LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

SPECIFICATION

LIGO

E080516	V1	D
Drawing No	Rev.	Group

Sheet 1 of 3

Advanced LIGO Power Recycling Mirror PR3

			APPROVALS		
AUTHOR:	CHECKED:	DATE	DCN NO.	REV	DATE
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Applicable Documents

LIGO-D080662- v1   Fused Silica Substrate, Advanced LIGO Power Recycling Mirror PR3
LIGO-D080053-A   Fused Silica Blank, Advanced LIGO Power Recycling Mirror PR3
LIGO-E080041-A   Fused Silica Blank, Advanced LIGO Power Recycling Mirror PR3

Requirements

Physical Configuration

According to LIGO-D080662- v1   Fused Silica Substrate, Advanced LIGO Power Recycling Mirror PR3

Fabricate from

LIGO-D080053-A   Fused Silica Blank, Advanced LIGO Power Recycling Mirror PR3
LIGO-E080041-A   Fused Silica Blank, Advanced LIGO Power Recycling Mirror PR3

Registration Marks

Registration marks shall be etched, ground or sandblasted and located per LIGO-D080662- v1

Surface, Side and Bevel Polish

All Surfaces, Sides and Bevels shall be polished using a progression of smaller grit sizes. The last step before final polish shall be equal to or less than a five micrometer grit finish. These surfaces shall appear transparent with no grey, scuffs or scratches visible to the naked eye when viewed in normal room light against a black background.

Bevel

Bevel for safety per D080662- v1

Serial Number

Serial Number "PR3 XX" shall be etched, ground or sandblasted on the barrel of the optic per D080662- v1, where X is incremental starting with 01.

Scratches, Sleeks and Point defects

Point defects of radius greater than 25 micrometers are treated like scratches for the purpose of this specification.

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Scratches and Sleeks, Surface 1

The total area of scratches and sleeks within the central 120 mm diameter shall not exceed 500 X 10^3 square micrometers (width times length.)

Point Defects, Surface 1

There shall be no more than 50 point defects of radius greater than 2 μm within the central 120 mm diameter. Average density of defects less than 2 μm radius must be less than or equal to 5 per $4mm^2$

Scratch and Point Defect Inspection 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.

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 centre to edge, then at ten positions around the edge, and ten to fifteen positions near the centre.

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

Optical Surface Figure, measured over the central 160 mm diameter

Surface 1: Spherical, concave. Radius of curvature: 34.00 m ± 0.17m.
Astigmatism: < 30 nm Amplitude of the Zernike coefficient $Z_{2,2}$ as defined in Born and Wolf pp. 523-525.

Surface 2: Nominally flat. ROC > | 7000 m |

Surface Error, Low Spatial Frequency: measurement aperture to 1 mm^{-1}

The following root mean square standard deviation (σ_{rms}) values are calculated from the phase maps which are to be provided with each optic. For this calculation the amplitudes for the best fit Zernike terms $Z_{0,0}$, $Z_{1,1}$, $Z_{2,0}$ and $Z_{2,2}$ or corresponding Seidel aberrations are subtracted from the phase map. Known bad pixels may be excluded from this calculation.

Surface 1, Frequency Band: < 1 mm^{-1}
Measured over the central 215 mm diameter aperture: σ_{rms} < 3 nanometers
Measured over the central 160 mm diameter aperture: σ_{rms} < 2 nanometers

Surface 2 - Frequency Band: < 1 mm^{-1}
Measured over the central 215 mm diameter aperture: σ_{rms} < 40 nanometers

Error, High Spatial Frequency: 1– 750 mm^{-1}

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Surface 1 HSF error $\sigma_{rms} \leq 0.3$ nanometers measured at the following locations:

1. Within 2mm of the center of the surface.
2. Four positions equally spaced along the circumference of a centered, 60 mm diameter circle.
3. Three positions equally spaced along the circumference of a centered, 120 mm diameter circle.

Inspection

Table 1: Inspections

Specification	Test Method and frequency	Data Delivered
Dimensions	Measurement 100%	Measurement Results
Scratches and Point defects methods 1 and 2	Visual Inspection 100%	Hand sketch including scratch/pit dimensions
Scratches and Point defects method 3	Visual Inspection 100%	Digital image of each inspection location
Figure	Interferometry 100%	Surface phase maps
Errors - Low Spatial Frequency	Interferometry 100%	Surface phase maps
Errors - High Spatial Frequency	Interferometry 100%	Surface maps for 3 central locations. Numerical values included with certification
Mounting Flat figure	Interferometry 100%	Surface phase map

Orientation: For the purpose of full surface phase maps the data shall be oriented such that the substrate registration mark is at the top center of the data.

Format: All Data shall be delivered according to Table 1. In addition to the hard copy, an electronic data set of the phase maps shall be delivered in either ASCII or Vision.OPD format.