Advanced LIGO Power Recycling Mirror 3 Coating Specification

AUTHOR:	CHECKED:	DATE	APPROVALS		
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Name	**PR3**
Applicable Documents	
Blank Specification	E080041-A
Polish Specification	Straight: E080516-v2, Folded: E080517-v2
Polish Drawing (Fabricate From)	Straight: D080662-v2, Folded: D080663-v2
General to Surfaces 1 & 2	
Figure Change Before / After Coating	Over a 160 mm diameter aperture, coating uniformity & stress from the coating process shall not change the Sagitta more than 8 nanometers, and shall not add surface figure Zernike terms higher than second order with amplitude > 0.5 nanometers. Confirming measurements are to be made on both sides of the optic, by the coating vendor, and need to be demonstrated only once, on a single part, unless there has been significant reconfiguration of the coating tool. The vendor is responsible for communicating that there has been such a change to the tool, and must repeat the confirming measurements.
Optical Performance Uniformity	On both surfaces, the specified single surface reflectance or transmittances at the specified wavelengths must be maintained over a 160 mm diameter aperture.

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Coating Deposition Method	Ion Beam Sputtered
Coating Area	To Bevel
Witness Sample Durability Testing	On one witness piece per run, coating to resist: 1. Adhesion test per MIL-C-48497A 4.5.3.1 Adhesion (snap tape). 2. MIL-C-4.5.3.2 Humidity (120F 95% RH for 24 hours), combined with before/after reflectance & transmittance spectrophotometer scans from 350 - 2500 nm in about 1 nm increments, marking the specimen ensure the same area is scanned. The scans will be provided in an Excel spreadsheet as columnar data. There should be no measureable spectral shift. 3. MIL-C-4.5.3.3 Moderate Abrasion (cheesecloth rub).
Surface 1	***ARROWS ON OPTIC SIDE POINT TO SURFACE 1***
Coating Type	High Reflection
Angle of Incidence	Straight - 0.608 deg, Folded - 1.144 deg, both 100% p-polarized light incident from the air-side. The non-folded version is PR3 and the folded version is F-PR3. There is also a non-folded and folded version of SR3. All four coatings may have the same design, provided this design meets the specifications at all the required angles.
Transmission at 1064 nm	<15 ppm requirement

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Transmission matching between parts at 1064 nm	N/A
Transmission at 532 nm	N/A
Thermal Stability at 532 nm	N/A
Thermal Stability at 1064 nm	N/A
Coating Materials	N/A
Surface Electric Field 1064 nm	N/A
Thermal Noise	N/A
Absorption at 1064 nm	<1 ppm
Max Scratches Surface 1 inside 120mm diameter (units sq. microns)	500,000
Max Scratches Surface 1 outside 120mm to 160 mm diameter (units sq. microns)	N/A
Max Point Defects Surface 1 inside 120mm diameter	50
Max Point Defect Density Surface 1 inside 120mm diameter	5 per sq. millimeter
Max Point Defects Surface 1 outside 120mm to 160 mm diameter	N/A
Surface 2	
Coating Type	Antireflection

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Reflection at 1064 nm	< 0.004 requirement
Reflection at 532 nm	N/A
Surface Electric Field at 1064 nm	N/A
Thermal Stability at 532 nm	N/A
Thermal Stability at 1064 nm	N/A
Coating Materials	N/A
Max Scratches Surface 2 inside 120mm diameter (units of sq. microns)	N/A
Max Point Defects Surface 2 inside 120 mm diameter	N/A
Other	
Additional Deliverables	

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Witness Samples	SURFACE 1 & 2: Two 1-inch witness samples per run required + as many 1 inch witness pieces that can be fit additionally per run (provided by vendor).
Layer Thickness Information	For all layers in the design, measured thickness data from the deposition for each run, designed thicknesses, and measured indices of refraction at both 1064 nm and 532 nm for both coating materials (based on individual layers).
Surface 1 Spectral Scans	On a representative witness piece for each run, normal incidence & 2 degree p-polarized angle of incidence spectrophotometer scans of reflectance and transmission of Surface 1 (HR coating) from 350-2500 nm before it is coated, between Surface 1 and Surface 2 coating, and after coating is completed. All spectrophotometer data to be provided in Excel spreadsheet format with columnar data in increments of approximately 1 nm.
Surface 2 Spectral Scans	On a representative witness piece for each run, normal incidence & 2 degree p-polarized angle of incidence spectrophotometer scans of reflectance and transmission of Surface 1 (AR coating) from 350-2500 nm before it is coated, between Surface 1 and Surface 2 coating, and after coating is completed. All spectrophotometer data to be provided in Excel spreadsheet format with columnar data in increments of approximately 1 nm.

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Surface Defect Analysis By Three Required Methods	METHOD 1. The surface is examined visually by two observers independently. The examination is done against a dark background using a fiber optic illumination 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. METHOD 2. Further 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. Data to be supplied as a hand sketch from both Methods 1 & 2. METHOD 3. 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: a) Within 10mm of the center of the surface. b) Equally spaced along the circumference of a centered, 60 mm diameter circle. c) Equally spaced along the circumference of a centered, 120 mm diameter circle. Data to be supplied as digital images.

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Durability Test Data & Samples	All samples from the durability tests and data, including transmittance and reflectance spectrophotometer scans of the representative coating on each side in an Excel spreadsheet with columnar data spaced by approximately 1 nm from 350 - 2500 nm.