GOVERNMENT OF INDIA
MINISTRY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH
LOK SABHA
UNSTARRED QUESTION NO. 5185
(ANSWERED ON 02.04.2025)

SCIENTIFIC TECHNOLOGY FOR E-WASTE MANAGEMENT

5185. Shri Shrirang Appa Chandu Barne:
Smt. Bharti Pardhi:
Shri Bajrang Manohar Sonwane:

Will the Minister of SCIENCE AND TECHNOLOGY be pleased to state:

(a) whether the Council of Scientific and Industrial Research (CSIR) has developed any specific technologies or processes for the safe and efficient management of e-waste;

(b) if so, the key technological solutions developed by CSIR for e-waste recycling, dismantling and material recovery;

(c) the current stage of development for these technologies;

(d) the manner in which the CSIR is collaborating with international research institutions to advance e-waste management technologies;

(e) whether the CSIR has partnered with any industries and Government agencies or NGOs to implement its e-waste management technologies;

(f) if so, the details thereof; and

(g) the safety measures incorporated into the CSIR's technologies to protect the workers and the surrounding environment?

ANSWER

MINISTER OF STATE (INDEPENDENT CHARGE) FOR THE MINISTRY OF SCIENCE AND TECHNOLOGY AND EARTH SCIENCES

(DR. JITENDRA SINGH)

(a)&(b) Yes, Sir. Council of Scientific and Industrial Research (CSIR) has developed a few technologies/processes for the safe and efficient management of e-waste through its constituent laboratories, namely

CSIR-National Metallurgical Laboratory (CSIR-NML), Jamshedpur and CSIR-Institute of Minerals and Materials Technology (CSIR-IMMT), Bhubaneswar.

CSIR-NML efforts are majorly focused on the recovery of metals from various parts of e-waste i.e. Printed Circuit Boards (PCBs), Li-ion (LIBs), Hard disk, Optical fibres to recover non-ferrous, rare, rare earth and precious metals. The technologies/processes have been developed for:

- **Recovery of Gold from Waste Mobile Phones and Scraps of various Equipment: A process has been developed for the dissolution of metal from the PCBs of waste mobile phones, small parts of various equipment containing gold on the outer layer. Chemical leaching followed by adsorption/ cementation with subsequent heat treatment was used to recover 99% gold.**

- **Recovery of Cobalt from Discarded Li-ion Batteries of Mobile Phones: A process has been developed for the dissolution of metals from discarded lithium-ion batteries (LIBs) of mobile phones. Diluted sulfuric acid in the presence of an oxidant was used to leach out ~70-80% cobalt along with other metals in 60 min at elevated temperature. The leach liquor generated was further processed through solvent extraction, precipitation, crystallization/ electro-winning techniques to recover cobalt as salt/ metal.**

- **Recovery of Neodymium as a Value Added Product from Waste Hard Disk of Personal Computers: A process has been developed for the recovery of neodymium as value added product from magnets of discarded hard disk. Under optimized condition, sulfuric acid leaches 98% Neodymium (Nd), 97% Iron (Fe), 60% Nickel (Ni) and 7.5% Boric Acid leaching was followed by selective precipitation of Nd and leaching of the precipitate with 5-20% HF solution.**

- **Recycling of Spent/Used/Discarded Lithium Iron Phosphate (LFP) Batteries for recovery of Lithium, Iron and Phosphorus: With acid leaching using 10-20% solids, 98-100% Lithium (Li), Iron (Fe) and Phosphorus (P) could be extracted. The leach liquor was subjected to selective sequential precipitation route to extract 90-95%% pure lithium as lithium carbonate/lithium hydroxide and 98% pure iron phosphate. Purified graphite was a derivative in the process. The developed process recovers lithium in most desired marketable form, apart from**

iron phosphate. The derived values can be used for multiple applications apart from new battery manufacturing.

- **Recovery of Lithium, Nickel, Cobalt, Manganese and Graphite from Spent/Used/Discarded Lithium-ion Batteries of mixed chemistries: With acid leaching using 20-30% solids, 94-96% Lithium (Li), Cobalt (Co), Nickel (Ni) and Manganese (Mn), was extracted. The leach liquor was subjected to selective sequential multistage solvent extraction and precipitation route to extract >96-99.9% multiple variant pure salts of lithium, nickel, cobalt and manganese. High pure graphite is a derivative product of the process. The process enables recovery of acid and reagents. The developed technology can extract critical elements like Lithium, Cobalt and Nickel apart from manganese as salts in most desired marketable form, with holistic recycling to result in reusable graphite. For generic value, an estimate of 100kg of spent laptop LIBs gives 25kg electrode material, from which 5.7 kg Cobalt sulfate, 0.69 kg Lithium Hydroxide, 0.51 kg Nickel Carbonate, 5.4 kg Manganese Carbonate, 0.5 kg Alumina Powder and 12 kg graphite powder can be separated. CSIR-NML has also developed a pilot-scale facility to dismantle and recycle LIBs at 1TPD scale. This facility is capable of processing all LIBs to synthesise metal salts suitable for new battery making.**

CSIR-IMMT has developed the following technologies/processes for the management of e-waste:

- **Utilising discarded desktop PCBs (e-waste) to form metal objects (artefacts) and construction materials: A process flowsheet for the recycling of the e-waste was developed following mechanical separation and hydrometallurgical route. The flotation technique (a physico-chemical separation method) was used to separate hydrophilic metallic and hydrophobic non-metallic particles. The fine metallic particles subjected for copper leaching. The residue obtained from the copper leaching circuit was subjected for tin and precious metal recovery circuit.**

- **Process flowsheet for the recovery of Nd and Pr and other Rare Earth Elements (REEs): The process flowsheet was developed for the recovery of Neodymium (Nd) and Praseodymium (Pr) and other Rare Earth Elements (REEs) from waste Neodymium Magnets (NdFeB) magnet, scrap, etc. present in the electronics.**

(c) The processes/technologies developed by CSIR-NML are at Technology Readiness Level (TRL) – 6 and above. Further, technologies/processes developed by CSIR-IMMT are at TRL – 4.

(d) CSIR has partnered with research and technology institutions in Germany, Australia, France and Bulgaria in the recent past on research projects related to e-waste management covering the following areas, among others:

o Advanced recovery of the battery materials and rare earth elements from ores and wastes;

o To develop an effective extraction and separation technology to selectively extract rare earth elements – Erbium (Er), Terbium (Tb), Europium (Eu), Praseodymium (Pr) Neodymium (Nd) and Dysprosium (Dy) from waste electrical and electronic equipment (WEEE); and

o International Clean Innovation Researcher Networks – Integrating End of Life (EoL) solar panel waste in a circular economy model

• CSIR-NML has partnered with the Korea Institute of Geoscience and Mineral Resources (KIGAM), Korea, for carrying out General Research in the domain.

(e)&(f) Yes, Sir. Technologies/processes developed by CSIR for e-waste management have been transferred to several industries for recovery of metals from various parts of e-waste i.e. Printed Circuit Boards (PCBs), Li-ion (LIBs), Hard disk, Optical fibres to recover non-ferrous, rare, rare earth and precious metals. The details are at Annexure-I.

(g) The provisions and standard regulations of the Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCB) have been followed for the treatment of solid, liquid, and gases during the development. Licensee(s) Industries are advised and instructed to follow the same to protect the workers and the surrounding environment.

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Annexure-I

S.No.	Name of the Technology /Process	Licensee(s)
1	Know-How for Recovery of gold from the waste printed circuit boards (PCBs) of used and discarded mobile phones	M/s. ADV Metal Combine Pvt. Ltd., Delhi
2	Know-How (Laboratory Scale) for extraction of precious metals (Au, Pt, Pd) from the metallic concentrate of PC-PCBs	M/s. Evergreen Recyclekaro Pvt. Ltd., Navi Mumbai
3	Know-How for extraction of cobalt and gold from the black cathode material of Li-Co batteries and gold coated surface of e-waste, respectively	M/s. EXIGO Recycling Pvt. Ltd., New Delhi
4	Know-How for extraction of cobalt metal/salt from Black Powder of Lithium Batteries	M/s. UNQ Ind Pvt. Ltd. Firozabad
5	Know-How (Lab scale) for extraction of valuable and precious metals (Cu, Au, Ag & Co, Mn) from scrap of electronic waste & waste Li-Cobalt Batteries	M/s. Walle Infotech, Ranchi
6	Know-How for extraction of cobalt metal/salt from the black powder of Li-cobalt batteries	M/s. Evergreen Recyclekaro India Pvt. Ltd., Navi Mumbai
7	Know-How (Laboratory Scale) for extraction of Cobalt and Manganese from the Black cathodic material of Li-cobalt batteries	M/s. SBCON Recycling Private Limited, Ahmedabad
8	Technological Know-How for the extraction of Cu, Al and Au from waste PCBs	M/s. Metaore Recycler Pvt. Ltd., Kolkata
9	Closed loop holistic recycling process for recovery of critical metals from any/mixed chemistries of lithium based batteries	M/s Recy Energy, Pune
10	Know-How for the recovery of Co, Li, and Mn form Lithium-ion batteries (LIBs)	M/s. MetaOre, Kolkata
11	Closed-loop Know-How to recycle spent Lithium-Ion Batteries (LIBs) to produce	M/s. NILE Li-Cycle India Pvt. Ltd, Hyderabad

	value-added products of Li, Co, Mn, Cu, Ni, saleable plastics and graphite	
12	**Recycling Lithium Ion Batteries (LIBs) to recover sellable metal/salts of Li, Co, Mn, Ni, Cu, Al, graphite and plastics**	**M/s. Recyclib Pvt. Ltd., New Delhi**
13	**Technological Know-How for the extraction of Cu, Al and Au as Metals/ salts from waste PCBs**	**M/s. Novasensa, New Delhi**
14	**Technological Know-How to recycle spent Lithium-Ion Batteries (LIBs) to produce value-added products of Li, Co, Mn, Cu, Ni, as metals/ salts**	**M/s. Novasensa, New Delhi**
15	**Know-How to recover saleable products of Cu, Al and Au as Metals/ salts from waste PCBs**	**M/s. Waste Management Pvt. Ltd., Bangalore**

Chemical Symbols used:

(i) Au- Gold	**(vi) Co- Cobalt**
(ii) Pt- Platinum	**(vii) Ag- Silver**
(iii) Pd- Palladium	**(viii) Cu- Copper**
(iv) Li- Lithium	**(ix) Mn- Manganese**
(v) Ni- Nickel	**(x) Al- Aluminum**