

OPTICAL SPECIFICATIONS | Optics

Substrate material

The material from which an optic is made.

The most common materials are N-BK7, UV grade fused silica, MgF_2 , and CaF_2 . CVI Melles Griot has experience with a wide variety of glasses, fused silicas, and crystalline materials.

Surface figure

The deviation from the ideal surface.

CVI Melles Griot specifies surface figure in terms of waves peak-to-valley (p-v) at 633 nm, prior to coating. The peak-to-valley specification is more stringent than an RMS or average surface specification and assures high quality parts for all applications. We manufacture flats to $\lambda/20$ and spherical surfaces to $\lambda/10$ accuracy on a routine basis. A coated surface figure may also be specified.

Cosmetic surface quality

Surface quality describes a level of defects visually detected on the surface of an optical component.

100% visual inspection is performed on all optics. Surface quality becomes critically important in high energy laser applications or where scatter must be reduced for better signal to noise performance.

MIL-PRF-13830B

This inspection criteria was adopted in 1997. The first number denotes the size and concentration of scratches as compared to a known NIST standard. The second number defines the largest pit by its diameter in hundredths of millimeters. For example: 10 dig = $\frac{1}{2}$ (Length of dig + Width of dig) = 0.1 mm diameter.

CVI Melles Griot Laser Quality

We have extensive experience in delivering high laser damage threshold optics and have developed a proprietary inspection method to consistently meet our customers' laser induced damage requirements. This proprietary inspection method utilizes significantly brighter light sources than those specified in MIL-PRF-13830B. CVI Melles Griot also utilizes magnification when required to detect scratches, digs and other imperfections.

Laser Grade

Laser grade is the highest level of inspection criteria in the optics industry. Laser grade optics are virtually defect-free. High power magnification is used to detect and measure defects.

Wedge

The angle between the two surfaces of an optical element.

This can also be expressed as the difference in edge thickness around the part, for example a 25.4 mm diameter optic with an edge thickness variation of 0.025 mm has a wedge of 3.44 minutes of arc.

Radius of curvature

The radius of the sphere coincident with the optical surface.

A flat has radius of curvature equal to infinity. The reciprocal of the radius is called the curvature of the surface. CVI Melles Griot can manufacture a wide range of curvatures using its existing tooling and test plates and has the capability to make new test plates if required. CVI Melles Griot's standard radius tolerance is $\pm 0.5\%$ and $\pm 0.1\%$ is available for selected radii.

Concentricity/Centrality

The deviation between the optical and mechanical axes of a lens.

Concentricity error is the measured maximum edge thickness variation. CVI Melles Griot's standard concentricity is ≤ 0.05 mm edge thickness variation and the standard centrality error is ≤ 3 arc minutes.

Clear aperture

The central area over which the optical specifications apply.

CVI Melles Griot specifies clear aperture in terms of the diameter or linear dimensions of this central area.

Angle and plane of incidence

The angle formed between the normal to the optical surface and the incident ray.

An incidence angle of zero degrees is referred to as normal incidence. The plane of incidence is the plane containing the incident ray and the normal.

Polarization

The orientation and phase shift of the electric field when resolved into components parallel and perpendicular to the plane of incidence.

P-polarized light has the electric field polarized parallel to the plane of incidence. S-polarized light has the electric field polarized perpendicular to the plane of incidence. UNP refers to unpolarized light, which is a random mixture of equal amounts of s- and p-polarization states. Specify the polarization state whenever ordering an optic for use at non-normal incidence angle.

Optics | LIDT & ENVIRONMENTAL TESTING

Laser induced damage threshold

Typical Laser Induced Damage Threshold Data

UV data

Antireflection coatings on fused silica

193 nm > 2 J/cm², 20ns, 20Hz

266 nm, 355 nm > 5 J/cm², 10ns, 10Hz

1064nm, 20ns, 20Hz data

Antireflection coatings on fused silica >15 J/cm²

Antireflection coatings on N-BK7 >10 J/cm²

Antireflection coatings on N-SF11 >4 J/cm²

Optical Cement >2 J/cm²

High reflection coatings >20 J/cm²

For higher damage thresholds call CVI Melles Griot to optimize the various material parameters and provide certification. CVI Melles Griot is a leader in damage resistant coatings for excimer and other high energy lasers.

Laser induced damage threshold testing

LIDT (Laser Induced Damage Threshold) is defined as any laser-induced permanent change which is observable at high magnification at the lowest power sufficient to induce damage at any test site. LIDT depends on test wavelength, pulse width, repetition rate, and inspection method.

To determine the damage threshold, CVI Melles Griot tests a number of samples at varied settings using increasing power. Visible observation is performed using a 20x microscope immediately before and after the optic is subjected to the laser. The test samples are then characterized for laser induced damage and any changes in beam scatter are documented. LIDT test procedures are subject to change, and can be changed upon the request of a customer.

The two main mechanisms that cause laser damage to an optical coating are dielectric breakdown and thermal absorption. Factors which significantly reduce the LIDT are scratches, pores, inclusions, and impurities.

Environmental testing

CVI Melles Griot is a valued supplier of critical optical components able to withstand the rigours of the most severe environments in defense and industrial applications. All tests, where applicable, are carried out per MIL specifications and on a representative witness piece coated in the same batch.

STATIC HUMIDITY TEST

A standard test typically performed over 24 hours in 98% Relative Humidity at 49°C. This can be varied for customer specific requests. For Hard Carbon coatings and STAR coatings, this test would be performed for 7 and 10 days respectively.

CYCLING HUMIDITY TEST

This test is performed only by specific request from a customer. Typically performed at 98% Relative Humidity between 35°C and 65°C. This test can be performed at other temperatures and Relative Humidity by request.

WATER IMMERSION TEST

A standard test typically performed over 24 hours.

SALT SOLUTION TEST

A standard test typically performed over 24 hours. By customer request this can be extended up to 7 days.

SALT SPRAY (FOG) TEST

This test is typically performed over 24 hours at 47°C. By customer request this can be extended up to 90 days.

TEMPERATURE TEST

A standard test which cycles between hot and cold temperatures, typically between -62°C and +71°C for 5 hours each. The temperature and duration can be varied to customer's specific requirements. We also have the capability to perform Thermal Shock Tests upon request.

ABRASION TEST

A standard test varying from Moderate Abrasion with cheesecloth to Severe Abrasion with an eraser at a known pressure. Other Abrasion tests that can be carried out include Sand Abrasion and Windscreen Wiper Abrasion.

ADHESION TEST

A standard test performed using adhesive tape to a known specification.

SOLUBILITY & CLEANABILITY TEST

This test is performed only by specific request from a customer. Typical chemicals used would be Acetone, IPA or AG101.

CHEMICAL DEGRADATION TEST

This test is performed only by specific request from a customer. A coated witness sample would be subjected to chemical attack using customer specified chemicals.

SHOCK & VIBRATION TEST

This testing is used to simulate the worst case handling and shipping environments of mounted components and complex optical systems to the limits of lifetime exposure. This testing protocol assures products delivered are robust.