



Coated Substrate, ALIGO INPUT MODE CLEANER FLAT MIRROR (IMCF) for L1 and H1 interferometers - unfolded

Table with columns: AUTHOR, CHECKED, DATE, APPROVALS (DCN NO., REV, DATE). Rows include R. Martin and D. Reitze, D. Tanner with dates from 04-02-07 to 11-18-09 and revision numbers -00, -01, -V1, -V2.

Name: IMCF-01 to IMCF-06

Applicable Documents

- D070091-A-D ALIGO Input Mode Cleaner Flat Mirror Substrate (Substrate Drawing)
E070078-A-D Substrate, ALIGO Input Mode Cleaner Flat Mirror (IMCF - Substrate Specification)
E070071-A-D Mirror Blank Material, ALIGO Input Mode Cleaner Flat Mirror (Blank Specification)

Physical Configuration

Fabricated from: D070091-A-D ALIGO Input Mode Cleaner Flat Mirror Substrate.

General to Surfaces 1 and 2

Coating Area To Bevel

Coating Deposition Method Ion Beam Sputtering

Surface Quality To comply with Advanced LIGO Component Specification E070078-A-D, Substrate, ALIGO Input Mode Cleaner Flat Mirror (Page 2): "Scratches and Point Defects".

Surface Electric Field Zero (Goal), <0.01V/m (Requirement)

High average optical power >10 MW/cm^2, sustained.

- Witness Sample Durability Testing
On a representative witness piece per run:
1. Coating to resist adhesion test per MIL-C-48497A 4.5.3.1 Adhesion (snap tape).
2. Coating to resist humidity test per MIL-C-48497A 4.5.3.2 Humidity (120F and 95% to 100% relative humidity for 24 hr), combined with before/after spectrometer scan from 500-1400 nm, marking the specimen to ensure the same area is scanned. There should be no measurable spectral shift.
3. Coating to resist abrasion test per MIL-C-48497A 4.5.3.3 Moderate Abrasion (cheese cloth rub)



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Surface 1: HR coating

Note: Arrow on the optic barrel points in the direction of Surface 1, the Highly Reflective (HR) surface!

Coating type	Highly Reflective, centered at 1064 nm
Angle of Incidence (AOI)	44.59 degrees on the vacuum side, S polarization
Transmission	6000 ppm ± 200 ppm at the design AOI The substrates will be coated in pairs, and the variation of transmittance from one mirror to the second one of the pair should be no larger than 50 ppm.
Absorption	< 0.5 ppm (Goal), <1ppm (Requirement)
Total Scatter	< 15 ppm over the central 40 mm diameter < 50 ppm over the central 140 mm diameter
Optical Performance Uniformity	The specified single surface reflectance at the specified wavelength and angle of incidence must be maintained over an 80 mm diameter aperture.

Surface 2: AR coating

Coating type	Antireflective, centered at 1064 nm
Angle of Incidence	43.70 degrees on the vacuum side, S polarization
Reflection	< 300 ppm at the designed AOI
Absorption	< 3 ppm
Scatter	< 60 ppm over central 140 mm
Optical Performance Uniformity	The specified single surface reflectance at the specified wavelength and angle of incidence must be maintained over a 140 mm diameter aperture.

	LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY		E070085 -V2- D
	COMPONENT SPECIFICATION		Drawing No Rev. Group
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ADDITIONAL DELIVERABLES:

Coating manufacturer to provide:

1. WITNESS SAMPLES for Surfaces 1 and 2:

Three 1-inch fused silica witness plates from each coating run (provided by the vendor). The witness pieces should be superpolished on the HR side and nominally polished and wedged at 0.5 deg on the AR side.

2. SPECTRAL SCANS - Surfaces 1 and 2

On a representative witness sample for each run, the coating manufacturer will provide the following data:

- a. Spectrophotometer scans of the Reflectance and Transmittance of each surface (Surface 1 – HR coating and Surface 2 - AR coating) at the specified angles of incidence, over the 500-1400 nm range. If possible, the scans will be taken before the sample is coated, between the Surface 1 and Surface 2 coating and after the coating is completed. All spectrometer data to be provided in Excel spreadsheet format, with columnar data in increments of approximately 1 nm.

3. SURFACE DEFECT ANALYSIS - Scratches and Point Defects:

a. **Hand Sketch:**

- i. The surface is examined visually by two observers independently. The examination is done against a dark background using a fiber optic illuminator system of at least 200 W total power. A 100% inspection of the surface is carried out. Pits and scratches down to 2 micrometers in width can be detected using this method of inspection. Any scratches or sleeks that are detected will be measured using a calibrated eyepiece.
- ii. Farther inspection will be done with a minimum 6X eyeglass using the same illumination conditions, again with two observers. Sleeks down to 0.5 micrometers wide can be detected using this method. The surface will be scanned along one or two chords from center to edge, then at ten positions around the edge, and ten to fifteen positions near the center.

- b. **Digital Images:** An inspection is then carried out with a dark or bright field microscope, with 5X objective at four positions at each of the following locations:

- i. Within 10 mm of the center of the surface (HR side).
- ii. Equally spaced along the circumference of a centered, 20 mm diameter circle (HR side).
- iii. Equally spaced along the circumference of a centered, 83 mm diameter circle, and aligned with the marks and the arrow on the barrel within 5 deg. (AR side).

4. DURABILITY TEST DATA & SAMPLES:

All samples from the durability tests and data including spectrophotometer scans of the representative coating on each side in an Excel spreadsheet.