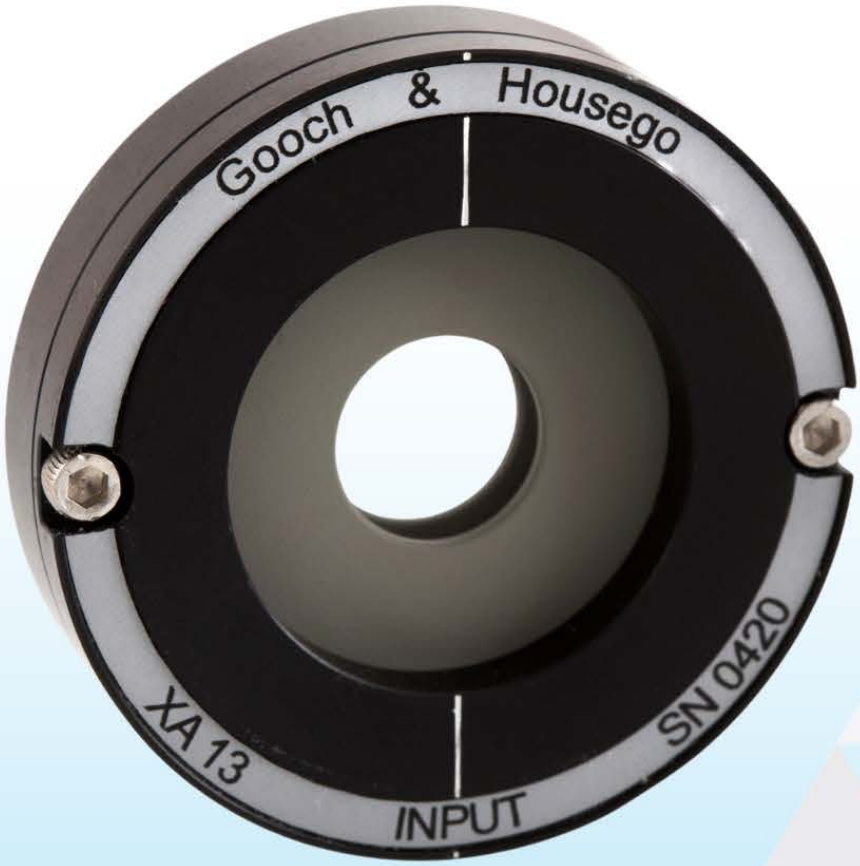
G&H

CRYSTAL OPTICS

PRODUCT & SOLUTIONS

GUIDE



G&H: A PHOTONICS SPECIALIST

G&H solves complex challenges for our customers by developing innovative photonics solutions that enhance performance, reliability, and efficiency. We are an award-winning name in the photonics industry with global reach and an established heritage dating back 75 years.

Emerging applications increasingly employ photonics as the enabler. Our customers require specialized, reliable and high-performance solutions. G&H pushes the boundaries in these key areas and provides differentiating product solutions. We maintain close and long-lasting relationships with our customers.

G&H is a photonics technology business headquartered in Ilminster Somerset, UK with operations in the USA and Europe.

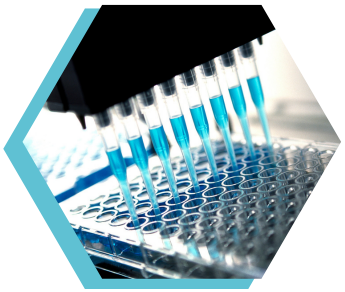
A BETTER WORLD WITH PHOTONICS.



Aerospace & Defense



Industrial & Telecom

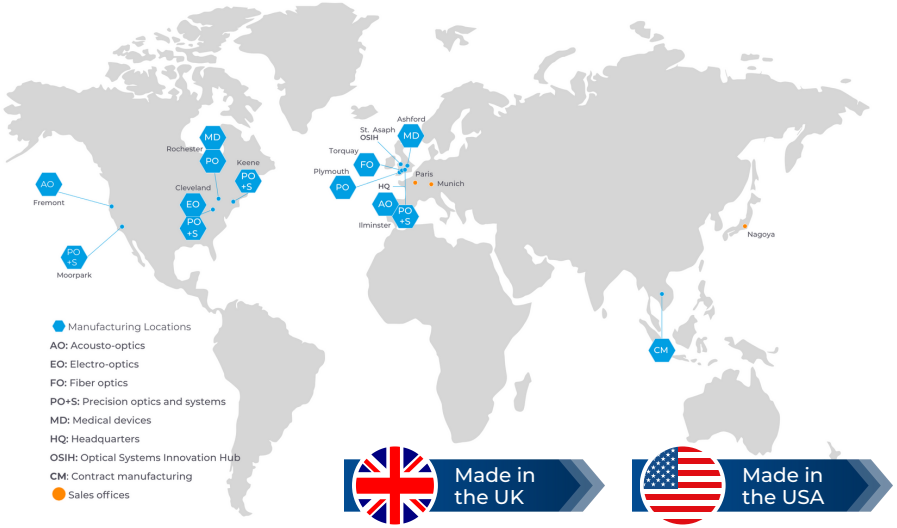


Life Sciences

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BROAD GLOBAL EXPERTISE





Ilminster, UK
49,679 ft²
4,615 m²



Fremont, USA
40,000 ft²
3,716 m²



Keene, USA
12,800 ft²
1,189 m²



Cleveland, USA
80,000 ft²
7,432 m²



Rochester, USA
43,226 ft²
4,015 m²



Moorpark, USA
50,000 ft²
4,645 m²



Plymouth, UK
22,000 ft²
2,043 m²



Torquay, UK
41,000 ft²
3,850 m²



St. Asaph, UK
9,149 ft²
850 m²



Ashford, UK
30,000 ft²
2,787 m²

G&H employs over 1,000 skilled employees across 10 manufacturing and design facilities. We also have 3 sales offices and a contract manufacturing partner in Thailand.

MANUFACTURING CAPABILITIES

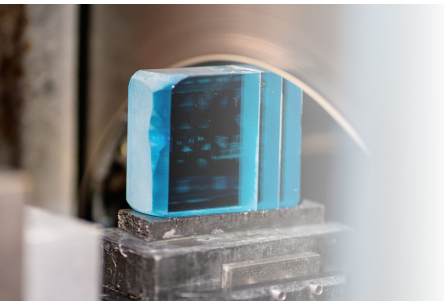


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G&H CRYSTAL OPTICS

As a pioneer in crystal growth techniques, G&H stands out as a premier supplier of specialized crystalline materials tailor-made for high-power optical applications. Crystals grown in our very own state-of-the-art facilities are used in our extensive range of passive and active precision optical components. These included a diverse range of passive components such as achromats, harmonic generating optics, prisms, and waveplates, as well as active electro-optics and acousto-optic devices.



LITHIUM NIOBATE WAFERS

Lithium niobate (LiNbO3 or LN) possesses fundamental properties that make it a versatile material in various optical applications, including electro-optics, acousto-optics, nonlinear optics, and guided-wave optics. These properties encompass a wide transparency range, high electro-optic and nonlinear optic coefficients, remarkable electro-mechanical coupling coefficients, and excellent chemical and mechanical stability. G&H offers a range of LN options, including X-axis and Z-axis orientation in congruent and 5.0 mol% magnesium-doped compositions. Our refined proprietary techniques for growth and processing ensure consistent high quality for both scientific and volume OEM applications. For infrared light applications, we provide congruent LN wafers, while our magnesium-doped periodically poled LN (MgO: PPLN) offers improved resistance to photorefractive damage at visible wavelengths.

	Diameter (mm)	Thickness (mm)	Orientation	Side 1	Side 2	Material
97-01514-10	100	1.00	Z-axis	10-5	20-10	LN
97-01763-01	100	1.00	X-axis	10-5	60-30	LN
97-01912-01	100	1.00	X-axis	10-5	Ground	LN
97-02641-01	125	1.00	Z-axis	10-5	60-30	LN
97-02604-01	125	1.00	X-axis	10-5	60-30	LN
97-03044-02	76.2	1.00	Z-axis	10-5	20-10	MgO: LN
97-03044-01	76.2	0.51	Z-axis	10-5	20-10	MgO: LN
97-00567-01	76.2	1.00	Z-axis	10-5	Ground	LN
97-00567-03	76.2	0.51	Z-axis	10-5	Ground	LN
97-00663-01	76.2	1.00	X-axis	Polished	Ground	LN
99-00629-01	76.2	0.50	X-axis	Polished	Polished	LN
99-00630-01	76.2	1.00	X-axis	Polished	Polished	LN
97-01183-01	76.2	0.50	X-axis	10-5	Ground	LN
99-00042-01	76.2	0.51	Z-axis	10-5	60-30	LN
99-60011-01	76.2	1.00	Z-axis	10-5	60-30	LN

APPLICATIONS

- Isolators
- Low pass filters
- Ophthalmic surgery systems
- Pockels cells
- Q-switching
- Rangefinders
- Waveguides



IN-HOUSE GROWN & PROCESSED

Our wafers undergo meticulous processing. The LN boules are poled to align ferroelectric domains along a single axis. The boule is shaped and sliced with X-ray diffraction orientation to within 6 arcmin of the x- or z-axis. A curved radius is applied to minimize cracking.

QUALITY GUARANTEED

Our LN wafters are lapped and chemical etched. Surfaces are polished to achieve a finish of Ra <0.2nm and a front surface scratch-dig quality of 10-5. We 100% visually inspect finished wafers and perform stress/strain characterization before packaging in a cleanroom.

CRYSTALS / NONLINEAR OPTICS

Crystals for polarization and frequency conversion, from Deep-UV to Mid-IR

G&H offers a comprehensive range of crystals and nonlinear optic (NLO) materials designed for various applications in polarization control and frequency conversion. Our crystals cover a wide spectral range, from the deep ultraviolet (DUV) to the mid-infrared, and are fabricated in-house using advanced processing techniques, tailored to meet specific requirements. Whether for one-off research projects or volume original equipment manufacturer (OEM) applications, we deliver custom-made crystals to both the scientific and industrial sectors.

KDP / KD*P

Potassium dihydrogen phosphate (KDP) is a transparent dielectric material best known for its nonlinear optical and electro-optical properties. Through the introduction of heavy water in the crystal growth process, the result is a deuterated form of KDP (KD*P) which can operate further into the near infrared regions. Our Cleveland facility has over 50 years of experience manufacturing KDP/KD*P crystals for use in nonlinear optics as well as Pockels cells.

We have dedicated large capacity rapid growth tanks that enable us to produce finished KDP and 70% KD*P optics up to 43cm. These state-of-the-art crystals are ideally suited for use with large-aperture laser systems and are critical components in major inertial confinement fusion (ICF) projects.

In addition to these large growth tanks, we have smaller tanks that incubate 95% and 99% KD*P crystal boules around the clock. Through a slow controlled growth process that takes almost 2 years to go from seed to boule, we can yield strain free and defect free crystals ranging from 8 mm to 25 mm in diameter.

CdS and CdSe

Cadmium Sulfide (CdS) and Cadmium Selenide (CdSe) are the premier crystals produced for near to mid-infrared applications. Whole boules of CdS and CdSe are thinly sliced into wafers and then aligned and stacked into IR achromatic waveplates or multiple zero order waveplates. Single CdS or CdSe wafers can be fabricated into a multiple order waveplate. When coupled with our proprietary dielectric AR coating, our finished CdS and CdSe crystals exhibit greater than 90% transmission from 3 – 12 µm at the designed wavelength range with clear aperture sizes from 9 to 29 mm in diameter.

HIGH QUALITY COATINGS

To meet specific optical requirements in the range 266nm to 12mm, we are equipped with a range of coating technologies including metal deposition and ion beam sputtering (IBS) and ion assisted e-beam coating systems.

In addition, our proprietary solgel process ensures high laser-damage threshold antireflective (AR) coatings, delivering high transmission and broadband performance for crystal diameters ranging from 5 mm to over 300 mm.

CRYSTAL HOLDERS

Our line of crystal holders accommodates a wide range of crystal sizes and apertures. These holders are designed to minimize mechanical stress and strain and are supported by our in-house machine shop, ensuring tight tolerance and high-quality manufacturing.

We possess comprehensive in-house metrology capabilities, including transmission and reflection interferometry, enabling us to measure contrast ratio, insertion loss, uniformity of birefringence, and other essential crystal characteristics.

$LiNbO_3$

Aside from wafers, Lithium Niobate crystals are processed from our rapid growth boules to be used for acousto-optic devices as well as electro-optic components, such as Pockels cells. These crystals can be further utilized in the production of waveguides, low pass filters, isolators, and Wollaston prisms. With the exception of a narrow absorption band at 2.85 µm, lithium niobate crystals exhibit high optical performance from 400 nm – 4 µm.

TeO_2

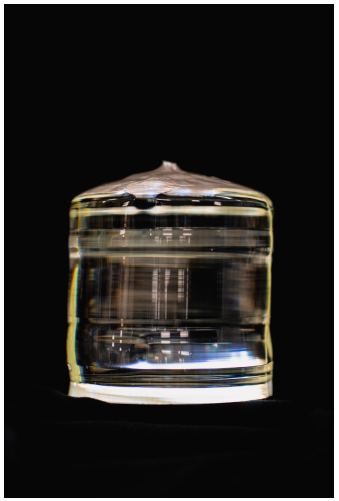
Our renowned craftsmanship in tellurium dioxide (TeO2) crystal cultivation has paved the way for the creation of exceptional optical and acousto-optic components. Through diligent control of growth parameters and stringent quality assurance processes, we consistently produce TeO2 crystals that stand at the forefront of optical technology. With their fast response times, high diffraction efficiency, and relatively low driving power, these crystals are ideal components of acousto-optic modulators, deflectors, and tunable filters, driving progress in laser technology, telecommunications, quantum computing, semiconductor fabrication, spectroscopy and more.

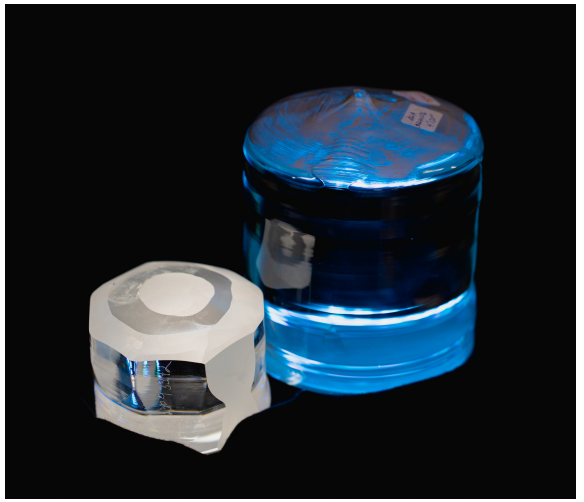
Customized crystals for diverse applications

With the aid of proprietary software and unique crystal growth capabilities, we specialize in supplying customized crystals for diverse applications. G&H offers large KDP boules weighing over 635 kg, crystals with cross sections as large as 43 cm square for inertial confinement fusion (ICF) applications, and large CdS and CdSe single crystals for infrared waveplates. Our precision polishing techniques enable the production of large diameter or high aspect ratio optics with excellent transmitted wavefront characteristics. We can provide special geometrical shapes with aspect ratios surpassing 100:1, including large diameter thin plates and smaller diameter plates as thin as 400 µm. For low-loss intra-cavity laser applications, we offer Brewster-cut bars.

G&H's crystals and nonlinear optics product line encompasses a wide range of applications, including the creation of beam deflectors, harmonic generators, infrared (IR) waveplates, isolators, low pass filters, modulators, Pockels cells, pulse pickers, Q-switches, waveguides, windows, and Wollaston prisms.

	Outer diameter (mm)	Aperture (mm)	Housing thickness (mm)
XC series	25.3	4, 6, 8, 10, 13	6.4
XP series	50.6	25, 28	13.5
XTP series	50.6 - 356	30 - 322	Varies





WAVEPLATES

Superior polarization control access across the spectrum

Thanks to our deep vertical integration, from crystal growth, crystal orientation and cutting, to fabrication and coating, G&H offers premium waveplates for your application.

All wavelength ranges with high retardation tolerances

For all wavelength ranges, we orient, cut, and polish the optical crystals for waveplate production. Tight internal controls enable better retardation tolerances within and between production runs. Polishing, coating, assembly, and metrology complete the manufacturing process.

Net zero-order and achromatic waveplates

Compound zero-order (also known as net-zero order) and achromatic waveplates are often optically contacted to reduce reflection losses at the surfaces. Air-spacing is recommended for high energy applications. Specialty waveplate designs such as off-axis or true-zero order waveplates are produced to custom specifications.

Waveplates from the UV to the NIR

We offer waveplates made from a wide range of materials to best match applications and wavelength requirements.

- Crystal quartz – standard material for UV-NIR waveplate applications
- $LiNbO_3$ – used in 1.5 µm applications and optical frequency shifters
- MgF_2 – typically used in combination with crystal quartz for achromatic waveplates
- Mica – for ophthalmology applications
- Sapphire – for defense applications in extreme environmental conditions
- YVO4 – waveplates for the 400 nm to 5 µm ranges

Waveplates for the IR, higher energies, or larger formats

As the world's only entirely vertically integrated CdS, CdSe, and KDP waveplate producer, we deliver accurate performance for demanding applications.

Our control over crystal growth benefits customers who need larger sizes, high laser damage threshold performance, or more accurate retardation tolerances.

APPLICATIONS

Waveplates find applications in a wide range of fields, including aerospace, astronomy, biomedical, military, semiconductor metrology, and more. They are commonly used for optical isolation, laser power control and attenuation, polarimetry, remote sensing, spectroscopy, and surveillance.

The company's IR achromatic wave plates, used for manipulating the polarization state of light over broad bands of wavelengths (in some cases over a full octave wavelength range), have a variety of applications in astronomy, spectrophotometry, remote sensing, etc.



For more information on **WAVEPLATES**, visit www.gandh.com/waveplates

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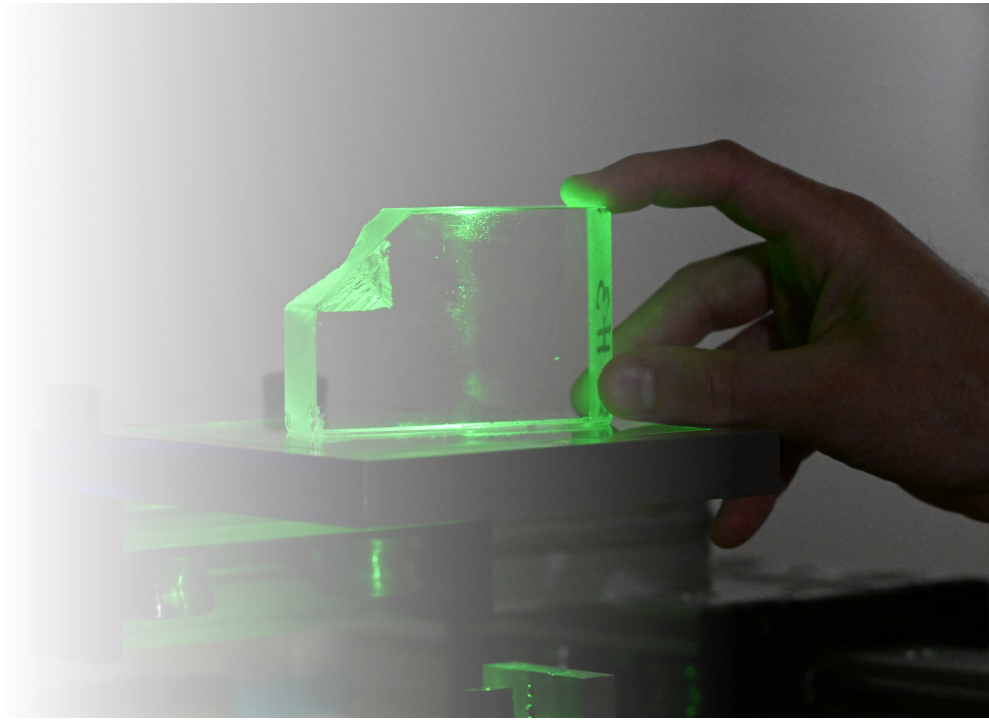
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