GLOBAL OPTICS

$CaCO_3$
Calcite

🔷 Key Properties of Calcite ($CaCO_3$)

🔍 Strong Birefringence: Δn ≈ 0.172 — widely used in polarizers, waveplates, and beam displacement optics.
🌈 Wide Transmission: 250 nm – 2.5 µm — covers UV to near-IR applications with high transparency.
🧭 Uniaxial Negative Crystal: Optical axis is aligned with the c-axis; angular sensitivity must be considered.
⚠️ Soft & Brittle: Mohs hardness of ~3 — handle with care and consider protective coatings for optics.
💧 Moisture Sensitive: Slightly soluble and can degrade in humid conditions — not recommended for exposed environments.
🔬 Highly Transparent: Clear in visible range — used in microscopes, lasers, and scientific instrumentation.
⚙️ Customizable: Can be cut, polished, and coated to suit high-precision optical systems.

Unit 6, Branksome Business Park,
Bourne Valley Rd, Poole BH12 1DW

+44 (0) 1202 767476
info@globalopticsuk.com
www.globalopticsuk.com

🧩 Applications of Calcite (CaCO3)

🔬 Polarization Optics: Calcite is one of the most commonly used crystals in the manufacture of polarizing beamsplitters, such as Glan–Thompson and Glan–Taylor prisms. Its strong birefringence enables effective separation of orthogonal polarization states in high-precision laser systems and optical benches.

🧪 Waveplates and Retarders: Due to its well-defined birefringent properties, Calcite is widely employed in quarter-wave and half-wave retardation plates. These components are critical in polarization control applications such as ellipsometry, circular dichroism, and spectroscopy.

📡 Beam Displacement and Splitting: Calcite's optical anisotropy enables lateral beam displacement without significant absorption or scattering. This makes it an essential component in beam displacers, interferometers, and polarimetric systems.

🔍 Precision Instruments: Its natural clarity and transmission range make Calcite ideal for use in microscopes, spectrometers, and polarimeters where high-accuracy measurement of light properties is essential.

📷 Imaging & Display Systems: Used in specialized imaging systems to enhance polarization contrast, Calcite improves visualisation in applications like LCD alignment, biological microscopy, and contrast-enhanced optics.

🧭 Scientific Research and Metrology: Frequently used in crystal optics experiments, mineral analysis, and educational optics due to its excellent natural cleavage and consistent birefringent behavior.

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Technical Parameters of Calcite (CaCO3)

Property	Typical Value
ransmission Range	~200 nm to 55 µm
Refractive Index	~1.74 @ 10 µm
Density	4.51 g/cm³
Hardness (Knoop)	~25 kg/mm²
Melting Point	~621 °C
Solubility in Water	~44 g/100 mL @ 25 °C
Crystal Structure	Cubic
Hygroscopic	Yes — requires dry handling or protective coating
Scintillation Use	Yes — emits visible light when exposed to X-rays or gamma rays
Chemical Formula	CsI
Thermal Conductivity	~1.8 W/m·K
Applications	FTIR, IR optics, scintillators, radiation detection, space optics
Coating Compatibility	Parylene, DLC recommended for moisture protection

Calcite ($CaCO_3$) is a naturally birefringent crystal known for its strong double refraction and excellent transmission from the ultraviolet through the near-infrared (~250 nm to 2.5 µm).

With a refractive index range of approximately no = 1.658 and ne = 1.486 at 589 nm, Calcite provides exceptional polarization control and is widely used in polarizers, beam displacers, and optical isolators.

It has a trigonal crystal structure, a density of 2.71 g/cm³, and a relatively low hardness (Mohs 3), making it easy to polish but sensitive to mechanical stress.

Calcite is temperature-sensitive and slightly soluble in water, so careful handling and environmental protection are recommended.

Its high birefringence and optical clarity make it ideal for laboratory optics, laser polarization components, and precision metrology applications.

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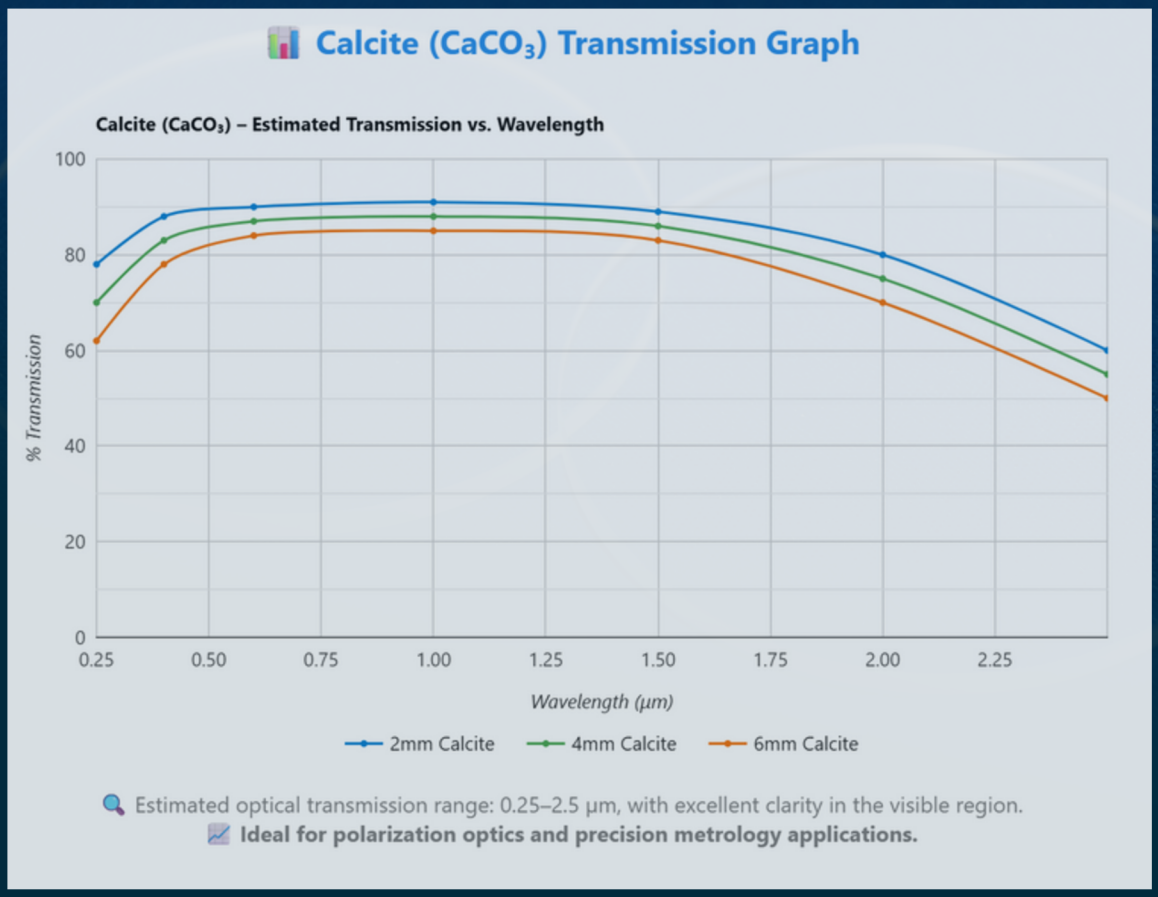

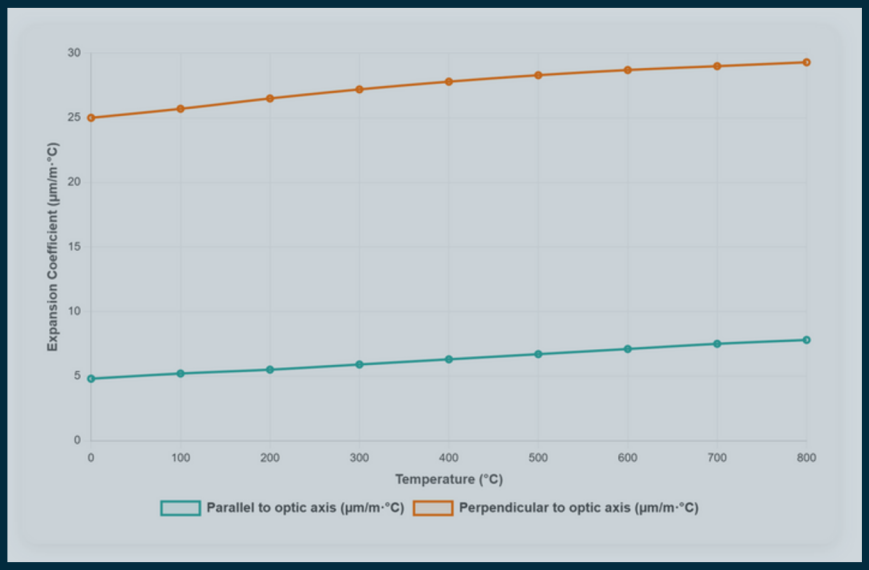

Transmission:

Calcite ($CaCO_3$) provides excellent transmission from the ultraviolet through to the near-infrared, typically spanning ~0.25 µm to 2.5 µm. It offers very high optical clarity and is strongly birefringent, making it ideal for polarization optics such as beam displacers, Glan–Taylor polarizers, and optical isolators. Transmission remains high (>85%) across the visible spectrum, with minimal absorption below 2.5 µm.

Thermal Expansion:

Calcite shows highly anisotropic thermal expansion, with coefficients of approximately 5 × 10^{-6} /°C parallel to the optic axis and 25 × 10^{-6} /°C perpendicular to it. This directional behavior means optical designs should account for temperature changes to avoid stress or alignment shifts. Despite its moderate softness, Calcite remains dimensionally stable and optically reliable under controlled environmental conditions.

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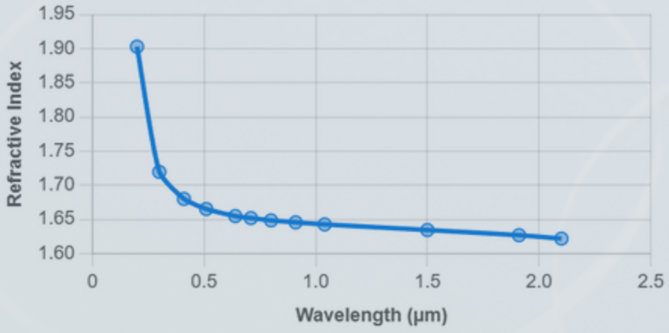
Refractive Index of Calcite ($CaCO_3$) vs. Wavelength



Experimental refractive index data across 0.2–2.1 µm wavelength range

Wavelength	Refractive index
0.2	1.9028
0.3	1.7196
0.41	1.6801
0.51	1.6653
0.64	1.655
0.71	1.6521
0.8	1.6487
0.91	1.6458
1.04	1.6428
1.5	1.6346
1.91	1.627
2.1	1.622

FAQ

Q: What is Calcite used for in optics?
A: Calcite is primarily used for its strong birefringence in polarizing optics such as beam displacers, Glan–Thompson polarizers, and waveplates. It's ideal for applications requiring separation or control of light polarization.

Q: Why is Calcite valued in optical systems?
A: Its extreme birefringence and broad transmission range (from 250 nm to 2,500 nm) make Calcite excellent for polarization control in spectroscopy, microscopy, and laser optics.

Q: Is Calcite fragile or hygroscopic?
A: Yes, Calcite is relatively soft (Mohs ~3) and slightly hygroscopic. It should be handled with care and stored in low-humidity environments to prevent degradation or surface damage.

Q: Can Calcite be coated?
A: Absolutely. Anti-reflective (AR) coatings can be applied to Calcite optics to improve transmission and reduce surface reflections, especially when used in laser and imaging systems.

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