

Technology Snapshot

Technology Licensing Opportunity

PERFECT Capture

Phase-separating Engineered Rare-earth
Fusion for Element Capture Technology

Value Proposition

PERFECT Capture is a gentle, water-based process that pulls valuable metals from sources such as mining waste and recycled materials without the aggressive acids and solvents that conventional methods require. It can be reset and reused across many cycles — a rare combination of performance, sustainability and economy that turns an environmental liability into a domestic resource.

Technology Readiness Level 3

IP Information for S-193669

U.S. Patent pending

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Overview

Rare earth elements power the magnets, motors and screens at the heart of modern electronics, clean energy and defense systems. Yet, the world depends on a costly, chemical-intensive supply chain to obtain them. PERFECT Capture, developed at Los Alamos National Laboratory, offers a cleaner path forward: an engineered protein that acts like a molecular magnet for rare earths, gathering these prized metals out of complex mixtures and then clumping them together so they settle out and can be collected with ease.



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Advantages

- Cleaner process that relies on water and gentle pH changes instead of strong acids, harsh solvents and high energy use
- Reusable protein that can be recovered and run through many capture cycles, lowering operating costs
- Strong, selective grip on rare earths, supporting high recovery even from complex, low-grade mixtures
- Flexible, modular design that can be adjusted to target different rare earths or related metals
- Simple separation by settling, avoiding the fragile beads and column hardware that tend to clog or foul
- Compatible with unconventional sources such as mining waste, wastewater and coal ash, turning liabilities into supply

Technology Description

Rare earth elements are indispensable to high-performance magnets, displays, catalysts and renewable-energy systems, but they are seldom found in concentrated or pure form. Extracting them from ore or waste streams typically demands multistep chemical separations that rely on strong

Continued on reverse

Technology Description continued

acids, organic solvents and large energy inputs. These processes generate substantial waste, including by-products that can be radioactive; and they concentrate production within a few regions, leaving manufacturers exposed to supply-chain and geopolitical disruption. Growing demand for clean-energy and electronic technologies only sharpens the need for a selective, sustainable and circular way to secure these critical metals.

PERFECT Capture answers each of those pressures with a single, water-based platform. At its core is an engineered protein that joins a self-assembling peptide to lanmodulin, a natural protein that binds rare earths with remarkable strength and selectivity. When the protein encounters rare earths in a mixture, the metal binding prompts the protein to gather into dense droplets that settle out of solution, so the valuable metals concentrate and separate through simple settling rather than aggressive chemistry. Lowering the acidity then releases the captured metals for collection and frees the protein to be recovered and used again. In laboratory testing the approach recovered the large majority of the rare earths present while returning most of the protein intact. Because the design is genetically modular, it can be tuned and paired with related proteins to target different metals, giving industry a selective, reusable and far gentler alternative to acid- and solvent-heavy separations.

Market Applications

- **Critical Minerals and Mining** (recovery from ore, tailings and process streams)
- **Recycling** (reclaiming rare earths from electronic and industrial waste)
- **Electronics and Computing** (magnets, displays and device components)
- **Environmental Remediation** (treatment of mining wastewater and coal ash)
- **Aerospace** (secure domestic supply of high-performance magnet materials)