COMPONENT SPECIFICATION

LIGO II Pathfinder, Sapphire Polishing Specification

APPROVALS:	DATE	REV	DCN NO	BY	CHK	DCC	DATE
DRAWN:							
CHECKED:							
APPROVED:							
DCC RELEASE:							

Applicable Documents

Fabricate from
LIGO-D000070 LIGO II Pathfinder Substrate

Requirements

Physical Configuration

Fabricate from
LIGO-D000070 LIGO II Pathfinder Substrate

Scratches and Point defects

Point defects of radius greater than 25 micrometers are treated like scratches for the purpose of this specification. Point defects of radius less than 2.5 micrometers are disregarded.

Scratches, Side 1
The total area of scratches within the central 80 mm diameter shall not exceed 25 X 10^3 square micrometers (width times length.)

The total area of scratches outside the central 80 mm diameter shall not exceed 250 X 10^3 square micrometers.

Scratches, Side 2
The total area of scratches within the central 80 mm diameter shall not exceed 75 X 10^3 square micrometers (width times length.)

The total area of scratches outside the central 80 mm diameter shall not exceed 750 X 10^3 square micrometers.

Point Defects, Side 1
There shall be no more than 10 point defects within the central 80 mm diameter
There shall be no more than 100 point defects on the entire surface

Point Defects, Side 2
There shall be no more than 30 point defects within the central 80 mm diameter
There shall be no more than 100 point defects on the entire surface

Point Defect Inspection Method

1. The surface is examined visually by two observers independently. The examination is done against a dark background using a three-bundle fiberoptic illumination system of 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 that are detected will be measured using a calibrated eyepiece.
2. Further inspection will be done with a 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 field microscope with a similar sampling frequency as described in section 2.

Figure, measured over the central 120 mm diameter

All specified quantities refer to the optical quality of the substrate.

Surface 1: Spherical, concave.
Sagitta: Amplitude of the Zernike coefficient $Z_{2,0}$ as defined in Born and Wolf, 26 nm ± 5 nm
Astigmatism: Amplitude of the Zernike coefficient $Z_{2,2}$ as defined in Born and Wolf, < 5 nm

Surface 2 - Bulk homogeneity compensation: Nominally flat, figuring of surface 2 is intended for compensation of bulk inhomogeneity. There is no explicit requirement for the surface alone, only in combination with the bulk material.
Measured in transmission through Side 2, passing through the material, reflected from Side 1.
Sagitta: Amplitude of the Zernike coefficient $Z_{2,0}$ as defined in Born and Wolf, 45 nm ± 5 nm
Astigmatism: Amplitude of the Zernike coefficient $Z_{2,2}$ as defined in Born and Wolf, < 5 nm

Errors, Low Spatial Frequency

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 Seidel terms piston, tip, tilt, power and astigmatism are subtracted from the phase map. σ_{rms} for the resultant phase map is defined as the square root of the mean of the square of each pixel value. Known bad pixels are excluded from this calculation.

Surface 1, Frequency Band: $< 4.3\ cm^{-1}$
Measured over the central 120 mm diameter aperture:
σ_{rms} <0.8 nanometers

Measured over the central 80 mm diameter aperture:
Goal $\sigma_{rms} < 0.4$ nanometers
Specification $\sigma_{rms} < 0.8$ nanometers

Errors, Low Spatial Frequency cont'd

Surface 2 - bulk homogeneity compensation, Frequency Band: < 4.3 cm $^{-1}$
Measured in transmission through Side 2, passing through the material, reflected from Side 1, over the central 120 mm diameter aperture:
$\sigma_{rms} < 20$ nanometers

Measured in transmission through Side 2, passing through the material, reflected from Side 1, over the central 80 mm diameter aperture:
$\sigma_{rms} < 10$ nanometers

Error, High Spatial Frequency

Surface 1 and Surface 2, Frequency Band: 4.3 - 7,500 cm $^{-1}$
Goal $\sigma_{rms} < 0.1$ nanometers
Specification $\sigma_{rms} < 0.2$ nanometers

Measured at the following locations:
1. The center of the mirror substrate.
2. Four positions equally spaced along the circumference of a centered, 80 mm diameter circle.
3. Three positions equally spaced along the circumference of a centered, 120 mm diameter circle.

Inspection

Specification	Test Method	Data Delivered
Scratches and Point defects	Visual Inspection	Hand sketch including scratch/pit dimensions
Figure	Interferometry	Surface Map
Errors - Low Spatial Frequency	Interferometry	Surface Map
Surface Errors - High Spatial Frequency	High resolution Surface Map	Surface maps for 3 central locations. Numerical values included with Certification

Orientation: For the purpose of full surface phase maps the substrate shall be oriented such that the point of minimum thickness shall be at the top center of the data. This location will be marked in indelible ink, with an arrow pointing toward side 1.

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 ASCII or Vision.OPD format.