CRYSTALLINE MIRROR SOLUTIONS

Redefining
precision laser optics.

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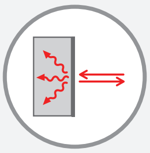
CRYSTALLINE MIRROR SOLUTIONS

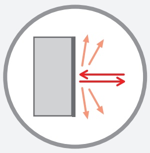
Ultralow-loss and ultrastable coatings

10× lower Brownian noise

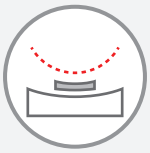
Center wavelength
900 – 2000 nm



Optical absorption
< 1 ppm



Optical scatter
< 5 ppm



Radius of curvature
> 10 cm

Other specifications

Optical transmission	Tunable, per customer request
Reflectivity	Typically > 99.99 %, with > 99.999 % achievable
Loss angle	< 4×10^{-5} at 300 K, < 5×10^{-6} at 10 K
Coating material	Single-crystal GaAs/AlGaAs
Substrate material	Typically fused silica, other materials available
Temperature range	Cryogenic, room temperature, and high temperature solutions available
Substrate diameter	0.5 - 1 inch (12.7 - 25.4 mm), other sizes available
Surface quality	1 Å RMS micro-roughness
Durability	Similar to fused silica, cleaning instructions provided on request

Select scientific publications

G. D. Cole, et. al. "High-performance near- and mid-infrared crystalline coatings," Optica, **3**, 647-656, 2016.
K. U. Schreiber, et. al. "Sensing Earth rotation with a helium-neon ring laser operating at 1.15 μm," Optics Letters, **40**, 1705-1708, 2015.
G. D. Cole, et. al. "Tenfold reduction of Brownian noise in high-reflectivity optical coatings," Nature Photonics, **7**, 644-650, 2013.

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CRYSTALLINE MIRROR SOLUTIONS

Ultralow-loss single-crystal coatings

10× lower mid-infrared absorption

Center wavelength
2 – 5+ μm

Optical losses
< 10 ppm (scatter + absorption)

Bandwidth
200 – 400 nm FWHM

Other specifications

Optical transmission	Tunable, per customer request
Coating material	Single-crystal GaAs/AlGaAs
Substrate material	Typically silicon, other materials possible
Substrate diameter	0.5 – 1 inch (12.7 – 25.4 mm), other sizes available
Radius of curvature	> 10 cm
Surface quality	< 5 Å RMS micro-roughness
Durability	Similar to fused silica, cleaning instructions provided on request

Select scientific publications

B. J. Bjork, et. al. "Direct frequency comb measurement of OD + CO → DOCO kinetics," Science, **354**, 444-448, 2016.
G. D. Cole, et. al. "High-performance near- and mid-infrared crystalline coatings," Optica, **3**, 647-656, 2016.

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CRYSTALLINE MIRROR SOLUTIONS

Thermally optimized optics

30× lower thermal resistivity

Semiconductor films bonded to high thermal conductivity substrates

Center wavelength
900-5000 nm

Optical losses
< 5 ppm (scatter + absorption)

Coating thermal conductivity
> 30 $Wm^{-1}K^{-1}$

Other specifications

Optical transmission	Tunable, per customer request
Coating area	Substrate dependent, mm-to-cm size scale possible
Coating material	Single-crystal GaAs/AlGaAs
Substrate material	SiC, diamond, or other materials possible
Surface flatness	< 0.10 wave P-V measured @ 633 nm
Radius of curvature	> 0.1 m
Surface quality	< 5 Å RMS micro-roughness
Durability	Similar to fused silica, cleaning instructions provided on request

Select scientific publications

Z. Yang, et. al. "16 W DBR-free membrane semiconductor disk laser with dual-SiC-heatspreader," Electron. Lett., **54**, 430-432, 2018.
A. Diebold, et. al. "Optimized SESAMs for kilowatt-level ultrafast lasers," Opt. Express, **24**, 10512-10526, 2016.

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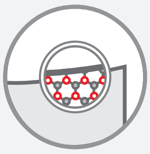
CRYSTALLINE MIRROR SOLUTIONS

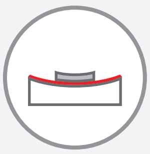
xtal custom™

Fully customizable solutions for direct-bonded components

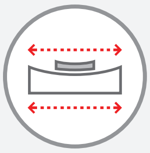
Using our proprietary direct bonding technology, CMS offers custom services for the heterogeneous integration of any number of disparate material systems. With this interlayer- and stress-free process, we can fuse a wide variety of materials in the form of bulk components, wafers, or chips.



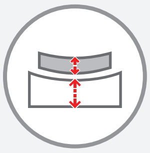
Example materials
Fused silica, Si, GaAs, Sapphire, SiC, Diamond, YAG, YVO4, Ti:Sapphire, etc.



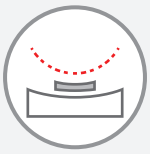
Surface quality requirements
Micro-roughness < 1 nm;
bow/warp < 10 µm;
P-V height variation < 100 nm



Size
< 5 mm ⟶ 200 mm

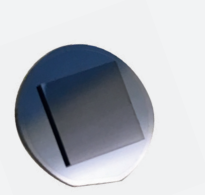


Thickness
> 1 µm ⟶ 30 mm

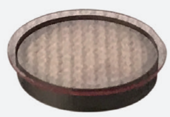


Radius of Curvature
Thickness dependent, ≥1 cm

Select Examples



- Semiconductor active regions on SiC and diamond for thermally-optimized saturable absorbers and high-power emitters
- Electrically-conductive interface layers between single-crystal semiconductors



- Laser disks directly bonded to polished heat sink materials
- Buried dielectric layers between single-crystal materials and thin films
- Integration of non-lattice-matched semiconductor heterostructures
- Semiconductor films on “soft” materials
- Joining dielectric and semiconductor layers for silicon and integrated photonics
- Simplify manufacturing by eliminating film stress

Please contact us to discuss a solution to your specific requirements.

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