Industry Conclave

on

Indigenization of Materials (IndiMat)

Challenges & Opportunities in Strategic Sector

SOUVENIR

APRIL 29, 2025

CSIR-National Metallurgical Laboratory

Jamshedpur

सीएसआईआर-राष्ट्रीय धातुकर्म प्रयोगशाला
CSIR-National Metallurgical Laboratory

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- Corrosion Protection
- Advanced Coatings and Functional Materials

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Industry Conclave

on

Indigenization of Materials (IndiMat)

Challenges & Opportunities in Strategic Sector

APRIL 29, 2025

CSIR-National Metallurgical Laboratory Jamshedpur

IndiMat 2025

INDUSTRY CONCLAVE ON INDIGENIZATION OF MATERIALS

IndiMat-2025

MESSAGES

mahindra Rise

Anand G. Mahindra
Chairman

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April 20, 2025

To,
Dr Sandip Ghosh Chowdhury,
Director,
National Metallurgical Laboratory, Jamshedpur

Subject: Message for Indimat 2025

India's emergence as a global manufacturing powerhouse hinges on our ability to innovate, engineer, and indigenize across the entire value chain—from design and components to the very materials we build with. As we aim to realise the vision of Atmanirbhar Bharat, materials indigenisation is not just desirable—it is ***mission-critical****.*

I am delighted to know that CSIR-National Metallurgical Laboratory (NML), a cornerstone of India's metallurgical innovation for 75 years, is organising the "Indigenisation of Materials (IndiMat): Challenges & Opportunities in Strategic Sector" industry conclave to foster meaningful dialogue and collaboration around this very theme. Strategic independence in materials technology directly empowers Indian industries to rise to global challenges with confidence and competitiveness. Collaboration between the key stakeholders will be a key enabler for India to build the strategic independence that is vital in the emerging world order.

CSIR-NML's contributions in alloy development, component life extension, failure investigations, and metallurgical solutions have touched nearly every strategic sector, from defence and aerospace to transport and heavy industry. These contributions exemplify how scientific R&D can transform national capability and resilience.

I extend my heartfelt congratulations to CSIR-NML on its Platinum Jubilee and commend the vision behind the IndiMat'2025 conclave. I am confident that this initiative will inspire deeper industry-academia collaboration and lay the foundation for India's leadership in advanced strategic materials engineering.

Yours sincerely,

Anand G. Mahindra
Chairman
Mahindra Group

सत्यमेव जयते

डॉ. (श्रीमती) एन. कलैसेल्वी
सचिव
वैज्ञानिक और औद्योगिक अनुसंधान विभाग, तथा
महानिदेशक

Dr. (Mrs.) N. Kalaiselvi
Secretary
Department of Scientific & Industrial Research, and
Director General

भारत सरकार
विज्ञान और प्रौद्योगिकी मंत्रालय
वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद्
वैज्ञानिक और औद्योगिक अनुसंधान विभाग
Government of India
Ministry of Science and Technology
Council of Scientific & Industrial Research
Department of Scientific & Industrial Research

Message

The **Council of Scientific and Industrial Research (CSIR)** has long served as the cornerstone of India's journey towards scientific excellence and technological self-reliance. As one of its premier constituent laboratories, the **CSIR-National Metallurgical Laboratory (NML)** has consistently exemplified this spirit by pioneering innovations in materials science and metallurgy that have had a lasting impact on Indian industry, infrastructure, and strategic capabilities.

As CSIR-NML steps into its **75th year of transformative service to the nation**, the organization not only celebrates a legacy of path-breaking research but also reaffirms its unwavering commitment to advancing India's technological sovereignty. The **industry conclave on "Indigenization of Materials (IndiMat): Challenges and Opportunities in Strategic Sector"** being held as a part of these Platinum Jubilee celebrations, is both timely and visionary. It brings together eminent minds and institutions from diverse domains—research, manufacturing, defence, aerospace, and policymaking—to engage in meaningful dialogue on one of the most pressing imperatives of our time, the **indigenization of defence manufacturing.**

In an era where global supply chains are increasingly volatile, the ability to design, develop, and deploy strategic-grade materials within our borders has become not just a scientific goal, but a national necessity. CSIR-NML's outstanding contributions—ranging from **development of indigenous alloys, life extension strategies and rejuvenation protocols for critical components, failure investigation of critical components** —stand as testimony to how a world-class R&D institution can meaningfully contribute to the pillars of **national security, industrial competitiveness, and economic resilience**.

I extend my **heartfelt congratulations** to the leadership and scientists of CSIR-NML, as well as to all distinguished participants of the Indi Mat conclave. I am confident that the ideas, collaborations, and resolutions emerging from this forum will **shape the roadmap for self-reliance in strategic materials** and catalyze innovations that strengthen India's position as a global leader in advanced materials technology.

April 15, 2025
New Delhi

N. Kalaiselvi
(N. Kalaiselvi)

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डॉ. जयतीर्थ आर. जोशी
उत्कृष्ट वैज्ञानिक, महानिदेशक (ब्रह्मोस)
मुख्य कार्यकारी अधिकारी एवं प्रबंध निदेशक, ब्रह्मोस एयरोस्पेस
Dr. Jaiteerth R. Joshi
FNAE, FTAS, FIIM, FISNT
Outstanding Scientist, Director General (BrahMos)
&
CEO & MD, BrahMos Aerospace

सत्यमेव जयते

भारत सरकार
Government of India
रक्षा मंत्रालय
Ministry of Defence
रक्षा अनुसंधान तथा विकास संगठन
Defence Research & Development Organisation
ब्रह्मोस एयरोस्पेस
BrahMos Aerospace

MESSAGE

I am pleased to learn that CSIR-National Metallurgical Laboratory (CSIR-NML), Jamshedpur has completed 75 years of exemplary service in fostering metallurgical innovation and promoting material indigenization since independence. CSIR-NML has consistently demonstrated its relevance through high-impact contributions in alloy and process development, life extension, failure analysis, sensor development, and advanced testing protocols. As the nation moves towards a stronger "Atmanirbhar Bharat" vision, the role of material's indigenization in defense sector will be indispensable for ensuring self-reliance, and reducing dependency on imports for critical technologies like missiles, propulsion engines, and warheads.

At BrahMos Aerospace, our mission is driven by excellence in self-reliant and world-class defence technologies that safeguard India's strategic interests. The development of homegrown supersonic cruise missile systems like BrahMos stands testimony to the power of indigenization, interdisciplinary innovation, and long-term institutional collaboration.

The Industry Conclave on Indigenization of Materials (IndiMat) organized by CSIR-NML marks a momentous platform to deliberate upon the material backbone that powers strategic systems, including advanced alloys, propulsion-compatible materials, sensors, and high-performance composites.

I extend my heartfelt congratulations to CSIR-NML on the occasion of its Platinum Jubilee and for taking the initiative to organize IndiMat. I am confident that such platforms will foster meaningful collaborations and partnerships among various stakeholders, paving the way for India's accelerated growth as a global leader in indigenous strategic technologies.

(Dr. Jaiteerth R Joshi)

17th April 2025

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डॉ आर बालमुरलीकृष्णन
उत्कृष्ट वैज्ञानिक एवं निदेशक
Dr R Balamuralikrishnan
Outstanding Scientist & Director

सत्यमेव जयते

भारत सरकार, रक्षा मंत्रालय
Government of India, Ministry of Defence
रक्षा अनुसंधान तथा विकास संगठन
Defence Research & Development Organisation
रक्षा धातुकर्मीय अनुसंधान प्रयोगशाला
DEFENCE METALLURGICAL RESEARCH LABORATORY
कंचनबाग डाकघर, हैदराबाद - 500058
Kanchanbagh, Hyderabad - 500058

Dt. 17 Apr 2025

MESSAGE

I am delighted to learn that CSIR-National Metallurgical Laboratory is organizing a One-Day Industry Conclave titled ***"Indigenization of Materials (IndiMat-25): Challenges & Opportunities in the Strategic Sector"*** on April 29, 2025. This event is even more special as it coincides with the celebration of CSIR-NML's Platinum Jubilee. My warmest congratulations to everyone who has been a part of this remarkable journey of innovation and excellence.

The theme of IndiMat-25 is highly relevant, bringing together key stakeholders from manufacturing industries, research and development institutions, and end-user organizations to deliberate on the indigenization of materials for strategic applications. The ability to design, develop, and produce key materials within our national ecosystem empowers us to respond swiftly to emerging challenges, reduce external dependencies, and ensure operational readiness in mission-critical domains.

CSIR-NML has long been a pioneer in metallurgical and materials research. Its legacy of excellence, commitment to nation-building, and tireless pursuit of innovation make it a vital contributor to India's technical and technological capabilities. I strongly believe that the IndiMat-25 conclave will pave the way for insightful discussions, strategic partnerships, and groundbreaking ideas that will contribute to our national goal of self-reliance in critical materials and technologies for aerospace and defence.

On behalf of DMRL, I extend my best wishes for the success of the **IndiMat-25** conclave.

17/04/25

Dr. R. Balamuralikrishnan
Outstanding Scientist & Director DMRL

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ಡಾ. ಡಿ. ಕೆ. ಸುನಿಲ್
ಅಧ್ಯಕ್ಷರು ಮತ್ತು ವ್ಯವಸ್ಥಾಪಕ ನಿರ್ದೇಶಕರು
डॉ. डी. के. सुनील
अध्यक्ष एवं प्रबंध निदेशक
Dr. D. K. SUNIL
Chairman & Managing Director

-A Maharatna CPSE-

ಹಿಂದೂಸ್ತಾನ್ ಏರೋನಾಟಿಕ್ಸ್ ಲಿಮಿಟೆಡ್
ಪ್ರಧಾನ ಕಛೇರಿ
हिन्दुस्तान एरोनॉटिक्स लिमिटेड
मुख्यालय
HINDUSTAN AERONAUTICS LIMITED
CORPORATE OFFICE

MESSAGE

I extend my heartfelt congratulations to CSIR-NML on completing 75 illustrious years of dedicated service towards fulfilling India's metallurgical and materials needs.

The aviation sector mandates materials capable of withstanding extreme thermal, mechanical, and environmental challenges. At Hindustan Aeronautics Limited (HAL), we have always recognized that material science forms the backbone of indigenous development of aircraft platforms, engines, and defence systems. CSIR-NML has played a pivotal role in addressing the nation's evolving material requirements and has consistently adapted its expertise to meet emerging challenges. Over the years, CSIR-NML's significant contributions in the areas of gas turbine materials, failure analysis, and advanced alloy development have supported several critical HAL programs and enhanced our indigenous capabilities.

It is truly commendable that CSIR-NML is organizing the *IndiMat Industry Conclave* to catalyze a national dialogue on materials indigenization. This initiative is a testament to the institute's enduring commitment to India's strategic growth. Platforms like *IndiMat* are vital for fostering collaborative ecosystems essential to achieving India's aspirations of self-reliance in aerospace, defence, and space technologies.

I once again congratulate CSIR-NML on its Platinum Jubilee celebrations and the launch of *IndiMat*. I am confident that this initiative will steer new collaborations, strengthen industry-R&D synergies, and significantly contribute towards positioning India as a global hub for indigenous strategic technologies.

(Dr. D.K. Sunil)

Date: 17 April 2025
Place: Bengaluru

15/1, ಕಬ್ಬನ್ ರೋಡ್, ಬೆಂಗಳೂರು - 560 001, ಭಾರತ, 15/1, कब्बन रोड, बेंगलूरु - 560 001, भारत
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सीए एन गौरी शंकर राव
अध्यक्ष एवं प्रबंध निदेशक
(अतिरिक्त प्रभार)

MIDHANI

CA N Gowri Sankara Rao
Chairman and Managing Director
(Addl. Charge)

Message

It gives me immense pleasure to know that CSIR-National Metallurgical Laboratory (CSIR-NML), Jamshedpur has entered its 75th year, standing as a pillar of metallurgical excellence and material innovation, dedicated to fulfilling the nation's vision of self-reliance since the early years of India's independence.

I commend CSIR-NML's initiative of hosting the material's conclave on Indigenization of Materials (IndiMat): Challenges & Opportunities in Strategic Sector. IndiMat is a well-timed forum that brings together technologists, manufacturers, defence users, and R&D institutions to deliberate on the future of strategic materials.

Aligned with the theme of material indigenization embodied by the IndiMat Conclave, Mishra Dhatu Nigam Limited (MIDHANI) has consistently integrated metallurgical expertise with mission-critical applications spanning defence, aerospace, and atomic energy sectors. Indigenization lies at the core of our ethos, and we take pride in contributing to national initiatives aimed at enhancing material self-reliance. I convey my best wishes to the organizers and look forward to stronger collaborations between CSIR-NML, MIDHANI, and other stakeholders in our collective pursuit of Atmanirbhar Bharat in strategic sectors.

मिश्र धातु निगम लिमिटेड MISHRA DHATU NIGAM LIMITED
(भारत सरकार का उद्यम) (A Govt. of India Enterprise)
पंजीकृत कार्यालयः पी.ओ. कंचनबाग, हैदराबाद, तेलंगाना-500058. Registered Office: P.O. Kanchanbagh, Hyderabad, Telangana-500058.
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डॉ. सुमन रॉय चौधुरी
उत्कृष्ट वैज्ञानिक
निदेशक

Dr. Suman Roy Choudhury
Outstanding Scientist
Director

सत्यमेव जयते

स्वच्छ भारत
एक कदम स्वच्छता की ओर

भारत सरकार, रक्षा मंत्रालय
रक्षा अनुसंधान तथा विकास संगठन
नौसेना सामग्री अनुसंधान प्रयोगशाला
शील बदलापुर रोड, अति अंबरनाथ (पू)
महाराष्ट्र पिन - 421506
Govt. of India, Ministry of Defence
Defence Research & Development Organisation
NAVAL MATERIALS RESEARCH LABORATORY
Shil Badlapur Road, Addl. Ambernath (E)
Maharashtra Pin - 421 506

Message

Indeed, it is a great pleasure to note that CSIR-National Metallurgical Laboratory is hosting a One-Day Industry Conclave, "Indigenization of Materials (IndiMat-25): Challenges & Opportunities in the Strategic Sector", on April 29, 2025. The theme of IndiMat-25 is highly relevant, particularly in the context of enhancing national self-reliance in strategic materials for aerospace, space and defence applications. The initiative to bring together stakeholders from industry, R&D institutions, and user organizations is commendable, and such platforms are essential for addressing current challenges while envisioning future possibilities.

I am sure that this conclave will serve as a cornerstone for strategic collaborations and pioneering advancements in material indigenization. I strongly believe that the outcomes of this gathering will contribute to strengthening India's goal of self-reliance.

The event holds special significance as it also marks the celebration of CSIR-NML's Platinum Jubilee. I extend my heartfelt congratulations to the entire team for their sustained excellence and invaluable contributions to the field of materials and metallurgy.

I wish the organizers and participants of IndiMat-25 a successful and impactful conclave.

Suman R Choudhury

कार्यालय / Office : 0251-2623037 फैक्स / Fax : 0251-2623004 ई-मेल / E-mail : director.nmrl@gov.in

कमोडोर आशुतोष भट
कमान अधिकारी
Commodore Ashutosh Bhat
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भा नौ पो एकशिला
मुलगाडा क्षेत्र
मिन्दी पोस्ट
विशाखपट्टणम 530012

INS Eksila
Mulagada Area
Mindi Post
Visakhapatnam 530012

22 Apr 25

DO/242/AB

Dr. Sandip Ghosh Chowdhury
Director
CSIR- National Metallurgical Laboratory (NML)
Jamshedpur, Jharkhand 831007

CONTRIBUTION OF CSIR-NML IN INDIGENISATION OF DEFENCE TECHNOLOGY

Dear Sir,

1. Indian Navy, being the first responder and a frontline guardian of India's maritime interests, has always emphasized the need for operational readiness rooted in self-reliance. The indigenisation of materials and technologies, as identified by CSIR-National Metallurgical Laboratory, stands at the very heart of this vision.

2. Over the years, INS Eksila had the opportunity to engage with CSIR-NML and reap significant gains in augmenting Naval capabilities through R&D contributions. Successful studies by NML for residual life assessment and development of rejuvenation protocols have benefitted in extension of life and thereby, the continued operational availability of critical shipboard equipment/ components.

3. The "Indigenisation of Materials (IndiMat): Challenges and Opportunities in Strategic Sector" Industry Conclave being organized as part of CSIR-NML's Platinum Jubilee celebrations is indeed a timely and commendable initiative. It will not only serve as a platform for showcasing scientific achievements but also catalyse new collaborations between industry, R&D institutions, and defence services.

4. We, in the Indian Navy, believe that the road to true strategic autonomy lies in creating a robust ecosystem where advanced materials, indigenous technologies, and reliable component assessment methods coalesce to deliver operational superiority.

5. On this august occasion, I convey my best wishes to the organisers and participants of IndiMat. May this conclave pave way for deeper engagements and transformative solutions in the strategic materials domain.

Warm Regards

CSIR-NML
राष्ट्रीय धातुकर्म प्रयोगशाला
(वैज्ञानिक एवं औद्योगिक अनुसंधान परिषद्
विज्ञान एवं प्रौद्योगिकी मंत्रालय, भारत सरकार)
जमशेदपुर - 831 007, (झारखण्ड) भारत

National Metallurgical Laboratory
(Council of Scientific & Industrial Research
Ministry of Science & Technology, Govt. of India)
Jamshedpur - 831 007, INDIA

डॉ. संदीप घोष चौधुरी, एफ.एन.ए.ई
निदेशक

Dr. Sandip Ghosh Chowdhury, FNAE
Director

MESSAGE

CSIR-National Metallurgical Laboratory was established at 1950. This year, CSIR-National Metallurgical Laboratory is celebrating its 75 years of impactful service to the nation. We look back with pride at the legacy of scientific contributions that have shaped India's metallurgical and materials landscape. From pioneering research in mineral processing and alloy development to strategic collaborations with defence, aerospace, and space organizations, CSIR-NML has remained at the forefront of innovation and societal impact.

The *Industry Conclave on "Indigenization of Materials (IndiMat): Challenges and Opportunities in Strategic Sector"*, being held as part of our Platinum Jubilee, is a testimony to our commitment toward National Missions like "Make in India" and "Atmanirbhar Bharat." It seeks to forge deeper engagements of Research Laboratories like CSIR with Industry, and strategic stakeholders to realize the vision of indigenous excellence in materials and metallurgical sector.

We are confident that this conclave will ignite transformative ideas, foster collaborations, and chart new pathways for the indigenization of strategic materials.

I extend a warm welcome to all dignitaries, speakers, and delegates. Let us come together to build a self-reliant India powered by materials science and metallurgical innovation.

(Sandip Ghosh Chowdhury)

Date – 23rd April, 2025
Place – CSIR-NML, Jamshedpur

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Working Days : Monday to Friday (09.15 am - 05.45 pm)

CSIR – National Metallurgical Laboratory

The National Metallurgical Laboratory (NML) was founded with the laying of its foundation stone by Hon'ble Shri C. Rajagopalachari on November 21, 1946. It was officially inaugurated and dedicated to the nation by Pandit Jawaharlal Nehru on November 26, 1950, “in a spirit of hope and faith in the future.” The establishment of the laboratory was a key component of Sir Shanti Swaroop Bhatnagar's vision to create a network of research institutions aimed at advancing India's progress in science and technology. Today, CSIR-NML is committed to achieving excellence in research and development in the fields of minerals, metals, and materials, encompassing both basic and applied science, technology, industrial services, and human resource and skill development.

CSIR-NML conducts cutting-edge research in various areas of metallurgy and materials science, addressing industrial challenges and contributing to technological advancements. The broad areas of R&D and flagship programmes at CSIR-NML are:

Broad Areas of R&D:

- **Materials Science & Engineering:**
  - Development and characterization of advanced materials, including steels, alloys, high entropy alloys, and aluminium alloys for industries such as cement, aerospace, defense, automotive, and electronics.
  - Research on thermomechanical processing, metal and alloy forming, and techniques such as cold and hot rolling, forging, and extrusion.
- **Additive Manufacturing (3D Printing):**
  - Research on the development of 3D printable metal/alloys powder technologies and materials for rapid prototyping and manufacturing.
- **Sensors, Devices & Materials Characterization:**
  - Development of new sensors and devices for material degradation, inspection, power plants and space and manufacturing industries.
  - Advanced techniques for analyzing and characterizing materials at the micro and nanoscales.
- **Corrosion & Surface Engineering:**
  - Study of corrosion mechanisms (aqueous, hot & molten salt) and prevention strategies for metals and alloys, including coatings, paints, and corrosion-resistant materials.
  - Development of corrosion protection techniques for industries such as marine, oil and gas, and infrastructure.
- **Nanomaterials & Nanotechnology:**
  - Development of novel nanomaterials (Graphene, 2D materials) for applications in electronics, healthcare, and energy.
  - Development of advanced amorphous alloys and coatings for energy applications.
- **Metallurgical Extraction & Process Engineering:**
  - Innovations in metal extraction, refining, and recycling.
  - Research on environmentally friendly processes for producing metals and alloys.
- **Waste Management & Recycling:**
  - Development of sustainable recycling methods for industrial waste and optimization of material reuse.
  - Solutions for improving resource efficiency in industries like steel, mining, and metallurgy.

Flagship Programmes:

CSIR-NML runs several flagship programmes aimed at pioneering research and technological advancements in metallurgy, materials science, and related fields. These programmes are designed to tackle critical industrial challenges, foster innovation, and contribute to the growth of key sectors like extraction, manufacturing, energy, and defense. A few key flagship programmes include:

1. Centre of Excellence for Wear and Corrosion Resistant Coatings Technology: The center will focus on four key areas of research and development:

- Non-metallic Coatings: Development of non-metallic coatings designed for infrastructure and highly corrosive environments.
- High-Performance Zinc Alloy Coatings: Creation of corrosion-resistant and powdering-resistant zinc alloy coatings, particularly for industries such as automotive, infrastructure, and railways, along with colorized zinc coatings.
- High-Temperature Material Upgradation: Enhancement of material performance at high temperatures, including the development of NiCr, NiCr-SiC, and MAO coatings for applications in thermal power plants, concentrated solar power (CSP), and aerospace, with a focus on microstructure tailoring.
- Erosion/Wear-Resistant Coatings & SCC Corrosion Fatigue Mitigation: Research on coatings that prevent erosion and wear, as well as the mitigation of stress corrosion cracking (SCC) and corrosion fatigue in critical industries such as hydro power plants and the nuclear sector.

2. Advanced Ultra Super Critical (AUSC) Materials Evaluation: This program focuses on the development of advanced materials evaluation and technologies for power plants operating under ultra-super critical conditions. CSIR-NML has been one of the partnering organizations in India's Mission Programme on Advanced Super Critical Power Plant, wherein the laboratory was involved in generating material data for qualification and design of indigenously developed materials to be used in boiler and turbine sections. This involves a host of mechanical tests such as creep, ductile fracture, fatigue crack growth, creep fatigue interaction studies, creep crack growth studies and high temperature oxidation and fireside corrosion studies simulating Indian coal ash conditions.

3. Development of Advanced NDE-Based Diagnosis and Prognosis Protocols: Creating advanced non-destructive evaluation (NDE) techniques for diagnosing and predicting the condition of materials in AUSC power plants. These protocols aim to improve the reliability, efficiency, and lifespan of critical components under extreme operational conditions, ensuring safe and optimal performance in power generation.

4. Rare Earth Extraction: This program focuses on sustainable and innovative methods for extracting critical rare earth elements and other valuable metals. The key areas include:

- Holistic Utilization of Red-Mud for Extraction of Metallic Values and Residue Utilization: Development of an integrated process to extract aluminum (Al), iron (Fe), titanium (Ti), and rare earth elements (REEs) from red-mud, a byproduct of aluminum extraction. A 100 kg feedscale of red-mud has been provided to delegates from NITI Aayog, NALCO, HINDALCO, Vedanta, and partner R&D laboratories to further this initiative.
- Extraction of Critical Metals from spent Li-Ion Batteries: Research on developing efficient methods to recover valuable metals such as lithium, cobalt, and nickel from used lithium-ion batteries. This initiative promotes recycling, supports resource conservation, and contributes to the advancement of a circular economy by reducing e-waste and reusing critical metals in new products.

5. E-Waste Cluster: This program aims to address the growing challenge of electronic waste (e-waste) by focusing on capacity building and technological advancements. Key initiatives include:

- Informal Sector Capacity Building and Upgradation: Strengthening the capabilities of the informal e-waste sector through training and development, helping to improve the efficiency and safety of e-waste recycling processes.
- Formation of Recycling Clusters under the MSME Scheme: Establishing organized recycling clusters under the Micro, Small, and Medium Enterprises (MSME) scheme to streamline and enhance e-waste recycling efforts.
- Enabling Technology for Resource Recovery: Developing and implementing advanced technologies for the recovery of valuable materials from e-waste, such as metals, plastics, and rare earth elements, thereby promoting resource efficiency and supporting a circular economy.

6. Strategic Metals: This program focuses on the development of innovative processes for the extraction and production of critical & strategic metals. Key activities include:

- Magnesium Production from Calcined Dolomite: The establishment of a pilot-plant facility for producing magnesium using the Pigeon process, derived from calcined dolomite, aims to provide a more sustainable and efficient production method. This process offers an environmentally friendly alternative to traditional magnesium production techniques, reducing energy consumption and minimizing carbon emissions, while enhancing resource utilization.
- Molten Salt Electrolysis for Sodium and Gadolinium Production: Development of a molten salt electrolysis process for the extraction of sodium and gadolinium, with the technology now ready for commercialization, enabling more efficient and environmentally friendly metal production.
- Recovery of Tungsten from Gold Mine Tailings and Alloy Scrap: Development of processes for recovering tungsten from gold mine tailings and alloy scrap, improving resource recovery, and reducing waste in the mining and metallurgy industries

Our Collaborators

NML has established a wide range of collaborations with both academic institutions and industries, including prominent government organizations such as:

- Indian Armed Forces, Indian Navy, DAE, BARC, IGCAR, NFDC, DST, DMRL, BHEL, NTPC, ONGC, IOCL, BPCL, SAIL, HAL, ISRO, Indian Railways, RDSO, various Ordinance Factories, MECON, ARDB, NRB, and many more.

In addition, NML partners with leading private sector companies, including:

- Tata Steel, JSW, Kalyani Steel, Vizag Steel, Essar Steel, JSPL, NALCO, Tata Motors, Vedanta, Hindalco, The Boeing Company (USA), Aditya Birla Group, Tata BlueScope, IFB Ltd., Quaker Chemicals, L&T, GE India, Bharat Forge, Ramakrishna Forging, Ashok Leyland, Shree Cement, GACL, Pfizer, Reliance Industries, and various refineries, among others.

About the Conclave

India on the path of Indigenization

India's strategic sector has undergone a remarkable transformation over the past decade, evolving from a largely material/technology import-dependent entity to a one with increased focus on self-reliance and indigenous production. Central to this transformation is the growth of India's defence manufacturing industry through initiatives such as "Make in India" and "Atmanirbhar Bharat", which has led to increased domestic production of defence grade materials and reduced dependence on foreign procurements. This paradigm shift has been a key component in positioning the Nation as an emerging hub for the production (and even export) of advanced defence technologies and equipments. On the other hand, the Indian Space sector has indigenously achieved remarkable and unprecedented feats in the past decade such as the launch of GSAT-11, Mars Orbiter Mission, Chandrayaan-2, Aditya-L1, Chandrayaan-3 etc., leaving the global contemporaries awestruck. All these success stories of ISRO are due to rigorous indigenization efforts and exhaustive background R&D activities.

Objective of IndiMat

Considering the impetus behind indigenization in Indian Strategic Sector, this industry conclave aims to provide an interactive platform to the leading manufacturing industries, premiere R&D institutes and dominant end users for discussions on the present status and major material challenges in the path of indigenization with respect to global standards, and to deliberate on the way forward through possible futuristic collaborations.

Scope of IndiMat

This conclave aims to provide a forum for interaction and exchange of knowledge/information regarding recent initiatives in the strategic sector towards indigenization of materials. The conclave will feature presentations by eminent speakers from defence organisations, major manufacturing industries and leading R&D institutions in the strategic sector.

Organising Committee

Dr. Sandip Ghosh Chowdhury, Director, CSIR-NML	
Dr. S. Sivaprasad, Chief Scientist	**Dr. Snehashish Tripathy,** Principal Scientist

TECHNICAL COMMITTEE	HALL MANAGEMENT COMMITTEE
Dr. Mainak Ghosh, Chief Scientist **Dr. Rajinikanth,** Sr. Principal Scientist **Dr. Suman Tewary,** Senior Scientist	**Dr. Kanai Lal Sahoo,** Chief Scientist **Dr. G.K. Mandal,** Sr. Principal Scientist **Dr. Atanu Das,** Principal Scientist **Mr. Sudip Kundu,** Principal Scientist
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Dr. V.C. Srivastava, Chief Scientist **Dr. A.K. Sahu,** Senior Technical Officer (3) **Dr. Naveena,** Senior Scientist	**Dr. J.K. Sahu,** Chief Scientist **Dr. H.N. Bar,** Sr. Principal Scientist **Dr. Avanish Chandan,** Senior Scientist **Dr. V. Shiva,** Scientist

Technical Programme

08:45 – 09:15 am	Registration
09:15 – 9:55 am	**Inauguration of the Event** Chief Guest: **Shri Jasbir Singh Solanki** CEO, Naval Systems, Homeland & Cyber Security, Mahindra Defence, Pune
10:00 – 10:30 am	Tea and Photography
Keynote Lecture Session - I	
10:30 – 10:55 am	**Shri Atul Kumar Srivastava** Vice President & Head - Hazira, Strategic Manufacturing Complex–L&T PES
11:00 – 11:25 am	**Shri Kundan Singh** Executive Director, Metal & Steel Factory - Ichhapur
11:30 – 11:55 am	**Dr. B. Basu** Outstanding Scientist, Naval Materials Research Laboratory, Ambernath
12:00 – 12:25 pm	**Shri V. N. Anil Kumar** General Manager, Foundry & Forge Division, HAL, Bengaluru
12:30 – 12:55 pm	**Shri Anand Dubey** Dy. CEO, Aluminium Alloy, Vedanta Limited, Jharsuguda
01:00 – 01:25 pm	**Dr. N. Eswara Prasad** Director R&D - MGIT Hyderabad and Former Director, Defence Materials & Stores Research & Development Establishment Kanpur
01:30 – 02:15 pm	LUNCH
Keynote Lecture Session - II	
02:15 – 02:40 pm	**Dr. D. S. Bag** Scientist G, Defence Materials & Stores Research & Development Establishment Kanpur
02:40 – 03:05 pm	**Commander Vishal Katheria** Dy. Officer in Charge, Indigenization Unit, Eastern Naval Command, Vishakhapatnam
03:05 – 03:30 pm	**Wg. Cdr. Praveen Narayan** Aircraft Service Division, 11, Base Repair Depot, Indian Air Force, Nasik
03:30 – 03:55 pm	**Dr.–Ing. C.V. S. Kiran** Vice President, R&D and Strategic Initiatives - Skyroot Aerospace Hyderabad
03:55 – 04:20 pm	**Dr. Ramprasad B.** Scientist/Engineer-SG, Liquid Propulsion Systems Centre ISRO Bangalore
04:20 – 04:45 pm	**Platinum Jubilee Capsule Video of CSIR-NML & Tea**
04:45 – 06:00 pm	**Expert Panel Discussion on** 'Way forward towards Self-Reliant Indian Defence and Space sector: Roadmap for R&D - Industry handholding'
07:30 pm onwards	NETWORKING DINNER

INDUSTRY CONCLAVE ON INDIGENIZATION OF MATERIALS

IndiMat-2025

ABSTRACTS

INDIGENIZED MILITARY MATERIAL, A KEY TOWARDS 'ATMANIRBHARTA' IN DEFENCE MANUFACTURING

Jasbir Singh Solanki

Naval Systems, Homeland & Cyber Security
Mahindra Defence Systems Limited, Pune

Abstract

Availability of military material has a crucial role for India to achieve its Sel-reliance in defence manufacturing. India has a significant import dependency for strategic military materials and is majorly dependent on countries like Australia, Brazil, few African nations and Russia. Although there have been a few success stories in substituting imported material with indigenously produced materials, defence manufacturers still heavily rely on imports to fulfil their requirements. This dependence put a huge constraint on the ability of Indian organisations to manufacture defence equipment / platforms. In the case of aero engines, one of the reasons for slow development of an appropriate aero engine with required wet engine thrust is the non-availability of indigenous metal for critical engine components. Resultantly, we are still relying on imported aero engines to power our indigenous fighter aircraft programme. This dependency has also led to delays in the Tejas Mk I and Mk 1A deliveries.

One of the largest Aircraft DPSU, imported raw materials worth Rs 3,629.4 crore ($ 500 million) in 2018-19. Six Indian defence businesses imported high alloy steel worth Rs 5250 crore in 2018-19. ($700 million). Despite availability of some of the military grade materials in India, they are not being used for military applications due to the lack of Know-How. In some cases, cost of development of indigenous material is marginally higher than its imported counterpart. For exotic material development, India requires better testing facilities. Lack of testing facilities impedes the creation of novel materials, making the country reliant on imported resources.

After years of R&D by Defence Material Research Lab (DMRL) and Naval Materials Research Lab (NMRL) and with help from the USSR /Russia, appropriate steel for warship and submarine programme has been developed and the technology has been transferred to the private steel manufacturers such as Essar Steel who now supply these special steels to the DPSU Shipyards.

While steel is one of the materials required for warship or submarine which would take care of hull and superstructure needs. There are various other material and composites which are required in Warships and Submarines in other critical structures.

Composites are also increasingly required in fighter aircraft fabrication, for military vehicles, light weight and strong military structures, weapons and missiles, torpedoes, munitions among others. Each requires a different type of composite. Development of these composites require huge investment in R&D.

Another case in the point being is French origin Scorpene Submarines from Naval Group. The hull of these six submarines were built under ToT by MDL from imported steel of France. The OEM (Naval Group) did not agree to the ToT for fabrication of this steel in India citing quality control concerns. This has been the same case with imported fighter aircraft and metallurgy of aircraft components which has not been shared. Policy-level initiatives by the GoI and government entities are underway and also DAP 2020 addresses some of the major issues highlighted above. Additionally, there is a need for Government and industry to collaborate on long-term domestic capability development. A think tank or nodal body should aggregate incentives from several ministries into a strategic material strategy with frequent milestone monitoring.

Indian defence industry still relies on imported materials for MRO of imported platforms and equipment. To overcome this shortcoming in the imported defence platforms, DAP must include a provision for ToT or Offset Obligation to an Indian entity for manufacture of metal used in those platforms and its component structures. This will allow telescoping timelines of R&D by CSIR or DRDO labs for developing special metals, alloys and composites.

Our certification standards also need follow internationally recognised norms for certifying materials rather than products. This will remove platform recertification and allow designers to pick from available option of approved materials. Each defence supplier should have a self-reliance indicator that compares raw material imports to the overall requirements. This will foster healthy competition for defence companies to minimise raw material imports.

L&T'S CONTRIBUTION IN INDIGENISATION OF MATERIALS, PROCESSES & EQUIPMENT FOR LAND AND NAVAL PLATFORMS & SYSTEMS

Atul Kumar Srivastava

Hazira Strategic Manufacturing Complex – L&T Precision Engineering and Systems

Abstract

L&T has been associated with the manufacture of multiple complex defence equipment for the last four decades. During this period L&T has built an all-round technical capability and infrastructure, mostly organically, through in-house R&D efforts. L&T has also contributed immensely in building a robust supply chain for defence products within the country and thereby strengthening the Nation's aspiration of being self-reliant in areas of defence equipment.

L&T harnesses this niche inhouse R&D capability into realising complete system of systems and platforms, having developed capabilities for manufacturing high end systems like, Turrets, Hulls, Fire Control Systems, Ballistic Materials, Platform Control Systems, Application Software, Hydraulic systems, Automatic transmissions, Running Gears & Tracks and Hydraulic Suspension Units, and integrating all of these to perform in-sync. Leveraging these, L&T has developed 155 mm 52 Cal artillery Gun systems, the K9 Vajra-T, Air Defence Gun systems, besides Pinaka Artillery rocket Launch systems and BM21 upgrade systems for Land forces.

Rolled Homogenous Armour (RHA) steel was successfully developed in India and ballistic tests were successfully performed before using in K9 Vajra Program. Robust GMAW welding process was developed to avoid hydrogen Induced cracking and eliminated back gouging and NDT of chip-back groove.

L&T has also played very important role in indigenisation of naval platforms and systems. L&T has inhouse indigenously designed & built fast Interceptor Boats for ICG, industry partner of NMRL-DRDO for Air Independent Propulsion for conventional submarines, partnered with DRDO for BRAHMOS & DHANUSH missile launch systems, Naval artillery systems such as WM-18 rocket launchers, ASW rocket launch systems, Torpedo Launchers, Propulsion shafting and Waterjet Propulsion Systems, etc.

L&T in partnership with various DRDO labs (DMRL, NMRL etc.) have indigenously developed & completed the certification of High Strength Low Alloy (HSLA) steel; forgings and welding consumables for Naval programs. L&T has recently indigenised Micro Alloy Steel for Naval Platforms.

Suitable GMAW, SMAW, SAW & GTAW welding processes with higher productivity variances like Twin-head, Tandem twin, square butt & tee, robotics, etc. have been developed for all thicknesses and consumables. L&T has indigenised composite materials and processes for Carbon Fibre Reinforced Plastic (CFRP), Glass Fibre Reinforced Plastic (GFRP), sandwich composites using high performance resin systems for Space, Missiles & Aerostructures and Naval platforms in collaboration with R&D institutes/laboratories.

L&T Special Steel and Heavy Forging has developed forgings for steam generators (shells, cones, tube sheets, and dished ends), forgings for pressuriser, SS plates for Calandria and end shields, Lattice tubes & end fittings, Headers and High-pressure piping for Nuclear projects.

REQUIREMENTS OF HIGH PERFORMANCE ADVANCE MATERIALS & SPECIAL QUALITY STEELS FOR INDIGENIZATION IN DEFENCE SECTOR UNDER "MAKE IN INDIA" AND "ATMANIRBHAR BHARAT" INITIATIVE

Kundan Singh

Metal and Steel Factory, Ishapore-743144 (A Unit of Yantra India Limited)

Abstract

MSF is committed to cater the requirements of high performance advance materials and special quality steels for indigenization, in terms of metallic materials required for Indian Defence Strategic Sector and to evolve successfully with the radical changes in line with government policies as well as Global Scenario. Herein, MSF is focussing on the requirements as well as advancement of ferrous materials having high strength to weight ratio meeting the requirement of very stringent inclusion rating i.e. A, B, C & D=1.0 (for Thin series) & Nil (for Thick series) with globular oxide (DS) - Nil utilised mostly for various critical defence ordnance items like 58 calibre gun barrels, breech rings etc., seamless tubes of EN -24 grade & NATO Series specification for forged quality Aerial Bomb as well as non-ferrous materials like alloys of Cu, Al, T & Ni based and other non -ferrous alloys specially for super alloys & aero space industries. Also the current import - export statistics justifies the need is enormous and will be multifold in future. However, all this needs to be achieved through “Make in India"' as well as "Atmanirbhar Bharat" initiatives which can be very well fulfilled by adapting well defined policies, developing favourable infrastructure and global collaboration for technological advancement in Strategic Sector.

Absorption or development of advanced defence technology is a slow process due to its complexity and difficult to forecast business risk involved, even though, the Government is committed to transform India to a Defence Industry Hub and export reached to Rs.23.622 Crore in FY: 2024-25 having growth of 12.04% over FY: 2023-24.Irrespective of technologies, the advance materials will play a role for efficiency and effectiveness of the current/future technology. The high performance and speciality (Ultra Clean) steels need for improvement in strength, stiffness, toughness and able to be produced in large quantities at a reasonable cost. These materials also need to have light weight improved thermal stability and excellent performance at high strain rates.

At present, the defence sector is heavily using various types of steel like carbon steel low & medium alloy steel, stainless steel, other alloy steels, super alloys, copper and aluminium & its alloys. The steels being used are having strength in the range 0.5 to 1.5 GPa but future requirements being forecasted for ultrahigh strength ultra clean steel beyond 2GPa with toughness about 50 Joules. Wherever drastic weight reduction is required, Ti and its alloys are slowly replacing steel. Development is also going on for developing new Aluminium based alloys and Nickel base super alloys. Each material choice is application specific and is selected based on its strengths. Today, the need is to develop advanced materials i.e. High performance and speciality steels through indigenization for strategic defence sector to improve the performance of the current technologies as well as to adopt new technologies.

R&D INITIATIVES TOWARDS SELF-RELIANCE IN DEFENCE SECTOR

B. Basu

Naval Materials Research Laboratory, DRDO, Ambernath

Abstract

India's defense sector has undergone a significant transformation towards attaining self-reliance through targeted domestic R & D initiatives aimed at developing critical materials and technologies to meet demanding operational requirements of India's armed forces. With the depth of material science knowledge available within the country, from the strategic importance point of view, Defence Research and Development Organisation (DRDO) has led multi-disciplinary research across a wide range of materials including high-strength structural steels, maraging steels, aluminium alloys, titanium alloys, advanced welding consumables, high entropy alloys, advanced composites, radar-absorbing materials, ceramics, paints and smart coatings. These research efforts have led to realisation of various products in naval platforms, armoured vehicles, aerospace systems, and missile technologies. A flagship success in this journey is the indigenous development of high strength naval structural steel with its allied welding technology by DRDO resulting in the development of DMR grade steels of different strength grades now being used in platforms like INS Vikrant and other frontline warships and submarines. These indigenously developed steels have superior strength, enhanced fracture toughness at low temperatures, required fatigue and dynamic properties, excellent welability and high corrosion resistance in marine environments. The overall development process involved laboratory-scale development, pilot-scale trials and eventually technology transfer to industries for large-scale production. This has been possible through extensive research and development in alloy design, steel making, microstructure-processing-property correlation, welding technology establishment, corrosion resistance improvement and large-scale industrial production through close collaboration between researchers, metallurgists, naval architects, Indian steel making industries and shipbuilders ensuring real-time feedback and continuous improvement. There have been technical as well as technological challenges such as availability of quality raw material sources, specialised steel making and processing technologies within narrow window, different product forms, mastering quality in up-scaled production, customised testing requirement and infrastructure, robust application oriented certification methodologies. These challenges have been addressed and largely resolved as we got progressively matured in establishing such technologies with active support from users and development partners. Each successful material development reduced import dependency and strengthened India's strategic autonomy. With support from initiatives like Make In India and increased academic and public-private collaboration, India's defence R&D ecosystem have created a robust ecosystem for defense-grade high quality, high performance steel production.

MATERIAL CHALLENGES AND OPPORTUNITIES IN RECENT AND NEAR FUTURE INDIGENIZATION ATTEMPTS

V. N. Anil Kumar

Foundry & Forge division, Hindustan Aeronautics Limited, Bengaluru.

Abstract

The indigenization of aerospace materials in India has transitioned from a difficult goal to a national strategic priority; this shift has been driven by changes in geo-politics and strong support from the Indian government to become self-reliant. Hindustan Aeronautics Limited (HAL) has taken the lead in this journey by building local capabilities to meet the stringent requirements of defense and aerospace specifications.

Material Challenges

Despite substantial investments in infrastructure for material development, testing, and quality assurance, several challenges have continued to hinder the indigenization of aerospace materials. One of the key difficulties lies in addressing the wide variety of specifications originating from multiple countries for the same material, which complicates standardization and development efforts. Additional hurdles include low Minimum Order Quantities (MoQ), coordination challenges with certifying agencies such as CEMILAC and DGAQA, and the need for laboratory accreditations aligned with aerospace standards.

The complexity further increases due to the diversity of specifications required for various platforms—Aircraft, Helicopters, and Aero-engines. This is particularly demanding for low-volume, high-performance materials such as Aluminum, Steel (typically VAR or ESR grades), Titanium (Double and Triple Melt grades), and Nickel alloys (VIM + VAR), where typical batch sizes range from just 3 to 5 tons. The long lead times associated with testing and airworthiness certification, combined with the limited economic viability of small-scale production and non-recurring demand due to irregular defence order placements, have discouraged many indigenous suppliers.

Moreover, aerospace materials demand strict adherence to quality management systems, documentation practices, traceability, test repeatability, long-term data retention, and third-party accreditations—culminating in airworthiness certification. Developing such materials to maturity involves significant time, technical effort, and investment. Given the relatively low domestic demand, India currently lacks the production volumes needed to make material development economically attractive for many private or public sector entities.

Material Opportunities

Over the last decade, India has seen a notable rise in opportunities for aerospace material indigenization. This has been driven by government initiatives like “Make in India,” which supported the development of local infrastructure for raw material production, testing, and quality assurance.

These efforts helped Indian manufacturers overcome the earlier challenges of varied international specifications, as many Indian mills are now equipped to meet global aerospace standards. Improvements in order volumes by projecting next 3-5 years requirement and also requirements from various other PSUs such as Bharat Dynamics Limited BDL , Mazagon Dock Shipbuilders Limited (MDL) etc and clearer procurement strategies have also helped address issues related to low Minimum Order Quantities (MoQ).

Strong support from certifying agencies like CEMILAC and DGAQA, along with good coordination between industry and certifying agencies has made the approval process more streamlined. More Indian laboratories are obtaining required accreditations, making it easier to meet certification needs. As a result, manufacturers are now more confident in handling the specification diversity for Aircrafts, Helicopters, and Aero-engines. Increased volumes of high-spec materials like Aluminum, Steel, Titanium, and Nickel alloys—especially with HAL's projected demand of over 50,000 metric tons in five years—have made small-scale production more viable.

In addition, the improved consistency in defence orders placed by the 16 DPSUs has encouraged more suppliers to invest in indigenization. The introduction of Global Tender Enquiry (GTE) and the use of platforms like GEM have further boosted opportunities for Indian manufacturers by simplifying procurement, vendor qualification, and certification processes.

Transformation: From Import Dependence to Global Supplier Potential

The shift from a limited opportunity to a building indigenous ecosystem has been accelerated by a combination of Government policy, industrial investment, and geopolitical climate and the guidance of Ministry of Defence (MoD). India's domestic suppliers are no longer focused only on meeting Indian defense needs—they are now strategically positioned to serve global aerospace supply chains. Certification to international standards (AS9100, NABL, and DGAQA) and capability enhancements in melting, forging, heat treatment, and non-destructive testing have made Indian suppliers viable partners in the international aerospace materials market.

In conclusion, what began as an effort to mitigate import dependency has evolved into a robust, forward-looking strategy. HAL's leadership, along with proactive government policies and growing industry competence, has enabled India to not only meet its domestic aerospace materials requirements but also to emerge as a competitive player in the global supply chain.

INDIGENIZATION OF HIGH-PERFORMANCE ALUMINIUM ALLOYS FOR STRATEGIC APPLICATIONS: TOWARDS SELF RELIANCE

Anand Dubey

Vedanta Limited, Jharsuguda

Abstract

Vedanta Ltd. Aluminium business stands as India's largest producer of Aluminium, contributing over half of the Nation's output. Vedanta is actively expanding its production capacity, diversifying product portfolio and investing in Research and Development to drive innovation and sustainability. Through strategic capacity expansion, a diversified product range and a strong focus on R&D, Vedanta Aluminium is positioning itself as global leader. In the pursuit of innovation and advancement, Vedanta has remained steadfast in its commitment towards pursuing ambitious R&D initiatives. This presentation encompasses Vedanta's effort on new product development and innovative solutions to the customers. Recent development of advanced Aluminium alloys caters to the requirements of Defense, Aerospace, Marine, High speed trains, Automotive and Electric Vehicles segments. This initiative aligns with the "Make in India" programme, aiming to reduce dependency on imports and strengthen domestic manufacturing capabilities.

NICHE INDIAN MATERIALS R&D/S&T INITIATIVES FOR SELF-RELIANCE IN DEFENCE PRODUCTION OF PRODUCTS, PROTOTYPES AND SYSTEMS

N. Eswara Prasad

Mahatma Gandhi Institute of Technology (MGIT), CBES, Hyderabad-500075

Abstract

Niche and Advanced materials, such as the materials for airframe, aero engine and aero missiles are not only some of the highly complicated and most advanced of the present day structural materials, but they are essential ingredients of any Nation's force economic multipliers, including Exportable Defence Systems. This is because the use of such materials ensures high fuel efficiency, enhanced structural reliability and low safety factors as well as ease to fabricate, inspect and repair. These materials also when adopted properly with advanced cutting edge technologies, international standard manufacturing capabilities and cost-effective production, they would make the systems the International best.

India has made several innovative contributions and significant strides in this important technological arena in the recent past and the present talk would illustrate some of the author's 4 decade experiences in Advanced Materials' R&D and S&T, which have led to several hundred crores INR airworthy production of products, prototypes and systems for Indian Defence. In this talk, effort will also be made to briefly cover salient features of design, existing Indian Industrial base, as also the relative advantages/merits of the presently available as compared to their alternate niche materials. Finally, the author will present the avenues of Industrial exploitation, including scope for exports.

R&D CHALLENGES AND OPPORTUNITIES TOWARDS SELF-RELIANCE IN ADVANCED MATERIALS AND SMART SYSTEMS FOR INDIAN DEFENCE

Dibyendu S. Bag

Defence Material and Stores Research and Development Establishment, DRDO, Kanpur

Abstract

Materials play a critical role in the realization of any concept, and development of any technology and system. Polymeric materials and composites are highly demanded in every aspect of our basic need as well as in the development of cutting-edge technologies because of their certain advantages over other materials like metals, alloys and ceramics such as light weight and ease of manufacturing process and low cost. Two aspects should be considered while discussion in materials research, challenges and opportunities in this 21st century: materials evolution and technological expectation. An example of the evolution of aeronautical materials may be cited. The first aircraft of 'Wright' brothers (Wilbur and Orville Wright), in 1903 was made up of 100% wood and fabric. In 1915 Junkar J1 was made of 100% steel, in 1917 Junkar J7 used 100% duralumin and subsequently in 1949 De Havilant Comet used 100% aluminium alloys. In 1972 polymer composites were introduced in Airbus A300 which used 4% polymer composites and over the period in the year of 2013, 53% composites are used in Airbus A350. Indian Light Combat Aircraft (Tejas) is having 45% polymer composites which is weighing only 9 tons, as compared to 19 tons for similar type of aircraft elsewhere in the world. Future flight path in 2050 relies on the development of new materials for aerostructures with improved specific properties and novel manufacturing techniques. It should have 75% reduction in CO2 emission, a 90% reduction in NOx emission and less than once accident per 10 million commercial flights. The perceived noise emission of flying aircraft should be reduced by 65%. Air vehicles should be resilient by design to current, and predicted on board and on-the-ground security threat evolution, internally and externally to the aircraft. They should be designed and manufactured to be recyclable.

Now-a-days, technological expectations are mainly automation and sustainability. The demand of fulfilling the requirement of cutting-edge technologies in defence and aerospace is to impart (i) smart and intelligent features into materials and systems, (ii) self-healing action, (iii) morphing structures, (iv) ensing and actuation capabilities, (v) electromagnetic functionality, (vi) in-situ energy harvesting and power generation, (vii) energy absorption and dissipation, (viii) thermal management, (ix) others likes - optical, non-linear optical, photo-switching, laser controlled, etc. Moreover, multifunctional smart materials and systems are demanded to fulfill the multi-mission objectives by a single material or a structure and system.

Self-healing materials can repair themselves if damage is initiated during service condition. Hence it can provide safety aspect of the components in its use as well as longevity. Therefore, it can also help us to create a more sustainable future. In the 21st century, with the changing scenario of sophistication and automation, advanced and smart materials have lots of opportunities and potential to change technology and design principles completely toward the creation of smart defence systems as well as 'smart world'. However, lots of challenges must have to be overcome for the successful integration of such materials into systems and their applications. This presentation describes an overview of such advanced and smart materials including R&D initiative and indigenization program at Author's laboratory.

FROM DEPENDENCY TO DOMINANCE: MATERIAL INDIGENIZATION AND TECHNOLOGICAL SELF-RELIANCE IN THE INDIAN NAVY

Vishal Katheria

Indigenisation Unit, Eastern Naval Command, Indian Navy, Visakhapatnam

Abstract

The topic explores the material challenges and opportunities encountered in the Indian Navy's recent and upcoming indigenization initiatives. Drawing from the Navy's institutionalized approach, the topic highlights the complexity of sourcing and developing advanced materials domestically, the persistent technology gaps-especially in weapons and sensors—and the supply chain vulnerabilities exposed by global disruptions. Despite these hurdles, the Navy's structured indigenization plans, robust engagement with industry (including MSMEs), and government-backed roadmaps have enabled significant progress, with platforms like INS Visakhapatnam achieving high indigenous content across critical segments. The topic emphasizes the importance of industry-Navy collaboration, long-term vision, and converting challenges into opportunities to achieve true self-reliance and position Indian industry as a global leader in naval material innovation.

LIFE EXTENSION OF MILITARY AIRCRAFT – CHALLENGES AND WAY AHEAD

Praveen Narayan

Aircraft Service Division, 11 Base Repair Division, Indian Air Force, Nasik

Abstract

The longevity of military airpower is being tested by aging fleets, delayed procurements, rising acquisition costs and ever changing geo-political environment. In this evolving defence environment, extending the service life of legacy aircraft has become essential not just to maintain readiness, but to ensure strategic and fiscal sustainability. This presentation examines the inevitable implementation of military aircraft life extension in the Indian context, challenges and way forward. the presentation aims to explore methods for structural and systems upgrades, assess cost-benefit outcomes compared to new acquisitions, and highlight the role of innovation and indigenisation through Indian industry in sustaining long-term fleet effectiveness.

A detailed case study of the Indian Air Force's MiG-29UPG program illustrates a successful model of comprehensive modernisation along with a Life extension program. The upgrade with enhanced avionics, improved combat capabilities with new weapon systems and extended service life of airframe from 25 to 40 years and beyond is a classic example of the feasibility of transforming legacy systems into potent multirole assets through targeted enhancements. India's defence ecosystem in conjunction with Defence R&D establishments, academia and Indian industry—including public sector units like HAL and BEL and a growing network of MSMEs—plays a critical role in obsolescence management and life enhancement through reverse engineering, indigenous component manufacturing, and licensed production under joint ventures. Military aircraft life extension is no longer a stopgap but a strategic necessity. By combining advanced engineering, indigenous manufacturing, and predictive technologies like digital twins, our nation can maintain combat readiness while controlling costs. For India, integrating Research and Development, industry and innovation will be key to institutionalizing sustainable and independent aircraft sustainment strategies.

MATERIALS' SOVEREIGNTY – STRATEGIC SECTOR IMPERATIVES

C. V. S. Kiran

Skyroot Aerospace Private Limited, Hyderabad

Abstract

India’s quest for strategic self-reliance is deeply intertwined with its ability to indigenize critical materials across defence, aerospace and atomic energy domains. Achieving materials' sovereignty is a strategic imperative for India’s defense, space, and advanced technology sectors. This keynote will explore recent material challenges - such as import dependence, qualification hurdles and supply chain vulnerabilities, while highlighting emerging opportunities in indigenous alloy design, advanced manufacturing and public-private collaborations. With a focus on translating R&D into deployment, the talk outlines a roadmap for building a resilient, future-ready materials ecosystem aligned with national missions like Make in India and Aatmanirbhar Bharat. Emphasis will be placed on building resilient supply chains, accelerating technology deployment and fostering collaborations to secure India’s strategic future.

INDIGENIZATION INITIATIVES IN SPACECRAFT PROPULSION SYSTEM - CHALLENGES AND PROGRESS

B. Ramprasad

Liquid Propulsion Systems Centre (LPSC), ISRO, Bengaluru

Abstract

Government of India's flagship program make in India had provided Impetus for indigenization efforts across various areas of technology. In my talk I will briefly touch upon few of the activities in which we are liquid Propulsion systems centre have put efforts towards indigenization. Onboard propellant gauging in a spacecraft is one of the crucial technology that involves numerous challenges. Accurate measurement of hazardous propellants in a given envelope maintaining high standards of operational integrity and reliability in harsh space environment is a technological challenge. I will talk on the concepts and applications of the same including its use in the Bharatiya Antriksh station (BAS). I will also touch upon other indigenization requirements in non-destructive evaluation and it's applications in niche areas of spacecraft propellant tank and its part manufacturing using cold metal transfer technology.

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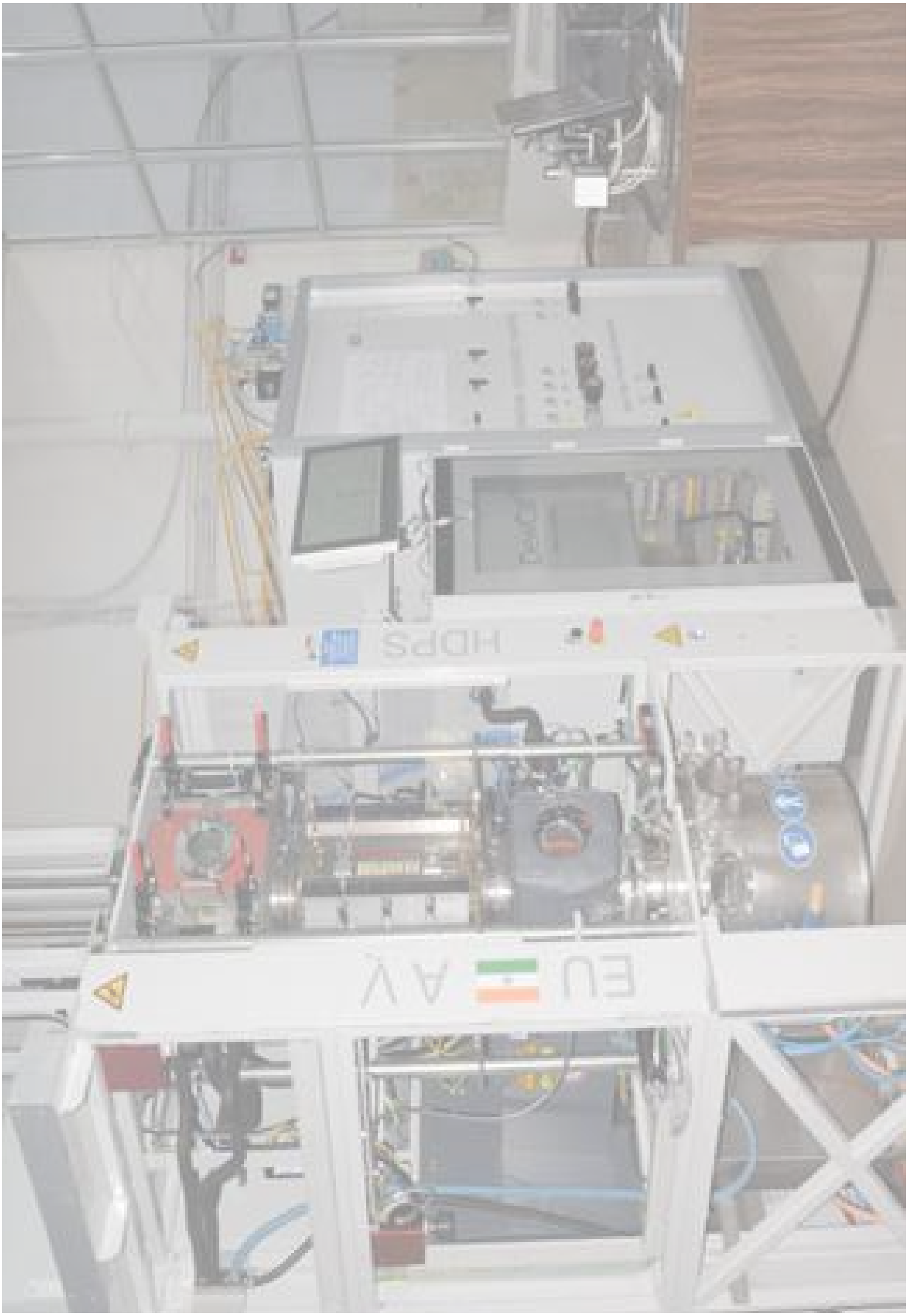
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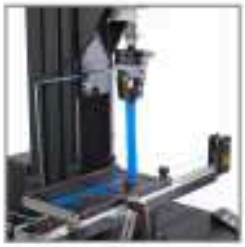

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