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Recovery of battery metals from secondary resources and low-grade ores

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# ABSTRACT

# *The escalating demand for critical minerals, driven by advancements in clean energy technologies such as electric vehicles and energy storage systems, is projected to increase by 4–30 times in India by 2030. This surge poses challenges due to the country's limited domestic reserves of key elements like cobalt, nickel, and lithium. In response, the Council of Scientific and Industrial Research-Institute of Minerals and Materials Technology (CSIR-IMMT), Bhubaneswar, has been developing a comprehensive suite of technologies to recover critical and non-ferrous metals from low-grade ores and secondary resources. These efforts encompass process development, pilot-scale validation, techno-economic evaluation, and commercial implementation.*

# *CSIR-IMMT has demonstrated the recovery of nickel and cobalt from chromite overburden containing 0.7% Ni and 0.03% Co at a 10 tonnes/day pilot plant scale. Additionally, the institute has advanced metal recovery from polymetallic manganese nodules (PMN) sourced from the Indian Ocean containing Ni (1%), Co (0.1%), Cu (1%), and Mn (25%) with a 500 kg/day demonstration plant. Current research focuses on improving process efficiency with product diversity.*

# *Complementing these resource efficiency strategies, CSIR-IMMT has operationalized a 90 tons per annum cobalt recovery technology from alloy scraps. Similar technologies have been transferred to various industries for the recovery of Co, Ni, Mn, and Li from industrial scrap and spent batteries. Furthermore, the institute has developed processes for extracting valuable metals such as Ni, Co, Zn, Cu, and V from various spent catalysts.*

# *In the international arena, CSIR-IMMT has provided a basic engineering process package for processing copper ores in the Democratic Republic of Congo, facilitating the production of 12,000 TPA copper with cobalt as a by-product. The institute has also optimized existing processes to enhance the purity of Electrolytic Manganese Dioxide (EMD), achieved specifications suitable for lithium-ion batteries, and developed engineering solutions to produce 10,000 TPA EMD.*

# *Recognizing the potential of Australia-India partnerships in battery metals, CSIR-IMMT is actively collaborating with the University of South Australia under the Australia India Strategic Research Fund (AISRF) Round 14 initiative. This partnership focuses on the sustainable processing of critical resources from Indian and Australian sources, including laterites, spodumene, copper oxide ores, and secondary resources. CSIR IMMT is also collaborating with Commonwealth Scientific and Industrial Research Organisation CSIRO, Australia, on Ti extraction.*

# *This presentation outlines CSIR-IMMT’s concerted efforts to develop technologies that utilize non-primary ores to bridge the supply gap. This contributes to efficiently using low-grade and secondary resources within a circular economy framework.*

# KEY WORDS

# *Critical Minerals Recovery, Deep-sea Minerals, Battery Materials, Nickel & Cobalt, Circular Economy*

# BIOGRAPHY

# Dr. Abdul Rauf Sheik is a Principal Scientist at CSIR-Institute of Minerals and Materials Technology (CSIR-IMMT), Bhubaneswar, specializing in hydrometallurgical process development and upscaling. He has played a vital role in preparing basic engineering process packages and techno-economic feasibility reports for metal recovery technologies. He handles large-scale projects with significant funding, leading initiatives such as the recovery of tellurium and selenium from copper anode slimes and process improvement for chromite overburden while managing sub-teams. As Co-leader for deep sea minerals metallurgy, he is also developing advanced facilities for solvent extraction and molten salt electrolysis to support India's critical minerals value-chain.

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