📘 MASTER DOSSIER: Luminarit-GreenRAM V2

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

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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.

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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 CO_2 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:

- HfO_2
- TiOx
- TiN
- Graphene
- Copper
- Nitrogen

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

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3. Technical Architecture

3.1 1T1R Cell (Transistor + RRAM)

Each cell consists of:

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

Filament resistance states:

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

Switching voltage:

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

Switching time:

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

3.2 Ultra-Fast Material Stack

Layer	Material	Function
Top Electrode	TiN / Graphene	Highly conductive, stable
Speed Buffer	TiOx	Ion accelerator
Active Medium	HfO_2:N	Nitrogen-doped, fast filament formation
Bottom Electrode	TiN	CMOS-compatible

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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

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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 HfO_2:N

$$\mathrm{HfO_2} + \mathrm{N_2} \rightarrow \mathrm{HfO_2 : N}$$

Step 2: ALD deposition of TiOx speed layer

$$\mathrm{TiCl_4} + \mathrm{H_2O} \rightarrow \mathrm{TiO}_x + 4\mathrm{HCl}$$

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.

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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

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7. Final Statement

🌍 Confident Closing Line

**“We understand: performance alone is no longer enough.
Technology must protect the environment — and GreenRAM delivers exactly that.”**

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