

MASTER DOSSIER: Luminarit-GreenRAM V2

The world's first rare-earth-free, environmentally friendly high-speed RAM

1. Introduction & Vision

Luminarit-GreenRAM V2 is built on a clear set of principles:

- **0% rare earth elements**
- **maximum environmental responsibility**
- **full CMOS compatibility**
- **DRAM-class speed**
- **non-volatile, energy-efficient, long-lived**

This creates a memory technology that is not only technically competitive, but also sets new ecological and geopolitical standards.

2. Why GreenRAM Protects the Environment

2.1 No Refresh → Drastically Lower Energy Consumption

DRAM requires constant refresh cycles.

GreenRAM does not.

Refresh power:

$$P_{\text{refresh}} = U \cdot I_{\text{refresh}}$$

For GreenRAM:

$$P_{\text{refresh}} = 0$$

→ **Up to 90% energy savings in idle operation.**

2.2 Manufactured Without EUV → Massive CO₂ Reduction

GreenRAM uses:

- **65–90 nm DUV lithography**
- **no EUV scanners**
- **no gigafabs**
- **existing 200/300 mm fabs**

This reduces:

- energy consumption
 - water usage
 - chemical waste
 - infrastructure emissions
-

2.3 0% Rare Earth Elements → Geopolitically Clean

Materials used:

- HfO₂
- TiO_x
- TiN
- Graphene
- Copper
- Nitrogen

All globally available, with no rare-earth mining, no toxic by-products, and no geopolitical monopolies.

3. Technical Architecture

3.1 1T1R Cell (Transistor + RRAM)

Each cell consists of:

- one access transistor
- one resistive memory element (RRAM)

Filament resistance states:

$R_{ON} \ll R_{OFF}$

Switching voltage:

$V_{set} \approx 1.2 - 1.8 \text{ V}$

Switching time:

$t_{switch} < 10 \text{ ns}$

3.2 Ultra-Fast Material Stack

| Layer | Material | Function |
|------------------|----------------|---|
| Top Electrode | TiN / Graphene | Highly conductive, stable |
| Speed Buffer | TiOx | Ion accelerator |
| Active Medium | HfO2:N | Nitrogen-doped, fast filament formation |
| Bottom Electrode | TiN | CMOS-compatible |

4. Performance Data

| Parameter | GreenRAM V2 | DDR4/DDR5 |
|--------------------|-----------------|-------------------------|
| Latency | < 10 ns | 10–15 ns |
| Idle Power | ≈ 0 W | High (refresh required) |
| Endurance | ≥ (10^9) cycles | Practically unlimited |
| Retention | ≥ 10 years | 0 seconds |
| Rare Earth Content | 0% | Often present |
| Manufacturing | 65–90 nm | 10–14 nm EUV |

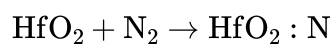
5. Manufacturing Process

5.1 CMOS Front-End

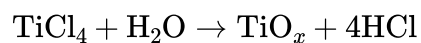
- Oxide formation
 - Gate stack creation
 - Source/drain implantation
 - Metal layers
-

5.2 RRAM Backend-of-Line Integration

Step 1: ALD deposition of HfO₂:N



Step 2: ALD deposition of TiO_x speed layer



Step 3: Electrode deposition (TiN / Graphene)

Step 4: Contact formation & metallization

Step 5: Multi-bank layout + integrated SRAM cache

This increases effective bandwidth and masks write latency.

6. Environmental Benefits

6.1 Energy Savings During Operation

Total energy:

$$E_{\text{total}} = \int P(t) dt$$

Since:

$$P_{\text{refresh}} = 0$$

→ overall system energy consumption drops dramatically.

6.2 Longer Lifetime → Less Electronic Waste

RRAM is non-volatile and robust.

Systems last longer and require fewer replacements.

6.3 No Rare Earth Elements → No Environmental Damage

Avoids:

- acid leaching
 - groundwater contamination
 - radioactive by-products
-

7. Final Statement

Confident Closing Line

“We understand: performance alone is no longer enough.

Technology must protect the environment — and GreenRAM delivers exactly that.”

**