



Intellectual Capital



Turning new ideas into possibilities

Aluminium and copper offer endless possibilities for creating new shapes and forms, unlocking the potential of technology. Our R&D efforts are two pronged. We tap internal expertise in product development, manufacturing, design; and we partner with recognised institutions to meet the fast-growing demand for new-age products.

Digital technologies have been a key driver in innovation at Hindalco and we are leveraging the digital transformation of our business and processes to deliver superior products to our customers. Our R&D capabilities have enabled us to enter and succeed in the high-end downstream product segments in a big way.

Key Highlights

114

Patents filed

320

Patents granted

₹716 CR

Research and Development (R&D) investments

40

New products and applications developed

Contributions to SDGs



Value Enhancing Growth

SP-2

Value enhancing growth

SP-3

Strong ESG Commitment

SP-4

Portfolio Enrichment

Interlinkages with Material Topics and Other Capitals

Material Topics

R&D innovation and Technology

Capitals Connected

Financial Capital

Manufactured Capital

Natural Capital



Our Focus Areas

Strengthening R&D for downstream products

New technological solutions

Product quality and performance

Digitalisation

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All of Hindalco's plants are equipped with their own research and development centers and technical cells

beverage can and specialties markets. Our Spokane centre in Washington specialises in molten metal processing. Gottingen center conducts R&D for new products and processes that can be added to our portfolio. At Koblenz and Zhenjiang we have innovation centers for aerospace. We also have centers in Ulsan and Detroit.

Development of Products

This year we took significant strides on new product development and will continue our efforts in the years to come to expand to other segments. As aluminium and copper are key metals and will be essential in future megatrends, we are exploring solutions and products that can be developed to cater to the market.

For aluminium-related products and processes, our focus is on developing specialty alumina-based products and their application in refractory castable and improving the efficiency of the Bayer's process. We are innovating aluminium-based solutions for coaches and railway wagons, recyclable packaging, and new-generation aluminium-based solutions. In the areas of EV and mobility, we plan to jointly develop aluminium-based solutions for Original Equipment Manufacturers (OEMs). The OEM's commitment to sustainable, lightweight, and high-performance products opens an opportunity for us to develop products in this sector.

We are focusing on developing new downstream products as well as value-added products from copper slag, electrorefining, electrowinning of copper, and mass balance of impurities from copper smelting and refining. We have developed two applications which have been accepted by the customers and two applications are at pilot stage in lab.

that all our labs are technically and analytically sound. In addition to that, all the plants are equipped with their own research and development centres and technical cells.

Our centres encompass the full spectrum of research and development, applied technology, and market-led innovation. At HIC-Belagavi, we conduct R&D related to bauxite, specialty alumina & hydrate and Bayer's process. At Talaja, we have HIC Tribology and HIC Semi-fab. We conduct R&D related to oil and lube at HIC Tribology, and aluminium-related metallurgical applications at HIC Semi-fab. HIC-Dahej specialises in R&D related to copper smelting, copper refining, byproduct applications and copper-related services.

Novelis is working on expanding the portfolio by introducing new technologies. It has eight research centers and four Customer Solution Centers (CSC) across the globe. At the Georgia, Shanghai and Sierre locations, we conduct innovations for applications of aluminium in the automotive,

Innovation at Hindalco

We foster a culture of innovation throughout the development cycle of our products and processes. Our focus is to strengthen the R&D capacity to develop downstream products and bring new technological solutions as we contribute toward India's Net-Zero Goal.

With support of a strong R&D team, we filed 114 patents in FY2021-22 and 320 patents were granted including patents applied in previous years. We invested ₹716 Crore in the R&D portfolio in FY2021-22.

We have four Hindalco Innovation Centers (HIC) at Belagavi, Talaja and Dahej with world-class R&D facilities. Our HICs are recognised by the Department of Scientific & Industrial Research (DSIR), Government of India. Quality assurance is important for us, and all our labs are accredited by the National Accreditation Board for Testing and Calibration Laboratories (NABL) with standard 17025:2005. The accreditation assures

At Novelis, we are continuously focusing on reduction of energy, waste, water as well as carbon footprint. On the technological front, we have developed BPA_ni coating for can end sheets, coating products and coffee capsules made with high recycled-aluminium content sheets.

HIC	Products and applications developed and accepted by customers	New products and applications developed in lab
HIC Belagavi	9	7
HIC Tribology	2	5
HIC Semi-fab	3	5
HIC Dahej	2	2



Novelis has eight research centers and four customer centers across the globe

Development of Hydrate to Produce EN45545/HL Composite for Railway Metro (Equivalent to ON904)

Railway vehicles are categorised as per the fire-safety Hazard Level (HL) associated with their operation and design. EN45545/HL is the European standard for fire safety with HL1, HL2, and HL3 as hazard levels, where HL1 is the lowest and HL3 is the highest. We have developed a special hydrate for EN45545/HL-3 composite for polymeric composite products. Our hydrate will be used as filler in the composite materials

of railways and metros and will make the coaches safer to travel. The Total Global sales potential is 130 KTPA and Indian Potential is 3 KTPA. Our product is commercialised as grade name HLV213 and is approved in Europe.

Development of Low Soda Submicron reactive alumina

Reactive alumina comprises fine particles with high thermal reactivity and low water absorption capacity. We have developed reactive alumina with low soda content with improved high-temperature mechanical properties.

It is produced through extensive milling by using specialised grinding aid to avoid agglomeration. Due to its properties, it is used in fine and advanced electro-ceramics and castable refractories. The plant trials of the product are completed, and the commercialisation of the product is in progress.

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Development of Precipitated Superfine Hydrate



We have developed a precipitated superfine hydrate to replace the halogen filler in fire retardants. Our product can bear temperature and has better flame resistance compared to conventional fillers and is developed through a precipitation process. We have completed the plant trials and the patent has been filed for the process. We will supply the hydrate to manufacturers of polymeric cable, composite silicone insulators and fire retardants. We plan to expand the capacity from 30 KTPA to 60 KTPA in the future.

Development of bimodal reactive alumina



We have developed bimodal reactive alumina for self-flow refractory castable. We developed this product by controlling milling of two feeds and by using grinding aid. We are also testing this value-added product in low cement castable composition to check the flowability and the strength. The process is developed at the lab and tested at the plant scale. We have also started commercialisation of the products.

DEVELOPMENT OF EPOXY BASE COAT FOR AC FINS AT TALOJA

AC fin stocks are used in domestic and industrial Heating, Ventilation and Air conditioning (HVAC) applications, and have stringent performance requirements of strength and formability. Epoxy coats are applied to the fins for protection and durability. Under Govt. of India's PLI scheme, at Taloja, we are planning to put an AC fin coating line.

As coating material is one of the major contributors to the cost of manufacturing coated fins, we have developed an in-house epoxy coat for AC fins. With this development, we expect a 30% cost reduction for coated AC fins.

ALUMINIUM E-BIKE PROTOTYPE

A large segment of urban last mile delivery service segment is being catered to by the e-bicycle segment. Aluminium frames are a preferred choice for these bikes and the market is currently reliant on imports to meet the demands.

Considering this as an opportunity, our HIC Semi-fab has designed and assembled an e-bicycle using aluminium frame manufactured by Hindalco Extrusions. We are also exploring preliminary CAD tools for frame designs and automating frame performance feasibility analysis under various load cases.

BB590- ALUMINIUM BUSBAR ALLOY

We have developed a new patented aluminium busbar alloy BB590 in association with Renukoot FRP for application in two-wheeler electric vehicles. BB590 is characterised by excellent formability and electrical conductivity. This product has best-in-class current carrying capacity and corrosion resistance. It also significantly improves electrical and thermal conductivity making it ideal for electrical applications. Actual application has shown a consistent 25% increase in wire pull-off load in assembly, thereby improving the reliability of the battery pack. We have tested the alloy successfully passed resistivity, corrosion and welding tests. We are currently manufacturing Busbar prototypes for testing at battery pack level.

Delivering High Quality

Aluminium has become the metal of choice for manufacturers across the globe. It is being used in a myriad of applications with expectations of different performance attributes. Hindalco is an industry leader, well known for delivering high-quality products with strict adherence to the customer's requirements and international quality standards.

Our R&D centres are constantly working to enhance the value provided to the customers through improvements in product performance and quality. To improve the process and ensure quality delivery of products, we conduct Life Cycle Assessment (LCA) at all our plants. We identify the potential impacts of products and services during their entire lifespan and take measures to reduce the impacts.

In FY2021-22, we initiated a refresh of the LCA for products from five of our downstream plants, out of which we have completed the assessment for Mouda.

QUALITY IMPROVEMENT OF LIBERATOR CATHODE AT COPPER REFINERIES

At the Birla copper, the electrolyser collects about 120-160 m³/day of electrolyte to control the concentration of copper and impurities (As, Bi, Sb) in the electrolyte. Copper from the solution is recovered in the liberator section by an electrowinning process using a Pb-Ca-Sn alloy as the anode. The reprocessing or recycling of liberated cakes is a challenge due to high levels of contamination. We have developed two processes to reduce the impurities in the liberator cathode and the inventory of copper. Before

electrowinning, the electrolyte must go through flocculation and centrifugation. At the same time, the quality of the existing liberator cathode inventory can be improved by grinding and screening. In this case, the impurities are separated into finer fractions and can be recycled.

With the application of the two processes, we observed improvement in the quality of the liberator cathode with a 90% reduction of arsenic and reduction in copper inventory.

ALLOY QUALITY IMPROVEMENT- DURANIUM™ BETA

In FY2020-21, we developed and patented a new alloy, Duranium™. This alloy provides superior strength and a better surface finish. In FY2021-22, we launched window systems made with this alloy.

This year we have developed a beta version of this alloy which seeks to enhance mechanical properties by approximately 20% as compared to the first-generation Duranium™ alloy which itself is a superior product compared to the competition.



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COLD CLADDING TECHNOLOGY

The cladding technology in the aluminium industry currently has inherent drawbacks leading to poor recovery, high cost and inconsistent quality. After initial lab development in collaboration with IIT Madras, we conducted pilot trials for one-side clad in FY2020-21. These trials demonstrated extremely good metallurgical bond between the core and liner alloy, and lab brazing simulations gave promising results. We also attempted two side cladding in these trials. Material produced from these trials was subjected to customer evaluation. We carried brazing

trials in a production furnace and performance evaluation was done by the customers.

Clad layer characterisation showed improved thickness percentage and uniform Silicon particle distribution with the novel method. The customer feedback that we received has been encouraging, and commercial qualification trials have been requested. We have completed the basic engineering of the technology and specifications have been agreed with the customer for commercial trials in FY2022-23.

and Technology Centre. For aluminium-based rechargeable battery and MELD on solid-state additive manufacturing technology, we have collaborated with Graphene Manufacturing Group. For the development of coated current collectors, collaboration with Birla Carbon and Novelis is underway.

We are also developing a solution for utilising processed copper slag in cement industry and are trying to implement an arsenic recovery process from the liberator cake waste of our copper plant. We are working with IIT Gandhinagar for extended process development for Ag/Au recovery from primary dore-slag from Precious Metal Recovery (PMR) plant.

We are partnering with Manush Labs, a startup incubator platform, to find innovative startups for finding solutions to alternative non-plastic packaging and Flue Gas De-sulphurisation (FGD) waste utilisation. We are working with IIT Bombay on a Bauxite residue neutralisation project, using flue gas from a power plant and polymeric bricks from waste Bauxite residue and fly ash, the latter project nearly at commercial stage.

Digital Hindalco

We have embarked on a journey of digital transformation and are continuously working to create best-in-class Information Technology (IT) infrastructure with robust cybersecurity. We have developed an IT policy to protect data and improve digital security. In addition, 90% of our IT infrastructure is certified with ISO 27001 Information Security Management System. We test our IT infrastructure twice a year for any potential cyberattacks and conduct external verification to identify the cyber threats and possible impacts on business.

We have a defense-in-depth strategy, which includes access on a need basis, 24x7 Security Operation Centre (SOC) to detect anomalous activity and incident threats, with Incident Review (IR) system and security controls at

different levels. We have introduced advanced technologies like Endpoint Detection Response (EDR), Secure Web Gateway and Network Access Control to further safeguard the infrastructure from threats. We have made updates to the existing Security Information and Event Management (SIEM) system, which identifies the patterns that could indicate cyberattacks, including other technologies like Security Orchestration, Automation, and Response (SOAR). In addition, we are focussing on introducing a Web Application Firewall (WAF) with Protocol Analysis Module as an engine, to block the users who don't comply with our firewall policy.

We keep our employees informed and updated about information security and cyber security through e-trainings and frequent communications. We conduct an annual information security week to increase awareness on digital security and cyber security. We have also developed a capability development programme, DISHA (Digital Shiksha), to upskill the workforce on the Internet of Things (IoT), Analytics, Augmented Reality (AR), asset maintenance, and other digital technologies. We educate all the newly joined employees about information security at the orientation programme. In the event of suspicious activity, the employees can register a complaint at the intranet portal, and then further actions are taken.

Our Directors and the executive committee members are involved in the decision-making related to information technology and cyber security. The Risk Management Committee looks after our cyber security strategy. Our Chief Information Security Officer (CISO) oversees the preparedness against cyber-attacks and ensures appropriate action is taken to safeguard company assets. As a result, we received no complaints regarding loss of data, breaches, and thefts, and the entire system was protected from cyber-attacks in FY2021-22.

TRACK AND TRACE

To track and trace our shipments sent by road, railways, and sea, we have adopted end-to-end digitalisation using IoT. Our domestic shipments are sent by road and railways and international by sea. To keep a bird's eye view over several outbound shipments, we track the shipments sent by road transport by GPS powered by digital dashboard. This enables us to get complete visibility and ensures security of the shipment. In case of emergency situations, the system notifies the drivers in the locality for help and also lists out nearby police stations to call for assistance. Through this system,

we can also predict delays and plan for mitigation actions.

We use the Indian railway's database for tracking shipments sent by rail. We track time live status, estimate the delay time, if any, and plan for the unloading of the shipments using data from this system.

The shipments that we send by sea are tracked by a third-party integrated platform which helps us keep an eye on our shipments, any potential stoppages and plan for quick delivery. We also detail out the mitigation actions for anticipated delays in the future.

BLOCKCHAIN SUSTAINABILITY SYSTEM FOR WASTE MANAGEMENT

Blockchain system is ideal for waste management as it stores data in blocks, provides a transparent and secure records ensuring that no one can tamper those records. At Hirakud, we installed a blockchain sustainability system for waste management to efficiently track waste from generation to end-of-life cycle transparently which aligns to UN-SDG for quantification into sustainability

metrics. The platform also enables us to authenticate certification for waste processing from the vendors, ensuring that the waste is actually being processed and does not get disposed unethically in the value chain. After the successful application of the technology at Hirakud, we also plan to implement this blockchain technology solution at our other plants.

Associations for Innovation

Hindalco's strong association with industry-leading technology providers and research institutions has enabled us to deliver high quality products and resolve complex problems across our operations.

Our collaborative research with Aditya Birla Science and Technology Center (ABSTC) continues to deliver benefits in various technology areas. We developed a new in-house design for 400+ ka cell

technology for stage-wise amperage increase. We have also developed Novel process flow sheets for production of 99.99% high purity alumina. With these innovations we have filed three patents.

We partnered with IIT Bombay, IIT Madras, Fraunhofer Institute, and Brandenburgische TU, Germany for projects on additive manufacturing of aluminium. The project worth is approximately €5,00,000 (₹41.2 Million) and is funded by Indo-German Science



Hindalco leverages its industry connect to find unique solutions to complex problems