

AUTHOR:	CHECKED:	DATE	APPROVALS		
			DCN NO.	REV	DATE
R. Martin	D. Reitze, D. Tanner	04-01-08		-00-	
		08-24-09	E0900231	-V1-	

Name: **PMMT1, F-PMMT1**

Applicable Documents

- D080160-v2-D ALIGO Pre-Mode Matching Telescope Mirror #1 Substrate (Substrate Drawing - unfolded)
- D080741-v2-D ALIGO Folded Pre-Mode Matching Telescope Mirror #1 Substrate (Substrate Drawing - folded)

- E080135-v2-D Substrate, ALIGO Pre-Mode Matching Telescope Mirror #1 (PMMT1, Substrate Specification - unfolded)
- E080504-v2-D Substrate, ALIGO Pre-Mode Matching Telescope Mirror #1 (F-PMMT1, Substrate Specification - folded)

- E080133-A-D Mirror Blank Material, ALIGO Pre-Mode Matching Telescope Mirror (PMMT, Blank Specification)

Physical Configuration

Fabricated from: D080160-v2-D ALIGO Pre-Mode Matching Telescope Mirror #1 Substrate, and
D080741-v2-D ALIGO Folded Pre-Mode Matching Telescope Mirror #1 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 E080135-v2-D and E080504-v2-D, Substrate, ALIGO Pre-Mode Matching Telescope Mirror #1 (PMMT1 and F-PMMT1) (Page 2): “Scratches and Point Defects”.

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

- High average optical power** >1 MW/cm², 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).



Coated Substrate, ALIGO PRE-MODE MATCHING TELESCOPE MIRROR #1

- 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)

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)	PMMT1: 7.01 degrees on the vacuum side, P polarization F-PMMT1: 7.00 degrees on the vacuum side, P polarization The two HR coatings for all PMMT1 and F-PMMT1 mirrors may have the same design, provided that this design meets the specifications at all angles of incidence.
Transmission	<50 ppm at the designed AOI, and should be maintained within these specifications for ± 3 deg around the design AOI.
Absorption	< 3 ppm
Total Scatter	< 50 ppm over the central 60 mm aperture.
Optical Performance Uniformity	The specified single surface reflectance at the specified wavelength and angle of incidence must be maintained over a 60 mm diameter aperture.



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Surface 2: AR coating

Coating type	Antireflective, centered at 1064 nm
Angle of Incidence	PMMT1: 7.74 degrees on the vacuum side, P polarization F-PMMT1: 7.73 degrees on the vacuum side, P polarization The two AR coatings for all PMMT1 and F-PMMT1 mirrors may have the same design, provided that this design meets the specifications at all angles of incidence.
Reflection	<300 ppm requirement at the designed AOI, and should be maintained within these specifications for ± 3 deg around the design AOI
Absorption	< 3 ppm
Optical Performance Uniformity	The specified single surface reflectance at the specified wavelength and angle of incidence must be maintained over a 60 mm diameter aperture.

 LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY COMPONENT SPECIFICATION	E080137 -V2- D						
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Coated Substrate, ALIGO PRE-MODE MATCHING TELESCOPE MIRROR #1

ADDITIONAL DELIVERABLES:

Coating manufacturer to provide:

1. WITNESS SAMPLES for Surfaces 1 and 2:

Two 1-inch witness plates plus as many 1-inch witness pieces that can be fitted additionally from each coating run (provided by the vendor).

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 graphs 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. 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 5 mm of the center of the surface (HR and AR sides).
- ii. Equally spaced along the circumference of a centered, 10 mm diameter circle (HR 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.