trained manpower but has excellent know-how in all areas of its operation such as process technology, state of art equipment, in house equipment design and maintenance team, state of art testing infrastructures. Today, MIDHANI has capacity and capability to meet the ever-growing requirements of special steels, super alloys, Titanium alloys, composites for armour products, welding electrodes, flux, filler wire any many complex semi-finished components for various sectors. MIDHANI has ability to indigenize any materials of OEM, where there is continuous dependence on foreign equipment suppliers. MIDHANI is also playing a leadership role in formulating policy for indigenisation of materials for defence and aerospace applications with an objective to make India as self-reliant in materials. With completion of modernisation projects worth 700 Crores (approx.) in different areas company is able to take quantum jump in increasing its sales turnover from current level of about Rs. 900 Crores to Rs.1500 Crores by the year 2025. Under the modernization program, many of the old machineries in various production shops have been up graded, revamped and modernized by retrofitting; some have been condemned; new production and testing facilities have been acquired and production capability expanded. An indigenous Electro-Slag Refining (ESR) furnace of higher capacity was designed, built, integrated, and commissioned with in-hose experience.

7. What are the plans of MIDHANI vis-à-vis national interest and export?

In terms of national interest, MIDHANI plans to focus on increasing its product portfolio to reduce India's dependence on import of special metals and alloys. The company has plans to expand its production capacity and invest in new technologies to promote new business. MIDHANI is also working on developing new products and materials for various strategic applications hitherto not explored so far. Company is working with a mission to achieve growth by increasing domestic and export sales of advanced materials and diversification of business and expansion of client base.

MIDHANI also has plans to expand its export markets by increasing its presence in niche segments of products. The company aims to leverage its technical expertise and competitive pricing to increase its share in the global market for special metals and alloys. MIDHANI has already established its presence in very short time in several countries, including the USA, Europe, and the Middle East, and plans to further expand its reach in leading aerospace, space and oil and gas companies of world. There is a plan to increase value addition by manufacturing of finished/semifinished products.

In addition to expanding its domestic production and export markets, MIDHANI is also committed to promoting sustainable and environmentally responsible practices in its operations. The company has set ambitious targets for reducing its carbon footprint and minimizing waste generation and plans to achieve these targets through the adoption of clean technologies and sustainable practices. Continuous efforts will be made in up-gradation and modernization of existing manufacturing facilities to reduce cost of production while ensuring high quality at each and every stage of operations. Overall, MIDHANI's plans are aligned with the national interest and aim to promote India's self-reliance in the production of special metals and alloys, while also expanding its global presence and contributing to sustainable development.

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Special Report IIM Thematic Group on Circular Economy of Metals

IIM Head Office is proud to inform that the Honourable President Dr. Samir Kamat, Chairman DRDO and former President & Vice Chancellor, VIT Bhopal, Dr. U. Kamachi Mudali met the Secretary of Ministry of Mines, Shri Vivek Bharadwaj and Principal Scientific Advisor to Government of India, Prof. Ajay Kumar Sood at New Delhi on 1st May 2023 and handed over the Report of the Thematic Group. They apprised them of the findings of the thematic group and requested for any additional assignment that IIM can work further and submit to the GoI. Later Dr. Mudali met Smt. Ruchika Chaudhry Govil, the Additional Secretary, Ministry of Steel, and Shri Nagendra Nath Sinha, Secretary, and handed over the Report. The Ministry of Steel concurred to our proposal to have a Workshop/Discussion along with SRTMI at MoS premises on the subject of Circular Economy and work further on specific objectives to achieve circularity in the Steel sector.

Former President of IIM, Dr. U. Kamachi Mudali handing over the Report to Secretary, MoS, Shri Nagendra Nath Sinha.

In its 351st National Council meeting of IIM, the then President Shri T.V. Narendran, Global CEO & MD, Tata Steel proposed a thematic group led by Dr. U. Kamachi Mudali to deliberate the circularity of metals sector and come out with proposals for implementation with government support. The following committee deliberated the topic, held a Workshop with professional experts and brought out a report on how to implement the strategy for a complete circular economy for the metals sector: Dr. U. Kamachi Mudali, Vice Chancellor, VIT Bhopal University & Former President, IIM; Dr. R. Balamuralikrishnan, OS & AD, DMRL, Hyderabad & Jt. Secretary, IIM; Dr. Vilas Tathavadkar, CTO, Hindalco Ltd. & Council Member, IIM; Dr. SVSN Murty, General Manager, LPSC, Trivandrum & Council Member, IIM; Dr. G. Balachandran, Former Head, R&D, JSW Bellary; Dr. Sidddhartha Misra, Chief Process Research, Tata Steel Limited. IIM acknowledges the committee for their service in bringing out this report. Based on the outcome, IIM is planning to organise a course on Circular Economy of Metals for the benefit of professionals from Industry, Research and Academia.

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Technical Article

Exploration of Metal Additive Manufacturing for Components Realization

Gururaj Telasang and Ravi Bathe

Abstract

International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI) is actively engaged in the development of Additive Manufacturing (AM) solutions, catering to diverse materials and industrial components. With more than a decade of expertise in Laser Directed Energy Deposition (LDED) or laser cladding, ARCI has successfully established AM facilities equipped with Powder Bed Fusion (PBF) technologies employing both Laser Beam (LB-PBF) and Electron Beam (EB-PBF) processes. ARCI has a proven track record in the areas of laser materials processing, additive manufacturing, repair, and refurbishment technologies. ARCI has extensive industry linkages and engagement models for taking up R&D and technology commercialization on the operational side. One of the key capabilities of ARCI lies in its state-of-the-art inert gas atomization facility, which enables the development of powders suitable for various AM applications.

ARCI has successfully showcased a wide range of component applications developed using AM technology, specifically tailored for critical engineering applications. These applications encompass diverse fields, including the creation of conformal channels, lattice structure, complex geometry, light weighting, part consolidations, hybrid manufacturing processes, and dissimilar metal processing. The comprehensive demonstration not only underscores the versatility of AM but also emphasizes ARCI's capabilities in addressing complex engineering challenges through innovative solutions. By combining cutting-edge technology, material expertise, and application development, ARCI continues to pave the way for the adoption of AM in various industries.

1. Introduction

Metal Additive manufacturing (AM) also known as metal 3D printing comprises the layer-by-layer building of components from a 3D virtual model to provide light-weight, integrated parts, and conformal channels within a short development times [1, 2]. Currently, there are various commercial metal AM technologies available, such as powder bed fusion with laser (L-PBF) [2] or electron beam powder bed fusion (E-PBF), direct energy deposition (DED) or Laser engineered net shaping (LENS) [3], Laser wire AM (L-WAM), Electron beam wire AM (EWAM), Wire arc AM (WAAM) [4-6], cold metal transfer (CMT) [7,8] and powder bed binder jet. Out of all metal AM technologies the powder bed fusion (PBF) technology gained a lot of attention from researchers and industries and has gone through several developmental modifications; however, AM parts exhibit certain potential drawbacks, such as porosity, undesirable phases, anisotropic microstructure, difficulties in assessing the quality of powders (composition, morphology, etc.) and possible debit in mechanical properties [9]. It should be noted that AM is still a relatively new manufacturing process, and it is expected that engineering and scientific research in this field will enable us to overcome most of the disadvantages by choosing right material composition, powder morphology, process selection, optimisation of process parameters and control, and equipment design.

2. Additive Manufacturing Facilities at ARCI

ARCI has over a decade of experience in Laser directed energy deposition or laser cladding. ARCI has established several facilities which enable the production of components by AM; these comprise of

International Advanced Research Centre (ARCI) for Powder Metallurgy and New Materials (ARCI), Balapur PO, Hyderabad 500005

equipment for powder production and development, design for AM, AM process development using Laser beam powder bed fusion (PBF-LB) and Electron beam powder bed fusion (PBF-EB) systems, laser direct metal deposition (LMD) also known as laser cladding, wire arc additive manufacturing (WAAM), Hot isostatic pressing (HIP), and vacuum furnace for post heat treatment and state of the art characterization facilities. ARCI has rich experience in the production of powders (metallic and composites) using various techniques (atomization, high energy milling, RF induction plasma, Flame spray pyrolysis etc.) as well as nano powders for various applications. The major AM facilities available at ARCI are outlined below.

2.1. Laser Beam Powder Bed Fusion (PBF-LB) for Metals

In the laser powder bed fusion, a fine laser beam spot is rastered on a powder bed as per the profile required resulting in melting and solidification of the powder that is exposed to the laser energy. In the process, a layer of the particulate profile is realized. In order to realise an actual component, the design is sliced into distinct layers, and the laser beam is made to move on the powder bed as per the layer requirement; schematic of the process is shown in Figure 1a. Once a layer is formed, the bed is moved down by a certain height, and a fresh layer of powder is spread. The laser beam scans the fresh layer as per the geometry of that layer; and the whole component is built layer by layer. Two commercial systems based on laser powder bed fusion were procured from SLM solutions, Germany (Fig.1b). These systems possess build volume of 280 mm × 280 mm and height of 365 mm.

2.2. Electron Beam Powder bed Fusion (PBF-EB) for Metals

Electron Beam Melting (EBM) AM works on the powder bed fusion AM principle where a high-power electron beam is used to create a melt pool; schematic of the process shown in Figure 2a. The facility established at ARCI is the EBM A2X system from ARCAM AM (GE Additive) make (Figure 2b). The system's specifications are as follows:

- Electron Beam Power: 3000 W
- Build Volume: 200mm× 200mm×380mm (W × D × H)
- Cathode Type: Tungsten filament
- Max. EB Translation Speed: 8000 m/s
- High Process Temperatures: Up to 1100°C
- Vacuum Process
- Open Software for Process Development

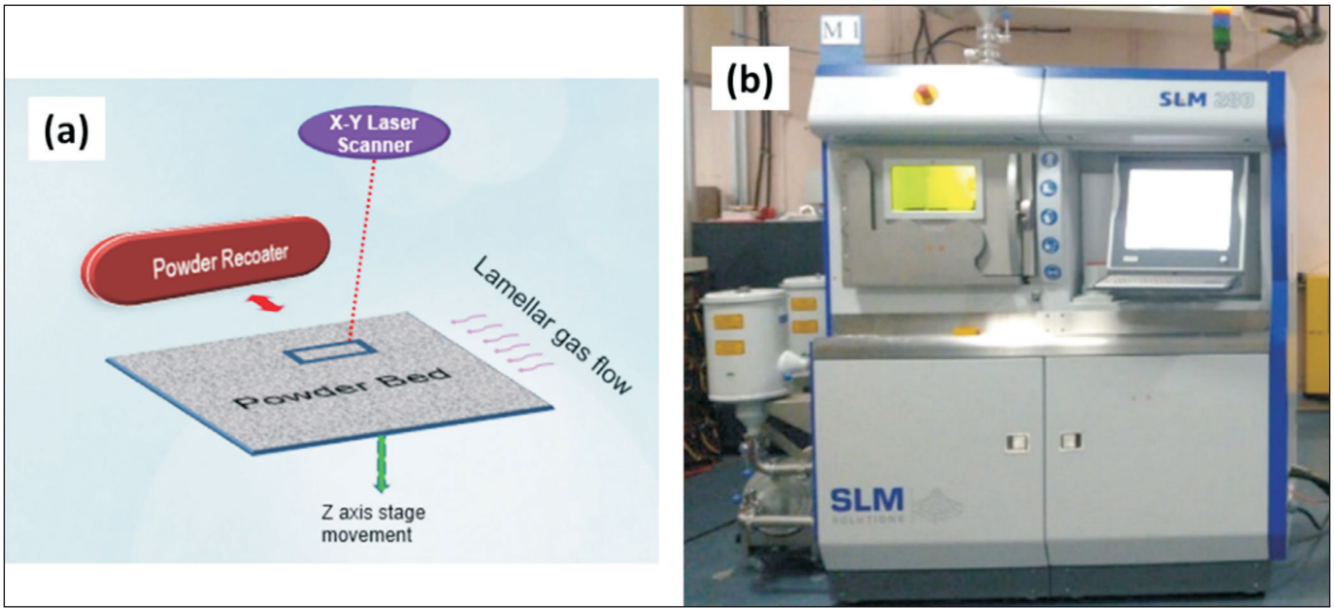

Fig. 1 : (a) schematic showing the laser beam (PBF-LB) powder bed fusion technology, and (b) Photographs of L-PBF AM systems available at ARCI.

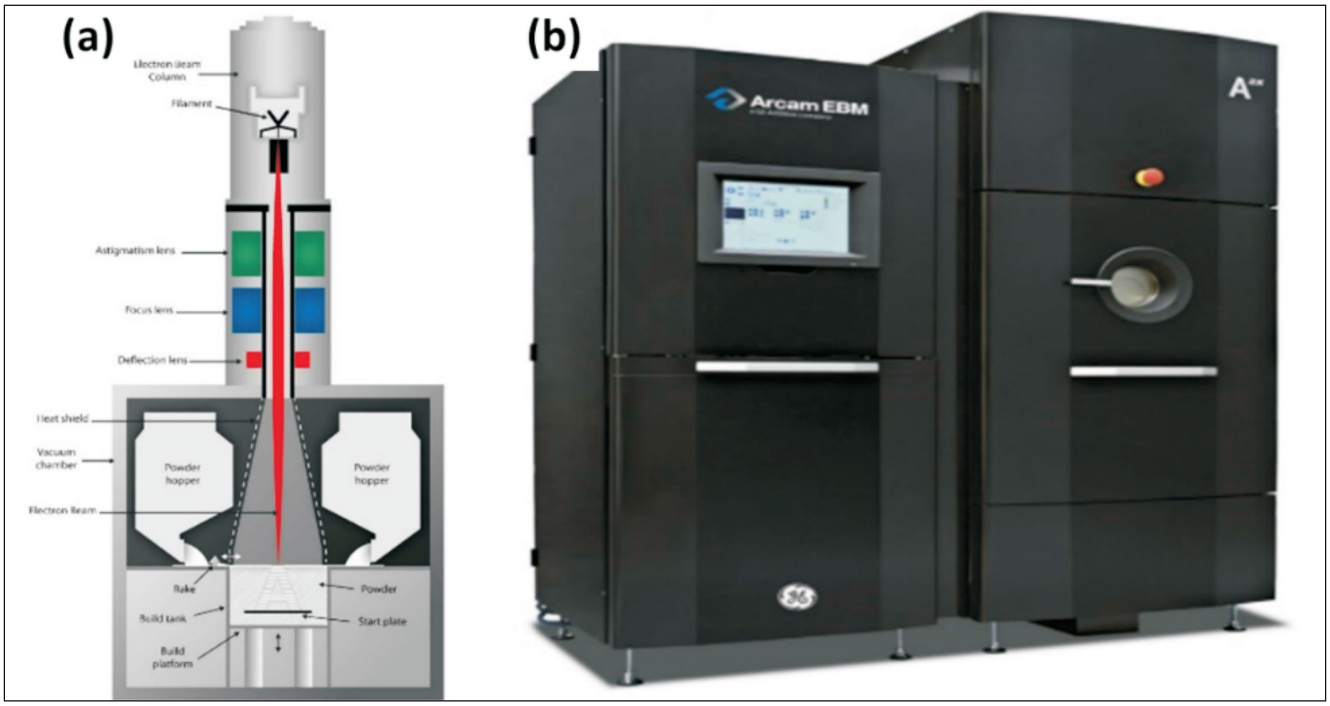

Fig. 2 : (a) schematic showing the electron beam (PBF-EB) powder bed fusion technology, and (b) Photographs of E-PBF AM systems available at ARCI.

The EBM A2X system operates under high vacuum conditions, making it ideal for processing reactive materials like titanium alloys. The system's higher bed temperature capability enables the processing of difficult-to-weld alloys while minimizing residual stresses in the components.

2.3. Laser Direct Metal Deposition

Laser cladding/metal deposition is a process which is used to fuse metal alloy powder using a laser beam and deposit on another substrate material which has different metallurgical properties. This process contributes to an increased thickness of the sustrate. A very thin layer of the substrate has to be melted in order to achieve metallurgical bonding with minimal dilution of deposited material. Laser cladding technology is especially suited for the restoration of an expensive workpiece. The laser cladding system available at ARCI is shown in Fig. 3 and system's specifications are as follows:

- Fiber coupled diode laser up to 10 kW power with wavelength range of 900 nm to 1,080 nm
- Continuous wave laser and programmable pulsing is also possible.
- Spot size in circular shape from 600μm to 5mm and rectangular shape with 4×4, 5×20, 1.5×11, 2×17 and 5×8 mm^2.
- Equipped with special Zoom Optics with spot size tenability of 8mm to 56mm
- The laser optic head is fixed with a 6-axis Robot arm and two additional rotary and tilt axis integrated with the system. Reach of 2.3 m is possible.
- Close loop-controlled temperature controlling system using E-MAqS camera and Pyrometer integrated with Lompocpro software.
- DCAM software with teach unit for easy programming and simulation of complex components.
- Equipped with Twin-hopper powder feeder and various Laser Cladding Nozzles such as Coax 8, Off-axis cyclone nozzle, Inner bore cladding nozzle, wide area deposition nozzle.

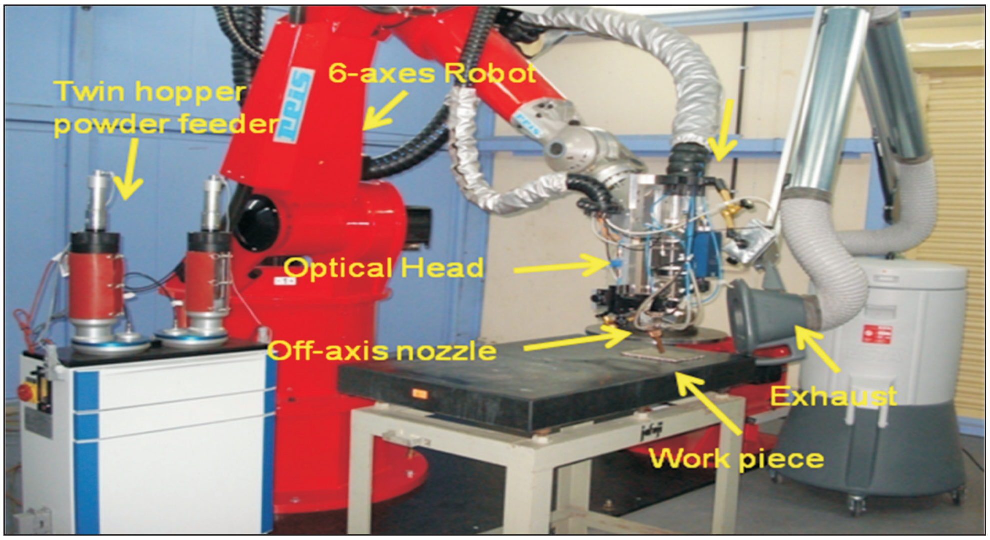

Fig. 3 : A photograph showing Robot with laser optic head and powder feeding system for laser direct metal deposition available at ARCI.

2.4. Wire Arc Additive Manufacturing (WAAM)

Wire Arc Additive Manufacturing (WAAM) is an advanced production process utilized for the purpose of 3D printing or repairing metal components. This cutting-edge technique involves the sequential deposition of multiple layers of metal material, allowing for the creation of intricate three-dimensional shapes. WAAM seamlessly combines the capabilities of two distinct production processes: Cold Metal Transfer Arc Welding (CMT) and additive manufacturing. The WAAM system, currently accessible at ARCI, represents a state-of-the-art technological platform designed to facilitate the implementation of this additive manufacturing process. The system boasts a host of specifications and features tailored to meet the demands of industrial applications. Fig. 4 visually represents the WAAM system, providing a comprehensive overview of its components and their arrangement The following are the detailed specifications of the WAAM system available at ARCI:

- Model : TransPuls Synergic 3200 CMT
- Welding current range : 3 - 320 A
- Duty cycle : 40 % d.c. at 320 A
- Open-circuit voltage : 65 V
- Base metals : Al, Steel, CrNi, and Special metals
- Wire Feeder : VR7000CMT (0.5 to 22m/min)
- 6-axis Robotic System (2.5 m arm reach)

Fig. 4 : A photograph showing WAAM facility with Robot, CMT system and controller.

3. AM grade Powders at ARCI

ARCI's state-of-the-art inert gas atomization facility enables the development of powders suitable for a range of AM applications. ARCI has extensive experience in utilizing a variety of in-house and commercially available powders to support research and development goals.

The powders developed at ARCI for AM using Inert Gas Atomized and Commercial powders used so far for AM

Powders Manufactured in ARCI	Commercial Powders
• Ni-superalloy – IN718 • Ni-superalloy – IN625 • Ni-superalloy – BZL alloy • Aluminium alloys – AM friendly	• Tool steel - AISI H13 • Tool steel – M2 HSS • Maraging steel - M300 • Stainless-steel – SS321 • Stainless-steel – SS316L • Ph steel - 15-5Ph • Aluminium Alloy – AlSi10Mg • Aluminium Alloy – H20 equivalent to Al6061 • Copper alloy – CuSn10 • Magnetic Materials • Co-Cr-Fe alloy

Research and development work on certain powders used for Additive Manufacturing is detailed below.

3.1. Additive manufacturing of Ni-based superalloy (IN718)

Powder bed fusion AM (L- PBF) technique (SLM280HL) was used to build test coupons using inert gas atomized IN718 alloy powder (manufactured at ARCI) having average particle size ranging between 35 to 45 μm and elemental composition: Ni-18.65Fe-18.15Cr-5.2Nb-3.0Mo-0.35Al-0.92Ti-0.009B-0.003C-0.035Si (wt%). The process parameters were optimized for 30 μm layer thickness to achieve best possible relative density >99.5%. The combination of the optimised parameters include laser power of 200 W, scan speed of 900 mm/s, and hatch distance of 0.12 mm. Microstructural analysis revealed the size and volume fraction of γ" and γ' and the utilization of Nb for γ" formation during aging treatment. As-built microstructure revealed Nb rich interdendritic phases dispersed within the interdendritic Nb-rich γ matrix. Increasing the solutioning temperature resulted in increased γ" volume fraction. [10].

3.2. Additive manufacturing of hot work tool steel (H13 tool steel)

Major progress has been made in the AM process development for AISI H13 tool steel alloy powder for advanced tooling applications [11]. The achieved superior mechanical properties are shown in Figure 5 for optimized post heat-treated sample, compared with conventional H13 tool steel properties and previously reported properties in the AM literature of AISI H13 tool steel [12]. Real-time demonstration of AM-built H13 tool steel core pin with efficient cooling channels resulting in enhanced service life has been carried out in collaboration with casting industry [11]. Further, the development focused on possible high build rate, and hybrid AM was explored for metallurgical and mechanical properties.

4. Applications developed at ARCI

ARCI has demonstrated a wide range of applications for various industries employing different materials. Figure 6a shows the photograph of diverging part made in Ni-based superalloy of height 30 mm with 3 mm wall thickness and seven channels of 1 mm diameter in its wall thickness running spirally along the diverging wall. Figure 6b reveals profile of a complicated micro-heat exchanger built as one piece using stainless steel (SS316L) alloy powder. The micro-heat exchanger is of size 30 mm in length and 25 mm in diameter having bundle of plates (with perforation of 1 mm size holes) spaced 0.8 mm gap are separated axially with 1 mm thick wall for two different fluid flows. Figure 6c shows the complicated valve block of size 110 mm x 110 mm and height of 110 mm built with stainless steel (SS321) and Aluminium alloy (AlSi10Mg). Figure 6d shows an aero engine component, a nozzle Guide Vane (NGV) built in one piece using Ni-based superalloy (IN-718) having hollow structure and 0.5 mm holes in different orientation on the surface. Figure 6e describes co-axial nozzle, with intricate conformal channels for powder feeding, cooling line and inert gas shrouding, built using Ni-based super alloy for direct energy deposition (DED) process and Figure 6f reveals the CT-scan image of the DED nozzle illustrating the intricate conformal channels inside the AM built DED nozzle.

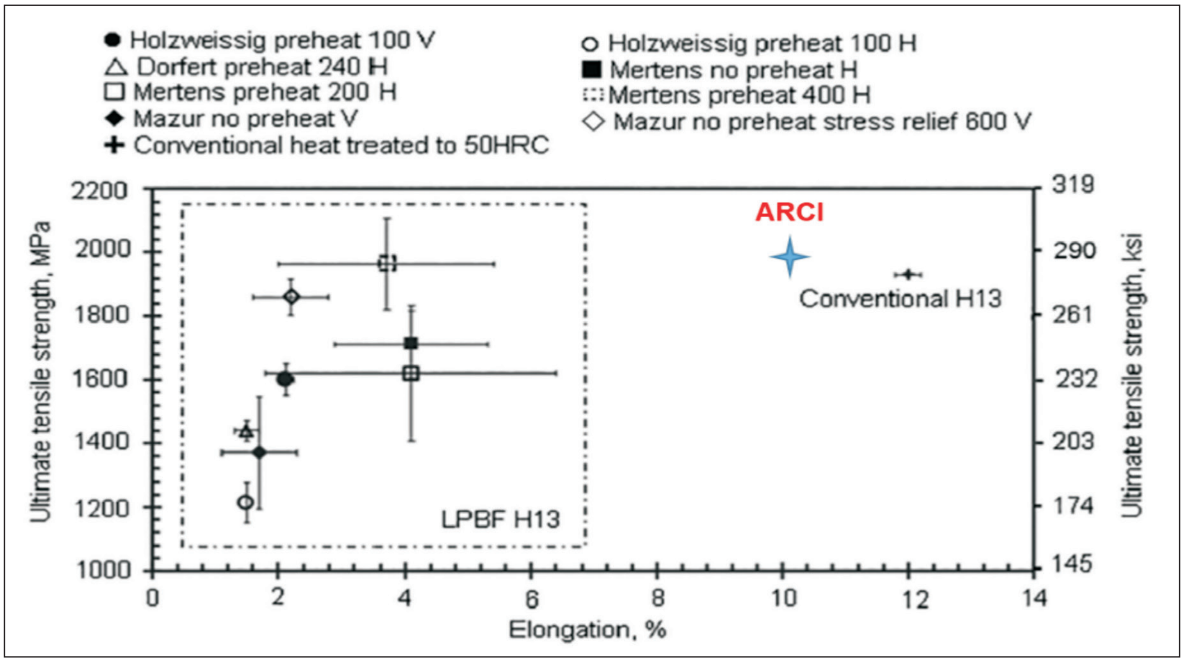

Fig. 5 : Plot showing a summary of literature reported mechanical properties for SLM-AM built AISI H13 tool steel compared with corresponding properties achieved by AM of AISI H13 tool steel at ARCI AM facility. Curtsey to [12].

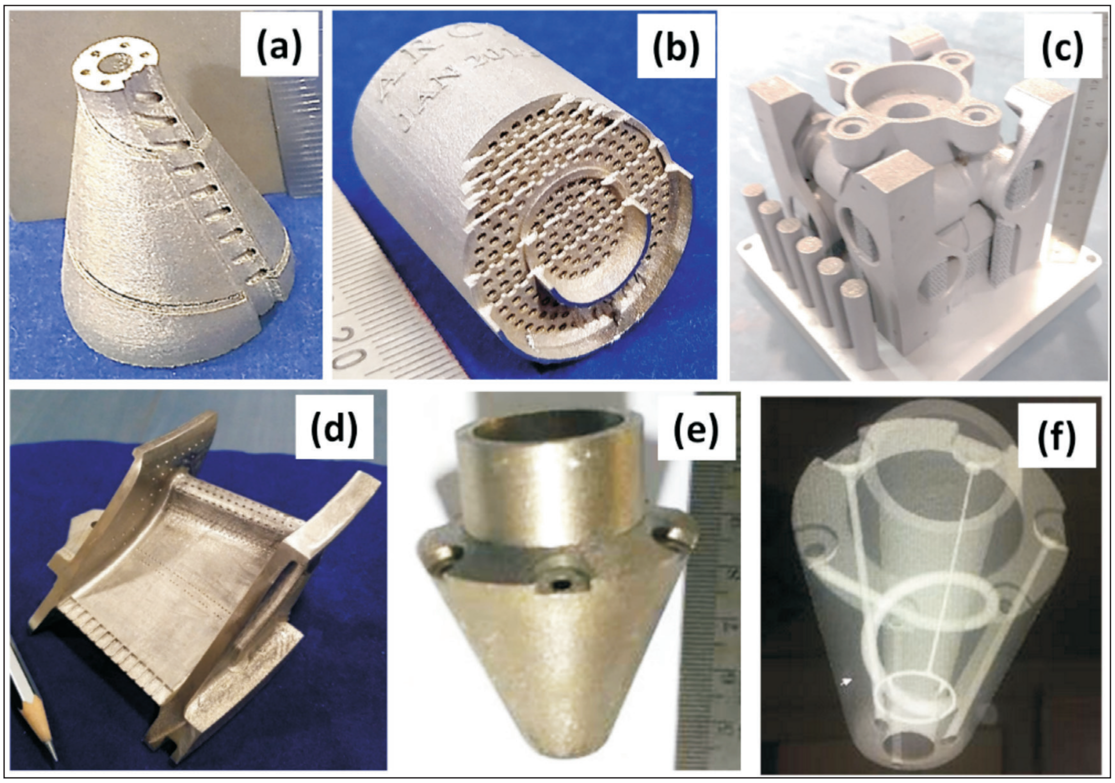

Fig. 6 : Photographs showing (a) diverging part with conformal channels, (b) micro-heat exchanger, (c) valve block, (d) Nozzle guide vane, (e) DED nozzle with conformal channel and (f) CT-scan image of DED nozzle.

4.1. High-Performance Core Pin with Conformal Cooling Channels for Pressure Die Casting Tooling Applications by Additive Manufacturing

ARCI developed AM-SLM process for AISI H13 tool steel alloy powder, tool material and design for complex cooling channels for pressure die casting (PDC) tools. A critical tool part of the PDC tool assembly, a core pin, was selected to demonstrate and validate the developed AM technology for AISI H13 tool steel alloy and design for the conformal cooling channel. A selected core pin without cooling channels is susceptible to heat checks leading to soldering of the cast part, inducing internal surface porosity. Details pertaining to SLM process parameter optimization, post-heat treatment conditions, and validation of the selected core pin manufactured with AISI H13 tool steel alloy powder were reported in [11]. The core pin of 200 mm in length has been modified with a specially designed spiral conformal cooling channel with a 2.5 mm diameter and separate inlet and outlet connectors, as shown in Figure 7a. A photograph of an additively manufactured as-built core pin using an SLM system in AISI H13 tool steel alloy powder is shown in Figure 7b. Figure 7c shows the X-Ray radiography image of the as-built core pin demonstrating a successfully achieved spiral cooling channel. Figure 7d is composed of the cut section parts of as- built cooling channel confirming the conformal channel design, top head design with no-internal overhang effect with Ra values of 7±2 μm internal channel surface roughness. The manufactured core pins were heat-treated with optimized conditions and post-processed to fit in the die-casting assembly along with cooling line connections and tested in real-time pressure die-casting process conditions. The additive-manufactured core pins with cooling channels have outperformed the conventionally manufactured core pins without cooling channels, in terms of the surface temperature dropping by 20% as shown in Figure 7e, cycle time reduced by 2 seconds, reduced soldering and number of part rejections, and served for more than 6000 shots compared to the cast part production.

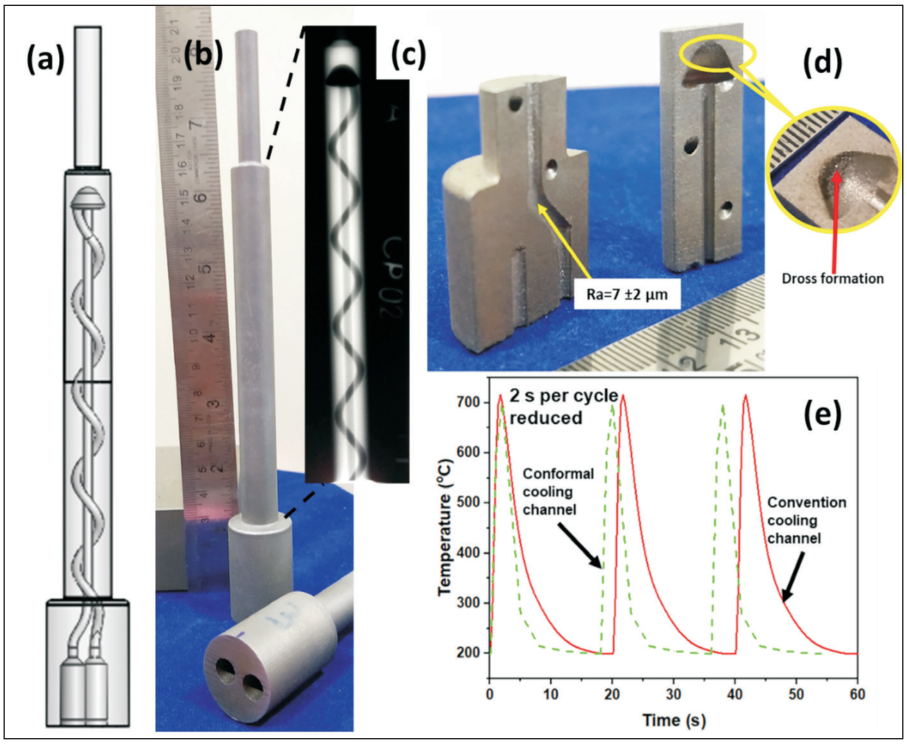

Fig. 7 : (a) Design Model of Core pin with conformal channels, (b) Photograph showing AM built AISI H13 core pin, (c) X-Ray radiography of as-built core pin, and (d) photograph of AM built core pin assembled with cooling lines in casting assembly. Table shows the effect of cooling channel as a drop in surface temperature of core pin between random casting cycles [11].

4.2. Hybrid Additive Manufacturing

The pressure die casting (PDC) tools are required of cooling channels running conformal to the 3D surface contour, which can improve the heat transfer efficiency and thereby resulting in improved tool service life. Such conformal cooling channels are challenging to conventional tool manufacturing; can be realised by AM technologies. Although AM gives greater design freedom, the building of conformal cooling channels with overhanging features (circular cross-sections) is a challenge as it requires sacrificial support structures to build and subsequent removal of supports. Generally, PDC tool core pins are of 300 mm length and a diameter of around 30 mm approximately; building such components is associated with a very long build time. In an effort to solve the above stated issues, attempts have been made using a laser-assisted metal powder bed technology. Possible use of self-supporting drop shape cross-section design for conformal cooling channel has been demonstrated with reduction in total build time by adopting AM on conventional CNC machined blank (about 75% of length) of the insert. The art of matching and building the top insert portion with the complicated and twisted cooling channel by additive manufacturing has been developed and adopted to build a model insert shown in Figure 8. Figure 8a demonstrates the 3D CAD model of two sections and Figure 8b shows the photographs of manufactured as-built hybrid core pin with section interface features at different locations justifying the near design match of the two sections.

4.3. Dissimilar Materials Additive Manufacturing

Dissimilar material structures offer the advantage of combining good properties of two different materials such as mechanical properties (stainless steel) with heat conductivity (copper). The difference in the physical properties of the two metals, including the melting point, thermal conductivity and thermal expansivity, make defect-free dissimilar metal building difficult. Hence, building dissimilar material structures is a challenge and using such a concept in additive manufacturing leads to a kind of hybrid additive manufacturing or rebuilding the part with different material. Attempts have been made to achieve and evaluate bi-metallic structure by building stainless steel section on a copper block [13]. Figure 9a shows the schematics arrangement of building stainless steel on copper plate. Figure 9b shows the Cu-Steel dissimilar material plate realised by powder bed fusion technology. Initial experiments showed good metal joining properties with respect to interface structure, porosity and strength as depicted by Figure 9c. Figure 9d shows the tensile behaviour of Copper-Steel joint demonstrating the interface strength is better than the copper substrate as the fracture happened on copper side away from the interface.

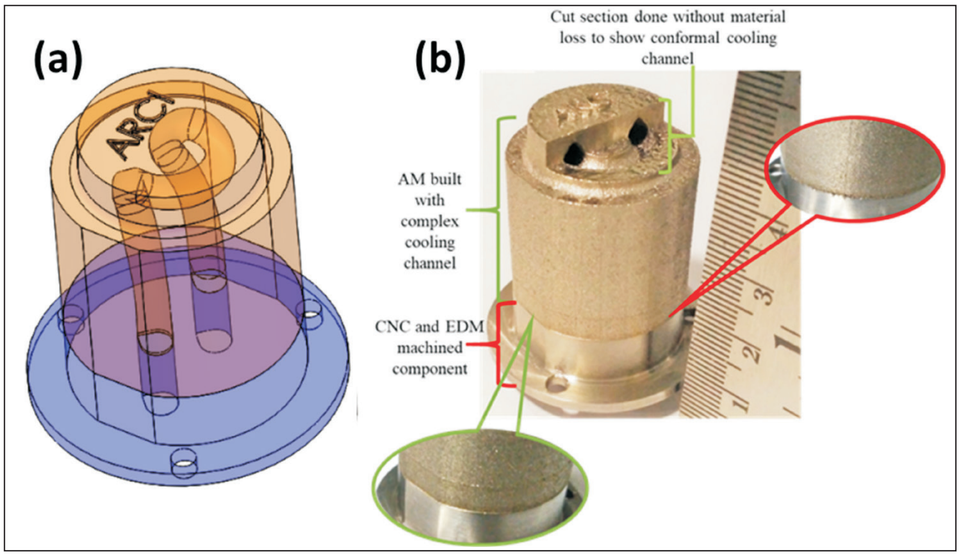

Fig. 8 : (a) Image representing 3D CAD model of hybrid core-pin and (b) shows the photographs of manufactured as-built hybrid core pin with both conventional and AM as-built sections.

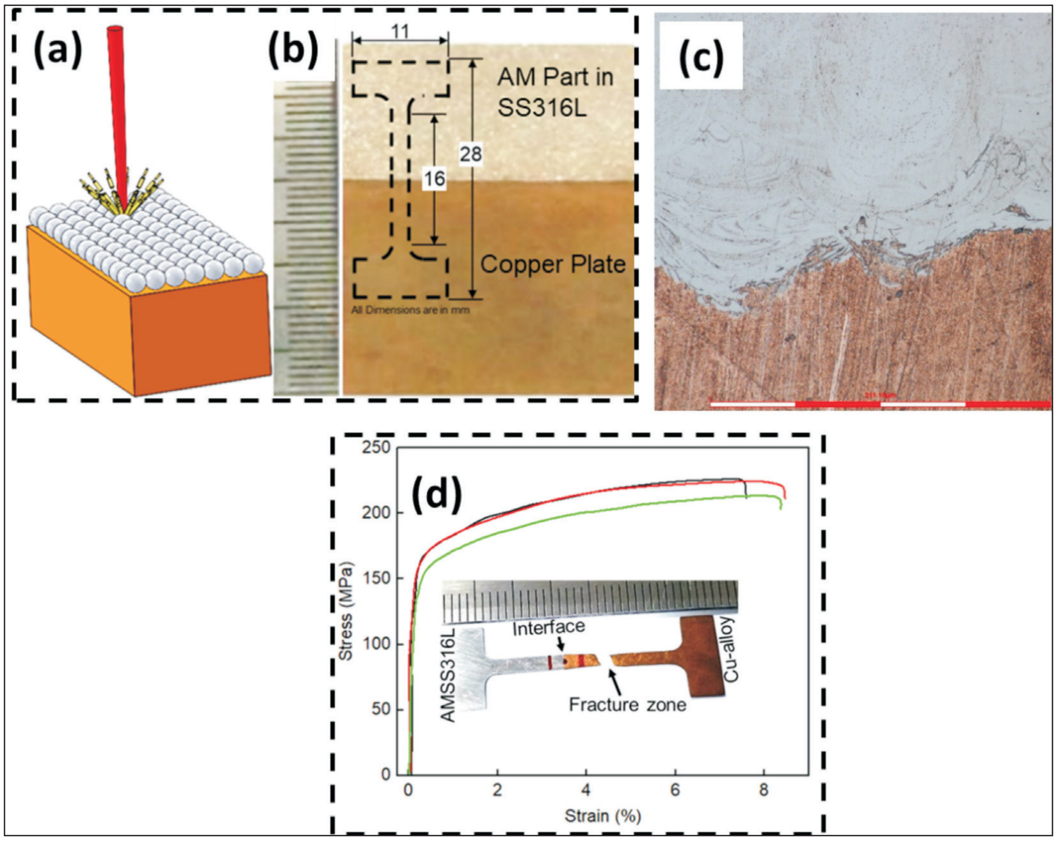

Fig. 9 : (a) schematic arrangement showing stainless steel powder deposition on copper plate, (b) a photograph showing bi-metallic structure with the AM built stainless steel on copper plate, (c) optical micrograph of Cu-SS defect free interface, and (d) shows the tensile behaviour of Cu-SS joint with fracture on copper side. [13]

5. Conclusions

- Developed, demonstrated, and adopted additive manufacturing technologies for industrial use by providing tailored solutions.
- ARCI is offering a one-stop-shop for all additive manufacturing needs.
- Process qualification of AM parts and testing protocols are similar to performance intensive processes like welding or casting.
- A great deal of work in terms of applying metallurgical fundamentals to materials processing and resulting behaviour needs to be conducted to accelerate and fully realise the potential of AM.
- As of now, few materials only have been explored fully in the AM context.
- Great amount of innovative research work needs to be carried out to accelerate AM revolution. Issues like high cost, predictability of properties, powder production and selection for particular application, parametric optimization, defects determination and assessment of their severity, and a gap in skills have to be addressed.

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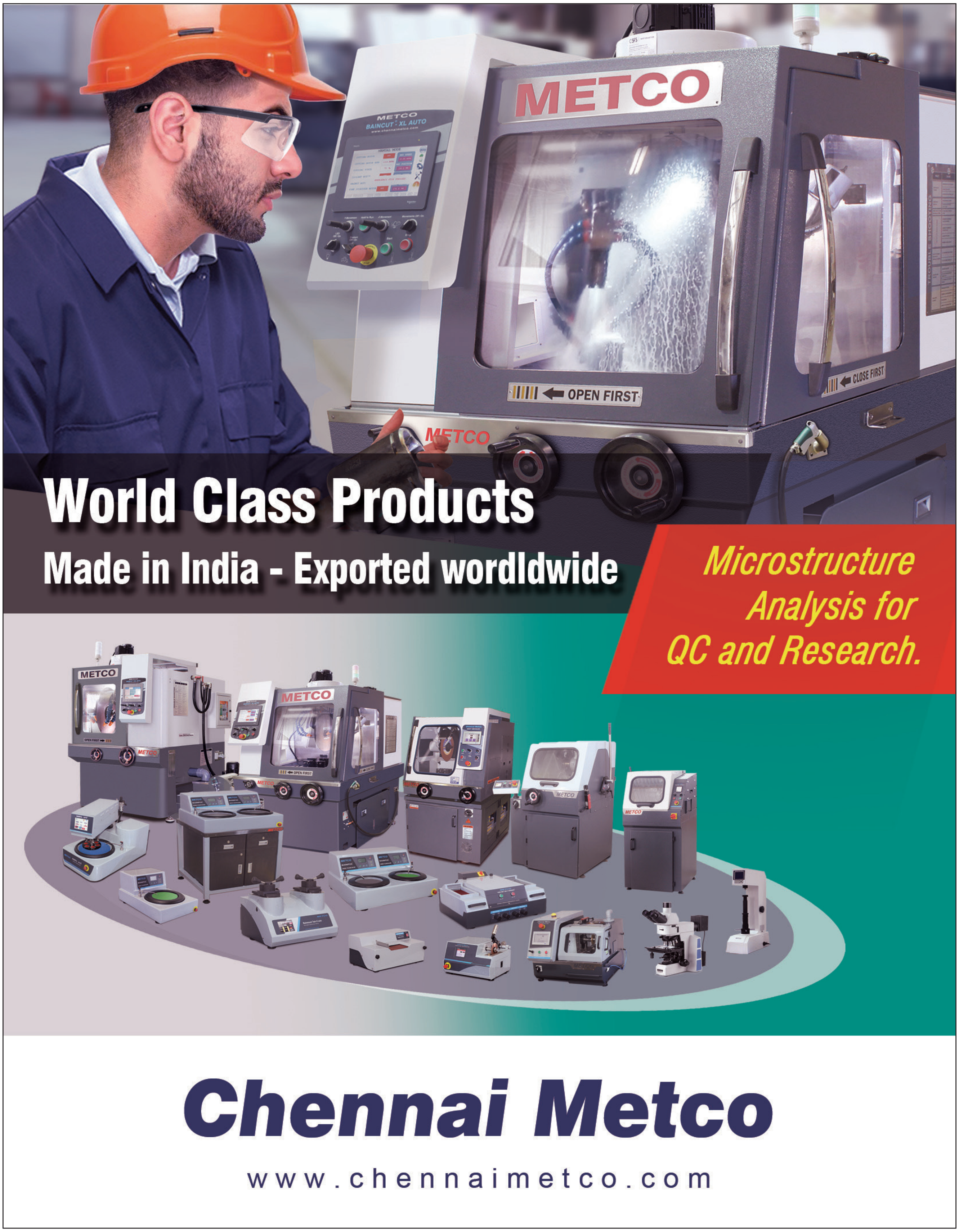
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Recent Developments National

India's first rare earth permanent magnets plant

Engineering Projects (India) Limited successfully executed the construction of Rare Earth Permanent Magnet Plant (REPM) for the Indian Rare Earth Limited (IREL) inside an existing facility of Bhabha Atomic Research Centre (BARC) in Visakhapatnam. The construction of REPM commenced in in 2021 and completed in March 2023 at a total cost of Rs.197 crores. On National Technology Day, Prime Minister of India inaugurated the REPM Plant on May 11th, 2023, through video conferencing and dedicated this cutting-edge technology facility to the nation. With a production capacity of 3,000 kg per year, the plant will manufacture rare earth magnets, which are high technology products and play a pivotal role in various sectors, including telecommunications, electric vehicles, microelectronics, wind turbines, missiles, fighter aircraft, hypersonic weapons and energy systems. This landmark development is a huge step in the direction of 'Atmanirbhar Bharat' as up to now most of the country's needs for this critical item were being met through imports only.

A permanent magnet is a type of magnet that can create a magnetic field without needing any external power source. It is called "permanent" because once it is magnetized, it can maintain its magnetism for a long time. Compared to ordinary ferrous magnets, rare earth permanent magnets have much stronger magnetic fields and can produce higher-performance, compact, and lightweight motors. Some important properties used to compare permanent magnets are: remanence (Br), which measures the strength of the magnetic field; coercivity (Hci), the material's resistance to becoming demagnetized; energy product (B•Hmax), the density of magnetic energy; and Curie temperature (TC), the temperature at which the material loses its magnetism. Rare-earth magnets have higher remanence, much higher coercivity and energy product, but (for neodymium) lower Curie temperature than other types The magnetic field typically produced by rare-earth magnets can exceed 1.2 Tesla's, whereas ferrite or ceramic magnets typically exhibit fields of 0.5 to 1 tesla.

The new plant established at Visakhapatnam will produce rare earth magnets like Samarium-Cobalt and Neodymium-iron-boron. The integrated plant/ facility for production of these permanent rare earth magnets will be using reduction-diffusion (R-D) technique developed by BARC indigenously for its nuclear fuel cycle activities.

By manufacturing these magnets domestically, India not only strengthens its strategic sectors and defence capabilities but also reduces its dependence on imports and safeguards India from supply chain disruptions in rare earth metals. Furthermore, the global demand for these rare earth magnets presents an opportunity for India to establish itself as a prominent exporter in the international market.

Source :

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Hydrogen route to steel production

As of 2020, steel manufacture is estimated to be responsible for 11 per cent of global carbon emissions and 7 to 9 per cent of greenhouse gas emissions. To reduce emissions, researchers at the Max Planck Institute for Iron Research at Dusseldorf in Germany investigated how pores in a solid change its chemical reactions and showed how this could make steel manufacture more sustainable.

The conventional process involves using coal to reduce iron oxide in the ore to iron. The use of hydrogen as a reactant to produce steel is potentially more environmentally friendly than using carbon, but an industrial-scale switch to using hydrogen involves a lot of challenges. One is that the reaction needed to make steel using hydrogen is mysteriously sluggish. Xuyang Zhou and his colleagues have now identified the main cause and suggested a method to mitigate it. This work has been published in Physical Review Letters.

Steel is made through an electron-exchange or redox (reduction-oxidation) reaction in which iron oxide reacts with another material to produce steel and an oxide byproduct—CO_2 if the oxidant is carbon, water if it is hydrogen. With the knowledge that removal of oxygen atoms during this process leaves behind nanometre-to-micrometre-scale pores in the iron oxide, using simulations and electron-microscopy observations, the researchers have shown that, when hydrogen is the reactant, water gets trapped in these pores and shifts the local equilibrium towards reoxidation, that is, removing electrons from the reduced iron, slowing the overall reaction.

Their findings have also offered a solution to this slowdown effect—if the pores are sufficiently interconnected to form channels, then the water formed would percolate out of the material before reoxidising it. "We should be able to achieve the required pore morphology by controlling temperature, pressure, and other parameters during the reaction," said Zhou.

Source :

1. *https://frontline.thehindu.com/science-and technology, R. Ramachandran, 4th April, 2023*

Indigenous Simulated Crew Module for 'Gaganyaan'

The country's human space flight programme 'Gaganyaan' has achieved a major milestone when the very first indigenous Crew Module (SCM), was built by Hyderabad-based Manjira Machine Builders (MMB). The private firm has built the 2.7 metres high, 3.1 metres wide and weighing 3.5 tonnes crew module based on aluminium alloy and steel in six months following precise specifications and design. "A test vehicle launch is waiting at the Satish Dhawan Space Centre (SDSC) in Sriharikota for this module for simulating the escape vehicle exercise for the unmanned flight in July 2023. It has been an arduous task in getting the configurations and integration of hardware and software systems right from the design to fabrication and manufacturing. The VSSC scientists and MMB engineers had worked round the clock in assembling and integrating the simulated crew module from the design stage with the remaining acoustic, vibration testing and other things, to be done at the launch centre. The capsule will be equipped with three giant parachutes to prevent sudden drop into the ocean during the descent from space or during abort mission.

Source :

1. *India Today Science Desk, Feb 25, 2023*

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Non-Ferrous Metals Statistics Domestic Scenario

Prices in India (as on 31st May, 2023)

(Mumbai Local Price in Rs. / kg)

Product	Rs. / kg	Product	Rs. / kg
Copper Armature	697	Aluminium Ingot	215
Copper Cathod	716	Aluminium utensil	172
CC Rod	730	Zinc Ingot	209
Copper Cable scrap	710	Lead ingot	187
Brass Sheet Scrap	507	Tin Ingot	2225
Brass Honey Scrap	470	Nickel Cathod	1805

Source : http://www.mtlexs.com/

News Updates National

Steel trade dips on expectations of price cuts

Activity in the steel trade market has slowed down to a trickle with buyers refraining from stocking on material on expectations of prices going down, said traders and industry executives.

The trade market involves dealers and sub-dealers of primary steel mills like Tata Steel and JSW Steel and they sell material to end-user industries. It is estimated to account for a quarter of the overall steel consumption in the country.

The trade market is already operating below the listed price of primary steel mills and there are expectations that the mills themselves will be marking down their prices in line with international prices of the alloy.

The Economic Times (5.5.23)

India asks European Union to recognise its carbon credit trading scheme

India has asked the European Union to recognise its Carbon Credit Trading Scheme (CCTS) amid concerns that its iron, steel and aluminium exports to the bloc will face extra scrutiny under the EU's Carbon Border Adjustment Mechanism (CBAM) that is due to kick in from October.

The issue is likely to be discussed at a key meeting on CBAM among top officials of various ministries including finance, commerce and industry, steel and MSME, and industry representatives, officials privy to the development said.

Under the proposed EU tax drill, non-EU steel producers must report direct and indirect emissions. The mechanism will translate into a 20-35% tax on select imports into the EU from January 1, 2026. From that date, EU importers will have to declare and purchase CBAM certificates to cover the emissions associated with producing imported steel products.

The Economic Times (7.5.23)

GSI terms reports on large lithium reserves found in Rajasthan as 'baseless'

The Geological Survey of India (GSI) termed media reports saying large lithium reserves being identified in Rajasthan as "baseless". "Media reports published in various newspapers regarding the finding of large lithium reserves by the Geological Survey of India (GSI), in Degana area, Nagaur district, Rajasthan are completely baseless and misleading," the survey organisation said.

It is to state that no such information was provided neither by the regional headquarters nor by the central headquarters of the GSI, it said.

It is to be informed that the GSI is carrying out exploration for tungsten, lithium and associated rare metals mineralisation in the Degana area, Nagour district, Rajasthan, since 2019-20 and the drilling work is still under progress. The resources will be established only after completion of the drilling work and finalisation of the report, it added.

The Economic Times (9.5.23)

Large steelmakers look for government support on path to green steel

Large Indian steelmakers are seeking some support from the local government as they look to produce green steel given that the higher costs of producing this steel is unlikely to be borne by end-users.

Steelmaking is an energy intensive business, and accounts for among the highest carbon emissions globally. Production of green steel basically means doing so without the usage of fossil fuels in order to cut down on carbon emissions.

While most steelmakers have committed to being net zero on emissions over a period of time, the process will entail significant costs.

“This transition to green will involve a lot of capital expenditure, if you shift from coal to gas or hydrogen, and at least for the next ten years will be more expensive,” TV Narendran, the chief executive officer and managing director of Tata Steel Ltd told ET recently.

One of the country's largest steel producers, Tata Steel, recently ran a trial for injecting hydrogen gas at its blast furnace in its plant at Jamshedpur, where it has the capacity to produce 12 Mt of steel each year. For the replacement of hydrogen as a clean fuel vis-à-vis coal, it has to be available at less than $2 per kilo, and must be green, Narendran said. The cost of the hydrogen used for the trials was around $12 per kilo which is not viable if it needs to be used at a large scale, he said.

Sajjan Jindal, chairman of the JSW group, which houses JSW Steel, said that while energy needs to become sustainable, customers are unlikely to bear the extra costs involved in making green steel.

"In India, we as an industry, don't believe that the government will be able to pay for these kinds of things. There could be some sort of cross subsidy that could probably happen, where they will put more tax of coal and then subsidise some industries," Jindal said at a recent discussion.

India has promised to be net zero on emissions by 2070. Tata Steel has a target of being net zero on emissions by 2045. Last month, Union steel minister Jyotiraditya Scindia said that the government may consider making it mandatory for local steelmakers to dedicate a portion of their output to green steel.

The Economic Times (10.5.23)

Tata Steel Mining inks pact to get LNG for Odisha plant from BPCL

In an attempt to secure long-term supply of liquified natural gas for its ferroalloys plant located in Odisha's Jajpur, Tata Steel Mining Ltd (TSML) has signed a memorandum of understanding with Bharat Petroleum Corporation Ltd (BPCL). As per the MoU signed here, central PSU BPCL will supply the agreed quantity of natural gas through its pipeline to the ferroalloys plant at Jajpur, said TSML, a 100% subsidiary of Tata Steel in a statement.

It said that the agreement is a part of TSML's sustainability initiatives and it will aid the business in significantly reducing its carbon footprint because it will allow it to produce ferroalloys using cleaner fuel LNG rather than furnace oil.

"Our partnership with BPCL will ensure a steady supply of LNG for our ferro alloys plant in Jajpur. This Memorandum of Understanding is consistent with our commitment to decarbonisation and our sustainability plan," TSML Managing Director Pankaj Satija said.

The Economic Times (12.5.23)

Enough growth opportunities within facilities to take capacity to 40 Mt in India: Tata Steel CEO

Tata Steel sees enough growth opportunities within its existing facilities to actualise an expansion plan to achieve 40 Mt capacity in India by 2030, almost double of its current capability in the country, CEO and Managing Director T V Narendran said. The steel giant will continue to hold talks with the UK government over a financial package for operations there, he said.

The company has planned capital expenditure to the tune of Rs 12,000 crore for India operations, he said.

"In India, basically we want to increase the capacity. We have already around 21 Mt. It will be 25 Mt soon because the Kalinganagar expansion is going on. We have a few more plans - Neelachal, Kalinganagar and Meramandali or Angul to achieve 40 million tonne capacity by 2030," Narendran told PTI in an interview.

There are multiple ongoing projects at various locations in India and the company has "prioritised completion of the 5 Mtpa Kalinganagar expansion", he said.

The company is in the process of expanding its plant capacity in Odisha's Kalinganagar to 8 Mt from 3 Mt.

"Within nine months of acquisition, we have successfully ramped up (the capacity of) Neelachal Ispat Nigam Ltd to one million tonne on annualised basis," he said.

The steel company, through its wholly-owned subsidiary Tata Steel Long Products Ltd, had completed the acquisition of Odisha-based one million tonne per annum steel mill NINL for a consideration of Rs. 12,100 crore in July 2022.

The Economic Times (14.5.23)

Jindal Stainless eyes 20% sales growth from rail projects, higher exports: MD

Jindal Stainless is looking to boost its sales volumes by 20% in 2023-24, aided by the company's participation in all major railways and metro infrastructures projects underway in the country, said its managing director, Abhyuday Jindal.

The government's removal of export duty on steel products will also help the company expand sales, he said.

The Centre had levied an export duty on most steel products briefly last year in a bid to arrest domestic inflation. The duty, which hurt the steel industry's export business, was scrapped in November. With this, the country's largest stainless steel player aims to increase its overall sales volume by 20% in this financial year to about 2.2 Mt.

"Anything that is being made in India and for India, and being made in India to export, we are a part of it," Jindal told ET.

The company, which was a supplier for the recently inaugurated Mumbai Metro lines, also has the Pune, Lucknow and the upcoming Mumbai Metro lines in its pipeline. Volumes from this segment are currently 12-15% of the company's revenue, and the company expects it to increase to 17-18% of the total volume, driven by the incremental demand.

Apart from the railways, sectors such as infrastructure, process industries and energy are likely to be major demand drivers for stainless steel, according to the Jindal Stainless managing director. Creating a non-corrosive infrastructure, as it is done in the developed countries, is also driving the demand for stainless steel, he said.

The Economic Times (19.5.23)

JSW Steel to acquire National Steel and Agro for Rs. 621 crore

JSW Steel will acquire flat-steel producer National Steel and Agro Industries (NSAIL) through the bankruptcy court for a cash consideration of Rs.621 crore through its wholly-owned subsidiary JSW Steel Coated Products, the company informed stock exchanges.

The steelmaker had got the approval from the Mumbai bench of the National Company Law Tribunal (NCLT) for its resolution plan last week, and the acquisition will be completed within 30 days of the effective date as in the resolution plan.

National Steel and Agro Industries, a manufacturer and exporter of steel from central India, had a turnover of Rs.815 crore in 2021-22 (April-March), and is primarily known for its flat steel products which include cold rolled coils, galvanised corrugated sheets, colour coils and pre-painted profile sheets etc.

This buyout is seen bringing synergy in terms of operations, procurement, marketing and sales for JSW Steel, it said. In accordance with the resolution plan, shares of National Steel and Agro will now be delisted from the exchanges.

The Economic Times (22.5.23)

JSW Steel, Japan's JFE Steel ink agreement to manufacture electrical steel in India

JSW Steel and JFE Steel have signed an agreement to set up a JV company to manufacture the entire range of cold rolled grain-oriented electrical steel (CRGO) products at Vijaynagar in Karnataka. In 2021, JSW Steel and Japan's JFE Steel signed a memorandum of understanding (MoU) to conduct a joint feasibility study to establish a CRGO manufacturing joint venture in India.

"The feasibility study has since been completed and both the companies have in principle reached an agreement to establish a 50:50 joint venture company (JV). The JV shall be able to manufacture the entire range of CRGO products at Vijayanagar, Karnataka, India," JSW Steel said in a statement.

This JV will be the first company to produce CRGO products with its entire chain of manufacturing processes in India. It aims to contribute to the rapidly growing domestic demand for CRGO.

The finalisation of the JV will be subject to the execution of definitive agreements and necessary regulatory approvals.

Jayant Acharya, Joint Managing Director & CEO, JSW Steel said, "The JV company would further strengthen JSW Steel's position as India's leading manufacturer of advanced steel products that lead to reduced CO2 emissions and create sustainable steel solutions".

The Economic Times (22.5.23)

Indian-global mills need technology breakthrough for Green Steel, face 30% cost increase

Steel makers in India and globally stare at a sharp 30 per cent increase in the production costs to manufacture 'green steel' for meeting their net-zero targets, experts said. Right now, there is no single definite technology for producing 'Green Steel' and whatever is available is based on different production process lines with different timeframes, said steel experts at the Singapore Green Steel Forum.

India's steel mills along with their global peer groups and consultants are seeking a major technology breakthrough to produce green steel, according to experts.

"Present estimates put production of 'Green Steel' 30 per cent higher compared with conventional steel that is being produced currently," said a consultancy group official anonymously.

"The debate is using electric arc furnaces based on green energy, which would be costly, and Blast Furnace (BF), which uses comparatively cheaper coal," the official said. "BF also offers large volume output compared to EAF," he added.

Nevertheless, it is healthy to note industry-wide talks and collaboration initiatives are on to seek solutions for making 'Green Steel', said another official.

"We are glad that both India and China, as large markets and producers of steel as well as industrial products, are focused on green products and have set net-zero targets," the official said.

The Economic Times (23.5.23)

JSW Group exploring possibilities to acquire coal mines in offshore markets

Homegrown firm JSW Group is exploring possibilities to acquire coking coal mines in offshore markets, industry sources said. The steel-to-infrastructure group is exploring the mineral assets in countries like Australia and Mozambique etc., they said.

“JSW Group is exploring possibilities to acquire coking coal mines in offshore markets like Mozambique, Australia etc. for captive purposes," sources said.

Captive coking coal mines will help group company JSW Steel reduce its cost of production for manufacturing steel, they explained.

JSW Steel is into manufacturing steel through the blast furnace route, a process which requires coking coal as a key raw material.

Due to the unavailability of coking coal, India remains dependent on imports to meet 85 per cent of its coking coal needs from far-located countries like Australia, South Africa, Canada and the US. Specifically, JSW Steel meets 60 per cent of its coking coal requirement via imports. JSW Steel is among India's top six steel manufacturing companies.

Business Standard (28.5.23)

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Chennai Metco Pvt Ltd	21
IREL (India) Limited	4th Cover

Chapter Activities — Mumbai, Bokaro, Kanpur, Kolkata

Mumbai Chapter : Second Srikumar Banerjee Memorial lecture

In memory of Late Dr. Srikumar Banerjee's outstanding achievements and contributions to the field of metallurgy, IIM Mumbai Chapter has instituted the "Srikumar Banerjee Memorial Lecture". The Inaugural lecture was delivered by Prof. Hamish Frasher and Prof R. Chidambaram on 25th April 2022.

This year on 25th April 2023 on the birth anniversary of Late Dr. Srikumar Banerjee, his friend and colleague Prof. Kamanio Chattopadhyay, National Science Chair, Department of Materials Engineering, Indian Institute of Science, Bangalore delivered Second "Srikumar Banerjee Memorial Lecture". The event was held at the DAE Convention Centre, Anushaktinagar, Mumbai, and was attended by around 150 people in person and an additional 50 online.

The event started with an welcome address by Shri Deependra Singh, Chairman of IIM Mumbai Chapter & CMD, IREL (India) Ltd. Prof. R Chidambaram, former AEC Chairman paid floral tribute to the photograph of Late Srikumar Banerjee. Prof. Rajsree Banerjee lit the lamp on the occasion.

Shri Deependra Singh imparted about the contributions of Late Dr. Srikumar Banerjee in the field of science and technology. Dr. R. Tewari, Chairman IIM Mumbai Chapter & Associate Director Materials Group BARC spoke about Srikumar Banerjee's guiding role in activities of Indian Institute of Metals. Subsequently, he introduced the Speaker Prof. Kamanio Chattopadhyay.

Prof. Chattopadhyay delivered the lecture on the topic "Physical Metallurgy at dissimilar interfaces: The evolving insights". The lecture was well-received by the audiences. After the talk, Dr. D. K. Singh, Secretary of the IIM Mumbai Chapter thanked Prof. Chattopadhyay for his insights into the latest developments in materials science. The event got a great success. Prof. R Chidambaram presented the memento to Prof. Chattopadhyay.

Bokaro Chapter

The Annual General Meeting of the Indian Institute of Metals, Bokaro Chapter was convened on May 4, 2023 at Zaika Happenings, Bokaro Steel City. The meeting was organised to apprise the members about the chapter activities conducted by the chapter in last one year and to plan for the year ahead along with election of the new Executive Committee members.

The new Executive Committee for the year 2023-24 is as follows :

- Chairman ➢ Shri B K Tiwari, ED(W), BSL
- Secretary ➢ Shri Nityananda Mondal, CGM, RDCIS, BSL
- Treasurer ➢ Smt. Biswasi Sunita Minz, DGM (RCL), BSL

Kanpur Chapter

1) Materials Camp :

A three-day 'Materials Camp' @ IIT Kanpur was organised by Material Advantage at IIT Kanpur, a student chapter in the Department of Materials Science and Engineering, in collaboration with American Society for Metals (ASM) International Kanpur Chapter, Indian Institute of Metals (IIM) Kanpur Chapter, and Indian National Academy of Engineering (INAE) Kanpur Chapter during May 6 - 8, 2023. The "Materials Camp" attracted participation of 38 students and nine teachers from nine schools of Kanpur (i.e., DPS Azad Nagar, DPS Kalyanpur, Dr. Virendra Swaroop Education Centre, Jai Narayan Vidya Mandir, Kendriya Vidyalaya IIT Kanpur, Methodist High School, Seth Anandram Jaipuria, Shieling House, and Sir Padmapat Singhania). Shri Pradeep Goyal, Senior Vice President of ASM International, graced the event with his online presence to inaugurate the event on May 6, 2023. Prof. Kallol Mondal, Head, MSE Dept. IIT Kanpur emphasised the role of material and processing in attaining required performance. Prof. Amarendra Singh, Chairman of IIM Kanpur Chapter, emphasised on the role of materials in civilization. Prof. Yogesh Joshi, Chair INAE Kanpur, elicited the convergence of all engineering fields through research in Materials Science. Prof. Sudhanshu S. Singh, Secretary of IIM Kanpur Chapter, also attended the event.

The first day sessions involved talks on "Classification of Materials" by Prof. Niraj Chawake, followed by real-life demonstrations on materials in a mobile phone by Ms. Shruti Dubey and Ms. Pooja Rani. After that Prof. Kantesh Balani delivered a talk on, "Fascinating World of Materials", which followed an impromptu session by Prof. Anish Upadhyaya on challenges in materials. Thereafter, a session on sample preparation and microscopy of various samples in physical metallurgy laboratory was coordinated by Mr. Gyan P. Bajpai and Mr. Ajay P. Singh.

The second-day session highlights included demonstrations of Electrospinning, Wetting, Lab-safety and Scanning Electron Microscopy by Mr. P. Shiven, Mr. Govind, Mr. Ajay P. Singh, Ms. Pooja Rani, Ms. Shruti Dubey, Mr. Murli Manohar and Dr. Deepak Khare with assistance of Mr. Dinesh Diwakar and Mr. Raj Babu. In addition, parallel session of virtual lab on "Electron Microscopy for Beginners" was demonstrated by Mr. Dhananjay Umrao, Ms. Sheetal, Mr. Vinay Tripathi, Ms. Reena, Ms. Suman Tripathi, and Mr. Harsh Dwivedi, and was very well received by students.

The third day of the 'Materials Camp' was more on mechanical testing and manufacturing processes to appreciate the utility of processing techniques in changing material shape and also attaining requisite performance. Shri Anil K. Verma, Shri S.K. Agnihotri, Shri I.P. Singh, Shri Rakesh K. Dixit, Shri Gaurav Mishra, Shri Gyanendra Singh, Shri Samardeep Shri Bharat R. Singh, and Shri Pappu Kannaujia anchored the event. Further, third day highlight was an industrial visit to Anod Plasma Spraying, wherein the surface preparation, and coating deposition techniques (such as plasma spraying, and flame spraying) on real-life components were demonstrated by Shri Ritik Tandon and Shri Viraj Tandon. The excitement was all evident in the eyes of participants and had not at all subdued even after three days of engaging sessions. The program ended with distribution of certificates to all the participants and concluded with a very positive note of satisfaction and grand success of 'Materials Camp'.

Glimpse of Materials Camp

Glimpse of Workshop on 'Characterization of Coating Materials'

2) Workshop on Characterization of Coating Materials :

The Indian Institute of Metals Kanpur Chapter jointly organised the workshop with Department of Materials Science and Engineering IIT Kanpur, Material Advantage, IIT Kanpur Chapter and Indian National Young Academics of Sciences (INYAS) in association with Anton Paar on Characterization of Coating Materials on 9th May, 2023 @ FB421, Department of Materials Science and Engineering, IIT Kanpur.

The workshop was on mechanical characterization techniques for the development and quality control of coated materials. Dr. Kallol Mondal, HOD of the

Department of Materials and Engineering at IIT Kanpur, Dr. Amarendra Kumar Singh, Chairman of IIM Kanpur Chapter, and Dr. Kantesh Balkani, faculty advisor of Material Advantage, IIT Kanpur, encouraged the students and demonstrated the importance of this workshop for the coating materials for structural Applications.

Dr. Ankit Jain, Mr. Jitendra Singh, and Mr. Abhishek Singh, all industry experts, were invited from Anton Paar. They conducted presentations to introduce the researchers to the X-ray diffraction spectroscopy equipment and the related solutions to combat different challenges related to various sample conditions for XRD analysis. The session provided participants with the opportunity to interact live with industry experts and gain practical experience. It featured practical training with a variety of cutting-edge surface characterization tools, including Calotest testers, nano-indentation, scratch testers, and tribometers. The mechanical characteristics of coatings, such as hardness, adhesion, wear resistance, and thickness, can be learned from these technologies in useful ways. There was also an online training for handling extremely complicated tribometer and scratch tester equipment. The session was attended by around 40 research students. The participants found the workshop very useful and informative for their own research work.

Kolkata Chapter

In memory of Prof. H.S. Ray a condolence meeting was held on 6^{th} May, 2023 at Nari Seva Sangha, Kolkata. The meeting was organised by IIM Kolkata Chapter in association with IAPQR and Millennium Institute of Energy and Environment Management (MIEMM). The attendees paid homage with floral offerings, songs, memorial talks. Shri Raj Shanker (son of Prof. H S Ray), Shri Bhaskar Roy, Acting SG of IIM, Dr. A K Ray, Shri T K Chakraborty, Shri P K Sen, Dr. Santanu Ray, Shri Subrata Ghosh of IAPQR, Dr. Barundeb Mukherjee, Ex-Scientist-CGCRI, Dr. S N Laha and many others shared their memories spent with Prof. H S Ray. Shri Subhasish Majumdar, President of MIEEM conducted the programme.

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Obituary Professor Hem Shanker Ray

With deep anguish and sadness we would like to convey that renowned Professor Hem Shanker Ray departed for his heavenly abode on April 28, 2023. He was the Honorary Member of IIM since 2005.

Prof. H S Ray, an alumnus of IIT Kharagpur, acquired his MSc and PhD in Metallurgy from the University of Toronto, Canada. Earlier in his career, he was the Assistant Professor at IIT Kanpur, Senior technologist and Manager of R&D, Pilkington Bros. Ltd., Professor of Metallurgical Engineering and Dean of Students' Affairs at IIT Kharagpur.

He served as the Director of the Regional Research Laboratory, Bhubane shwar. He was an Emeritus Scientist at Central Glass & Ceramic Research Institute, Kolkata, an Adviser to SAIL and MECON. He was honored with National Metallurgists Day Award in 1984, Kamani Gold Medal in 1979 and many more. He wrote innumerable books and papers on Popular Science, Creativity and different topics of Metallurgy. A pleasant personality, he was also popular for his knowledge in instrumental and vocal music, and skills in magic.

May his soul rest in peace.

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77th Annual Technical Meeting
The Indian Institute of Metals (IIM)
Incorporating International Symposium on
Sustainable Transformations in Metals Industry
22nd to 24th November 2023; Venue: KIIT, Bhubaneswar
Organising Chapters: IIM Sambalpur, IIM Angul, IIM Bhubaneswar in association with Hindalco Industries Ltd. and KIIT Deemed to be University
ADITYA BIRLA
HINDALCO
Main Themes of IIM-ATM 2023
Fundamentals of Metals & Materials Science
Advanced Non-Ferrous Metallurgy
Pig Iron
Cast Iron
Wrought Iron
Advanced Ferrous Metallurgy
Advanced Battery Technologies
CO_2
Decarbonization & Green Technologies
Industry 4.0
Raw Materials Processing
WASTE
WASTE COLLECTION
TO PLANT
WASTE PROCESS
ENERGY
Energy, Environment and Waste Utilization Generated from Metal Sectors
Advanced Materials Processing and Manufacturing Techniques
Industrial Safety in Minerals, Metal & Material-Based Industries

Metallurgy
Materials Engineering

IIM – ATM 2023

77th Annual Technical Meeting of the Indian Institute of Metals (IIM-ATM) and International Conference on Metals.

Date 22nd November – 24th November, 2023

Venue KIIT, Bhubaneswar

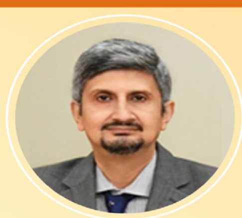
Organising Chapters IIM Sambalpur, IIM Angul in association with Hindalco Industries Ltd

The flagship annual event, IIM ATM, is a unique platform wherein the relevant people representing all significant sectors of industry, academia and R & D institutes from all parts of India join together to deliberate the future advancements and development initiatives. The participating Metallurgists and Material Scientists / Engineers will do lot of knowledge-sharing and speak about their rich experiences and do exchange of ideas.

The International Conference will throw light on contemporary topics of relevance such as green manufacturing, strategic and rare metals, additive manufacturing and accelerated development of materials. There will be various themes which covers all the crucial and emerging topics of interest that benefit of the industrial community at large. The valuable deliberations and presentations during the conference would also immensely benefit the research community in the field of metals and materials.

A Technical exhibition & Metallography contest on the theme topic and presentation of IIM Awards will be added attractions of the IIM-ATM 2023.

President of The Indian Institute of Metals : 2022-23



Dr. Samir V. Kamat, Chairman
Defence Research and Development Organisation (DRDO)

Incoming President of The Indian Institute of Metals : 2023-24

Mr. Satish Pai, Vice-President IIM
Managing Director
Hindalco Industries Ltd

TENTATIVE PROGRAMME SCHEDULE

22nd November
- Inaugural function
- International Conference
- Opening of Technical exhibition & Metallography contest

23rd November
- IIM Award ceremony
- IIM Memorial Lectures
- 77th Annual Technical Meet (ATM)

24th November
- 77th Annual Technical Meet (ATM)
- Valedictory function

Chairman : **Mr S S Mohanty**
Convener : **Mr Bibhu Prasad Mishra**

The IIM-ATM 2023 organising committee cordially invites you to join this magnificent platform of learning, sharing and networking. We also sincerely thank all our esteemed co-organizers for their active participation and involvement during this phase of programme conceptualization and planning.

Contact: bibhu.mishra@adityabirla.com

Second Announcement

IIM Metallurgy Materials Engineering

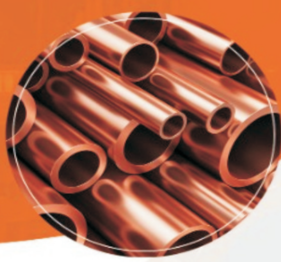
IIM-ATM 2023

77th Annual Technical Meeting of the Indian Institute of Metals

22nd – 24th November 2023

Venue: KIIT, Bhubaneswar

Organisers: IIM Sambalpur Chapter, IIM Angul Chapter, IIM Bhubaneswar Chapter and Hindalco Industries Ltd.



77th ATM 2023, an annual flagship event of IIM will be attended by many prominent industry captains, technical experts, senior academicians and students from various technical institutions from all parts of India and abroad. The ATM's multiple sessions are a centralised hub for sharing knowledge, exchange of ideas and deliberating new initiatives.

CHAIRMAN

MR SS MOHANTY
MD & CEO,
Essar Minmet Ltd.

CONVENOR

MR BIBHU MISHRA
Advisor,
Hindalco Industries Ltd.

- Online Abstract submission till 30th June 2023
- Be a Sponsor to the Mega Event of Industry and Academia
- Advertise in the 77th IIM-ATM Memorial Souvenir
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- For details log on to www.iimatm.org

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Come, Be a Part of the Brainstorming on Metal Industry.

- **9** Plenary Talks at the International Conference
- **40** Keynote Addresses
- **360** Technical Paper Presentations
- **300** Poster Presentations

22nd November

- Inauguration of IIM-ATM 2023
- Inauguration of Technical Exhibition
- International Symposium

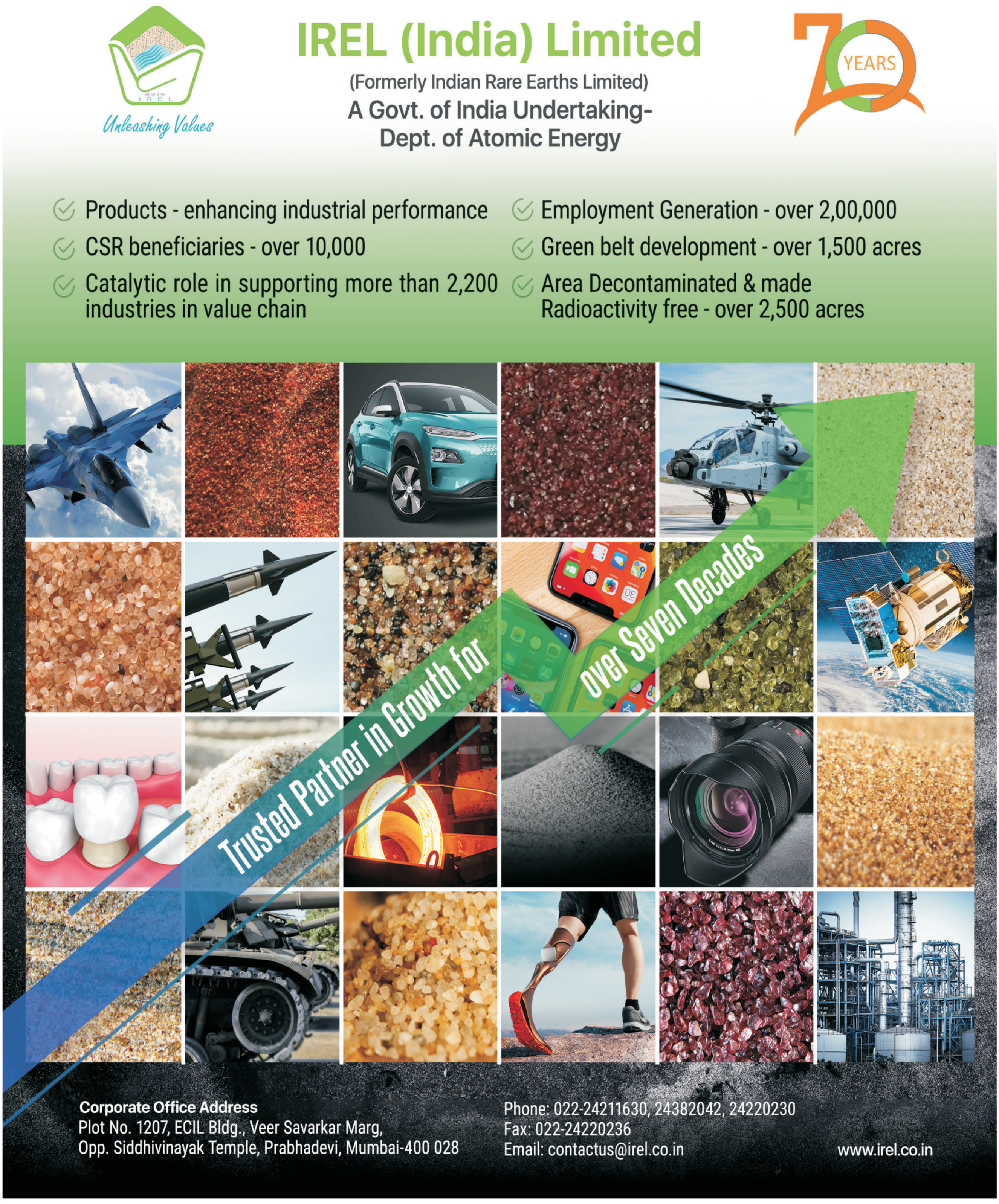
23rd November

- Inauguration of 77th ATM Technical Meeting
- IIM Award Ceremony
- IIM Plenary Lectures

24th November

- 8 Parallel Technical Sessions
- Valedictory Session

The IIM-ATM 2023 Organizing Committee, cordially invites you to join for a wonderful learning, sharing and networking experience, in Bhubaneswar - The City of Temples and the emerging Educational and Health Services hub of Eastern India. We look forward to your valuable participation and overwhelming support.



Unleashing Values
IREL (India) Limited
(Formerly Indian Rare Earths Limited)
A Govt. of India Undertaking-
Dept. of Atomic Energy
70 YEARS
Products - enhancing industrial performance
CSR beneficiaries - over 10,000
Catalytic role in supporting more than 2,200 industries in value chain
Employment Generation - over 2,00,000
Green belt development - over 1,500 acres
Area Decontaminated & made Radioactivity free - over 2,500 acres
Trusted Partner in Growth for over Seven Decades
Corporate Office Address
Plot No. 1207, ECIL Bldg., Veer Savarkar Marg,
Opp. Siddhivinayak Temple, Prabhadevi, Mumbai-400 028
Phone: 022-24211630, 24382042, 24220230
Fax: 022-24220236
Email: contactus@irel.co.in
www.irel.co.in