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Gold from E-Waste — How Modified 'Rice Paper' Enables Urban Mining

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Gold from E-Waste — How Modified 'Rice Paper' Enables Urban Mining

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✓ Every fact web-verified against primary sources

A study published in the **Proceedings of the National Academy of Sciences (PNAS)** in 2026 — featured in *The Hindu's* May 31 Sunday science page — shows that ordinary **starch-based “rice paper”**, **chemically modified through hydrazination**, can **selectively recover high-purity gold** from dissolved electronic waste (e-waste). The technique is a low-toxicity alternative to conventional gold-leaching and a boost for **“urban mining”** and the **circular economy**.

THE SCIENCE IN BRIEF

STEP	WHAT HAPPENS
Base material	Edible starch-based “rice paper” (a cheap, biomass-derived sheet)
Modification	Hydrazination — aqueous-phase chemical treatment that adds hydrazine functional groups, creating a stratified mesoporous structure
Result	Hydrazine-functionalized rice paper (Hz-RP) — an adsorbent with high mechanical strength in water
Action	Hz-RP selectively binds gold (Au) ions from e-waste leachate and reduces them to solid gold , even in complex mixed-metal solutions
Recovery	The loaded sheet is calcined (heated) to yield high-purity gold

The selectivity is the key advance: it pulls gold out preferentially, **without** the highly toxic **cyanide** or **aqua regia** used in conventional and informal recovery.

WHAT IS “URBAN MINING”?

Urban mining is the recovery of metals and materials from discarded products — especially e-waste — rather than from natural ore.

- E-waste is a remarkably rich ore: a tonne of discarded circuit boards can contain **far more gold than a tonne of mined ore** (printed circuit boards may hold tens of times the gold concentration of natural deposits).
- Recovering gold, copper, palladium, and rare metals from e-waste reduces dependence on **primary mining and imports** — central to **critical-mineral security**.

WHY THIS MATTERS FOR INDIA

1. India's E-Waste Mountain

India is among the **top three e-waste generators in the world** (after China and the USA), producing well over **1.7 million tonnes** annually and rising fast. Most is processed by the **informal sector** using crude, hazardous methods (open burning, acid baths) that poison workers and the environment.

2. Regulatory Framework

INSTRUMENT	DETAIL
E-Waste (Management) Rules, 2022	Current framework; introduced a strengthened EPR (Extended Producer Responsibility) regime with tradable EPR certificates
EPR principle	Producers are responsible for the end-of-life collection and recycling of their products
CPCB	Central Pollution Control Board administers EPR registration and targets

3. Critical-Mineral & Circular-Economy Link

Green-chemistry recovery feeds directly into:

- **Critical-mineral security** (gold, copper, palladium, and tech metals)
- **Mission Circular Economy / LiFE** (Lifestyle for Environment)
- Reducing the **carbon and water footprint** versus primary mining

4. Indian R&D in Urban Mining

Indian institutions active in this space include **CSIR-NML (Jamshedpur)**, **C-MET (Hyderabad)**, and **IIT Bombay**; **Attero Recycling (Noida)** does industrial-scale recovery.

THE CATCH — FROM LAB TO INDUSTRY

- Lab-scale selectivity must be **scaled** to industrial **throughput** economically.

- **Formalising** India's e-waste chain (currently ~90% informal) is the bigger systemic challenge — better technology helps only if collection and EPR enforcement improve.

UPSC RELEVANCE

PAPER	RELEVANCE
GS3	Science & Tech (green chemistry, materials science); environment (e-waste, circular economy); economy (critical minerals, import substitution)
Mains	“Green-chemistry approaches to urban mining can advance both critical-mineral security and pollution control. Discuss, with reference to India's e-waste challenge.”
Prelims	Hydrazine-functionalized rice paper (Hz-RP); urban mining concept; E-Waste (Management) Rules 2022 + EPR; CPCB; India among top-3 e-waste generators

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GOLD-FROM-E-WASTE TECHNIQUE (2026):

Published in PNAS (2026); covered in The Hindu Sunday science

Material: hydrazine-functionalized rice paper (Hz-RP) — modified starch “rice paper”

Selectively binds and reduces gold ions from e-waste leachate; calcined to high-purity gold

Advantage: low-toxicity alternative to cyanide / aqua regia

URBAN MINING:

Recovering metals from e-waste instead of ore

E-waste is a richer “ore” of gold than most natural deposits

INDIA'S E-WASTE:

Among top-3 e-waste generators globally (after China, USA)

~90% handled by informal sector (hazardous methods)

Governing law: E-Waste (Management) Rules, 2022 with EPR; administered by CPCB

INDIAN PLAYERS: CSIR-NML JAMSHEDPUR, C-MET HYDERABAD, IIT BOMBAY, ATTERO RECYCLING

Sources: PNAS, The Hindu, Central Pollution Control Board

Source: Gold from E-Waste — How Modified 'Rice Paper' Enables Urban Mining — Ujjyari.com | Free UPSC & State PCS Current Affairs

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