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Gadolinium Oxide

Gd2O3 Technical Guide

Identity, properties, grades, neutron interaction, phosphor and thin-film context, nanoparticle research boundaries, safety, sourcing and supplier qualification.

Material	Value
Formula	Gd2O3
Common name	Gadolinium oxide / gadolinia
CAS Registry Number	12064-62-9
Molecular weight	362.50 g/mol
Typical appearance	White powder
Representative density	~7.407 g/cm3
Representative melting point	~2,420 C

Purpose. A source-linked, supplier-neutral reference for engineers, researchers and technical buyers. Property values marked as representative should be verified against the exact grade, phase, test method and lot documentation.

Prepared 6 September 2026. AI-assisted research and synthesis; source hierarchy and limitations are disclosed in the methodology section.

1. Material identity

Gadolinium(III) oxide is an inorganic rare-earth oxide with the formula Gd2O3. Common synonyms include gadolinium oxide, gadolinia, gadolinium sesquioxide and digadolinium trioxide. PubChem and NIST list the molecular weight as 362.50 g/mol and the common CAS Registry Number as 12064-62-9.

Naming matters in procurement

Use both the formula and CAS number in purchase specifications. The phrase “gadolinium oxide” is common, but Gd2O3 removes ambiguity and helps align supplier, SDS and analytical documentation.

Crystal structure context

At ordinary conditions, Gd2O3 is widely associated with the cubic rare-earth sesquioxide structure. Other polymorphs are reported under different synthesis, temperature or pressure conditions. Powder performance can also depend on crystallite size, defects and agglomeration, which are not described by the chemical formula alone.

Practical physical reference values

Parameter	Reference context	Use
Appearance	White powder (typical supplier description)	Incoming visual check only
Density	~7.407 g/cm3 (representative supplier value)	Composite loading and volume calculations
Melting point	~2,420 C (representative supplier value)	Refractory-material context

Data-quality rule: distinguish an ideal compound property from a product specification and from a lot-specific result. For engineering decisions, the purchase specification and lot COA normally take priority.

2. Grades, purity and particle size

A useful Gd2O3 grade specification has two dimensions: chemical composition and physical powder form. Headline purity alone is rarely enough to predict process behavior.

Shorthand	Nominal purity	Important caveat
3N	99.9%	Check whether purity is reported on an REO basis.
4N	99.99%	Request individual rare-earth and non-REE impurities.
5N	99.999%	Ultra-high purity; application-specific impurity limits still matter.

Purity basis

Rare-earth suppliers often report purity relative to total rare-earth oxides (REO). Moisture, loss on ignition and non-rare-earth impurities may be treated separately. Ask the supplier how the percentage is calculated.

Particle-size metrics

- D10, D50 and D90 describe percentile points in the measured particle-size distribution.
- BET surface area helps distinguish dense/coarse powders from high-surface-area powders.
- SEM or TEM reveals morphology but should not be confused with a bulk particle-size distribution.
- For nanopowders, primary particle size, crystallite size, hydrodynamic size and agglomerate size are different quantities.

Illustrative purchase specification

Example only: Gd2O3 >=99.99% REO; total REO >=99%; D50 1-3 um; D90 <=8 um; Fe <=10 ppm; Si <=20 ppm; Ca <=20 ppm; Cl <=50 ppm; LOI <=0.5%; lot COA and SDS required. Limits must be derived from your actual process and performance needs.

3. Application map

The economic and technical value of gadolinium oxide usually comes from the property it contributes to a larger material system.

Application	Why Gd2O3 is considered	Key specification questions
Neutron-absorbing composites	Gd isotopes strongly absorb thermal neutrons.	Gd loading, dispersion, PSD, matrix compatibility, gamma management
Phosphor host	Stable rare-earth oxide host for optically active dopants.	Rare-earth impurity profile, phase, dopant concentration, calcination
Glass / ceramic	Dense refractory rare-earth oxide component.	Dissolution/sintering, Fe/Si/Ca limits, particle size
Electronic thin films	Rare-earth oxide dielectric research.	Film stoichiometry, interface chemistry, deposition route
Gd compound precursor	Raw material for other gadolinium chemistry.	Dissolution behavior, anion impurities, overall purity
Nanoparticle MRI research	Paramagnetic Gd3+ in engineered nanoscale platforms.	Surface coating, hydrodynamic size, Gd release, toxicity, clearance

Do not transfer claims across applications. A powder appropriate for a ceramic composite is not automatically appropriate for a phosphor, thin film or biomedical formulation.

4. Neutron shielding and Gd capture

The isotopes 155Gd and 157Gd have exceptionally large thermal-neutron absorption cross sections. NIST NCNR lists values of roughly 61,100 barns and 259,000 barns, respectively. This is the core reason Gd-containing materials are used in neutron-absorbing systems.

Why Gd2O3 is a practical Gd-bearing phase

The oxide is a stable ceramic powder that can be incorporated into glasses, polymers, concretes or metal-matrix composites. The preferred Gd form depends on the matrix, manufacturing route, mechanical properties, transparency, cost and radiation field.

Secondary gamma radiation

Neutron capture by gadolinium can generate secondary gamma radiation and other emissions. A complete radiation shield therefore cannot be optimized on thermal-neutron attenuation alone. Reviews of Gd-containing shielding materials emphasize combined neutron/gamma design.

Engineering boundary: Shield thickness, dose reduction and regulatory compliance must be calculated for the actual neutron spectrum, geometry and source term by qualified radiation-protection professionals.

Useful purchase parameters for shielding studies

- Purity and impurity profile sufficient to control unwanted phases.
- D10/D50/D90 and dispersion behavior in the selected matrix.
- Loading basis: distinguish wt% Gd2O3 from wt% elemental Gd.
- Surface treatment or coupling chemistry for resin/polymer systems.
- Evidence of homogeneity after compounding.

5. Phosphors and optical materials

Gd2O3 is widely studied as a host lattice for rare-earth dopants. Reviews describe doped Gd2O3 systems with narrow, characteristic emission bands and applications in optoelectronics, sensing and imaging research.

What controls emission

- Dopant identity and concentration.
- Crystal phase and local coordination environment.
- Defects, vacancies and charge compensation.
- Calcination temperature and atmosphere.
- Crystallite size, morphology and agglomeration.
- Trace rare-earth or transition-metal impurities.

Optical-purity lesson

A 4N powder can still be unsuitable if the residual 0.01% contains an impurity with a strong absorption or emission at a critical wavelength. Optical specifications should therefore include element-specific limits, not only total purity.

Glass and transparent shielding systems

Research reviews describe Gd2O3-containing glasses that combine neutron interaction with useful transparency in selected compositions. Optical transmission, density and shielding performance remain formulation- and thickness-dependent.

6. Thin films and electronic-material research

Rare-earth oxides have been investigated as high-k dielectrics and in advanced electronic-material stacks. Gd2O3 films have been studied using atomic layer deposition and other deposition routes.

Why bulk powder data is not enough

Device behavior depends on film stoichiometry, thickness, density, roughness, oxygen vacancies, precursor residues, annealing, interface traps and band alignment. The bulk powder formula does not predict leakage current or dielectric performance.

Questions for a thin-film program

- What deposition precursor or source form is required?
- What is the target film stoichiometry and thickness?
- How is the semiconductor interface prepared and characterized?
- What anneal conditions are required?
- How are leakage, hysteresis, breakdown and interface traps measured?

Where oxide powder may fit

High-purity Gd2O3 can serve as a starting material for ceramic targets, source preparation or synthesis of downstream deposition chemistry. Specify the required physical form before ordering.

7. Nanoparticles and MRI research boundaries

Surface-modified Gd2O3 nanoparticles are an active research topic for T1 MRI contrast enhancement and multifunctional imaging. Recent reviews report promising relaxivity and animal-study results for selected formulations.

The critical distinction

Industrial Gd2O3 powder is not a clinically approved MRI contrast agent. Clinical gadolinium contrast agents are generally chelated molecular compounds. Experimental nanoparticles depend on deliberately engineered surface chemistry and biological behavior.

Translation challenges

- Hydrodynamic size and colloidal stability in physiological media.
- Surface coating integrity and protein interactions.
- Dissolution and release of Gd species.
- Biodistribution, renal clearance and long-term retention.
- Reproducible sterile manufacturing and toxicology.

Medical safety: Do not administer industrial or research Gd2O3 powder to humans or animals. Biomedical use requires purpose-designed formulation, toxicology, manufacturing controls, regulatory approval and clinical evidence.

8. Synthesis and particle engineering

Literature reports precipitation/coprecipitation, sol-gel, combustion, hydrothermal/solvothermal and other routes for Gd2O3 and doped Gd2O3. Industrial powder workflows may include precursor formation, washing, drying, calcination, milling and classification.

Why route matters

Different synthesis routes can yield the same formula but different crystal phase, particle morphology, surface chemistry, crystallite size, porosity and agglomeration. Calcination develops the oxide and crystallinity but can also promote grain growth and hard agglomeration.

Important process levers

- Precursor chemistry and concentration.
- pH, supersaturation and precipitation agent.
- Aging temperature and time.
- Washing efficiency and residual ions.
- Drying route.
- Calcination temperature/time/atmosphere.
- Milling, deagglomeration and classification.
- Surface modification for dispersion-sensitive systems.

9. Safety and handling

Use the current SDS for the exact material and jurisdiction. A Thermo Fisher U.S. SDS revised 22 December 2025 classifies its gadolinium oxide product as causing serious eye irritation (Category 2). Classifications can change by jurisdiction, product and revision.

Practical powder controls

- Avoid generating or inhaling dust.
- Prevent eye contact and use appropriate eye protection.
- Use gloves and protective clothing consistent with the workplace risk assessment.
- Use local exhaust or other engineering controls for dusty operations.
- Wash hands after handling and before eating, drinking or smoking.

Storage and spills

Store in a tightly closed, correctly labeled container in a dry area according to the SDS. Avoid dry sweeping of spills if it generates dust; follow facility procedures and local environmental requirements.

Transportation

Do not infer transport classification from a generic website. Review the current SDS and applicable shipping regulations for the exact product, package, origin and destination.

10. Supplier qualification and RFQ checklist

The fastest way to compare suppliers is to send the same measurable specification to each one and compare evidence at the lot level.

RFQ field	What to request
Identity	Gadolinium(III) oxide, Gd2O3, CAS 12064-62-9
Purity basis	Purity percentage and whether it is REO-based
Impurity table	Rare-earth and non-REE impurities, units and test methods
Particle size	D10/D50/D90 and measurement method
Surface area	BET m2/g when process-sensitive
Moisture / LOI	Maximum and test conditions
Phase	XRD if crystallographic phase matters
Packaging	Container/liner materials and contamination controls
Documents	Lot COA, current SDS, specification sheet
Consistency	Lot-to-lot control strategy

Supplier questions

- Is the material manufactured in-house or resold?
- Can the supplier provide analytical methods and retained-sample support?
- What is the process-change notification policy?
- Will the qualification sample represent future production material?
- Can critical particle-size and impurity limits be guaranteed rather than reported as typical?

Procurement principle: Do not overpay for purity you do not need. A lower headline purity with tighter limits on the impurities that actually affect your process may be more robust than a generic ultra-high-purity grade.

11. Source hierarchy and editorial methodology

This guide is supplier-neutral. AI is used to assist research organization and synthesis; it is not used to invent laboratory data, supplier credentials, medical suitability or engineering performance.

Source hierarchy

- Government and scientific databases for identity and fundamental reference data.
- Current supplier specifications and SDS documents for product-specific values and handling statements.
- Peer-reviewed reviews and primary literature for application performance and emerging research.
- Secondary commercial sources only when clearly labeled and cross-checked.

How to resolve conflicting values

Check whether the sources describe the same phase, temperature, particle form and test method. For a real purchase, prioritize the purchase specification and current lot COA. For safety, prioritize the current SDS. For scientific claims, inspect the original paper or review and confirm the composition and test conditions.

12. References

Open the linked sources for the exact source wording, methods, version and scope. URLs were checked during preparation in September 2026.

PubChem - Gadolinia / Gadolinium oxide (Gd2O3), CID 159427
https://pubchem.ncbi.nlm.nih.gov/compound/Gadolinia

NIST Chemistry WebBook - digadolinium trioxide
https://webbook.nist.gov/cgi/cbook.cgi?Name=Gd2O3&Units;=SI

NIST Center for Neutron Research - Neutron Scattering Lengths and Cross Sections
https://ncnr.nist.gov/resources/n-lengths/list.html

USGS Mineral Commodity Summaries 2026 - Rare Earths
https://pubs.usgs.gov/periodicals/mcs2026/mcs2026-rare-earths.pdf

Thermo Fisher Scientific Chemicals - Gadolinium(III) oxide product information
https://www.thermofisher.com/order/catalog/product/036355.14

Thermo Fisher / Fisher Scientific - Gadolinium oxide SDS (rev. 22 Dec 2025)
https://www.fishersci.com/store/msds?countryCode=US&language;=en&partNumber;=AA11289&productDescription;=keyword&vendorId;=VN00024248

American Elements - Gadolinium Oxide technical data
https://www.americanelements.com/gadolinium-oxide-12064-62-9

Recent Progress in Gd-Containing Materials for Neutron Shielding Applications: A Review
https://pmc.ncbi.nlm.nih.gov/articles/PMC10303270/

Review on synthesis, structural and photo-physical properties of Gd2O3 phosphors
https://www.sciencedirect.com/science/article/abs/pii/S0030399220312962

Current Status and Future Aspects of Gadolinium Oxide Nanoparticles as Positive MRI Contrast Agents (2025)
https://www.mdpi.com/2079-4991/15/17/1340

Atomic Layer Deposition of Gd2O3 and Dy2O3 - Chemistry of Materials
https://pubs.acs.org/doi/10.1021/cm2020862

Website: https://gadoliniumoxide.com

This document is informational and does not replace a supplier specification, certificate of analysis, SDS, engineering design review, medical guidance or regulatory determination.