Substrate, End Test Mass, Gin Gin Experiment

AUTHOR:	CHECKED:	DATE	APPROVALS		
			DCN NO.	REV	DATE
G. Billingsley		8-27-02	E020804	A	9-16-02

Applicable Documents

LIGO-D020424-A-D Substrate, End Test Mass, Gin Gin Experiment

Requirements

Physical Configuration

According to
LIGO-D020424 Substrate, End Test Mass, Gin Gin Experiment

Fabricate from
Supplied m-axis sapphire blank ~150mm x 80mm

Registration Mark

Registration marks shall be etched, ground or sandblasted.
Reference LIGO-D020424, Substrate, End Test Mass, Gin Gin Experiment.

Side and Bevel Polish

All sides and Bevels will be polished as supplied by Caltech. Care should be taken to prevent any scratches during the final polishing operation.

Scratches and Point defects, Surface 1

There shall be no scratches, sleeks or point defects within the central 10 mm
The total area of scratches, sleeks and point defects within the central 20 mm diameter shall not exceed 1 x 10^5 square micrometers (width times length.)

Scratches and Point defects, Surface 2

80-50

Minimum Point Defect

Point defects which have a maximum dimension of 5 micrometers are disregarded.

Substrate, End Test Mass, Gin Gin Experiment

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 three-bundle 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 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 center to edge, then at ten positions around the edge, and ten to fifteen positions near the center.
3. An inspection is then carried out with a dark field microscope with a similar sampling frequency as described in the previous paragraph.

Surface Figure, measured over the central 30 mm diameter

All specified quantities refer to the physical surface of the optic.

Surface 1: Concave.

Radius of curvature: 720 ± 100 meters

Astigmatism: < 5 nanometers (surface peak to valley)

Surface 2: Nominally flat.

Radius of curvature > ±5,500 meters

Astigmatism: < 5 nanometers (surface peak to valley)

Surface Errors

The following root mean square standard deviation (σ_{rms}) values are calculated from the phase maps which are to be provided with each optic. σ_{rms} 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

Low Spatial Frequency Band < 32 cm^{-1}: The surface is measured using a commercial phase measurement interferometer and calibrated reference flat. With piston, tip, tilt, power (best fit spherical surface) and astigmatism removed over the central 30 mm diameter aperture:

σ_{rms} <2 nanometers

High Spatial Frequency Band: Micro-roughness is measured with a commercial microscopic interferometer or surface profiler.

σ_{rms} < 0.1 nanometers

Substrate, End Test Mass, Gin Gin Experiment

Surface Errors (continued)

Measured at the following locations:
1. The center of the mirror substrate.
2. Four positions equally spaced along the circumference of a centered, 30 mm diameter circle.

Surface 2

Low Spatial Frequency Band < 32 cm^{-1}: The surface is measured using a commercial phase measurement interferometer and calibrated reference flat. With piston, tip, tilt, power (best fit spherical surface) and astigmatism removed over the central 30 mm diameter aperture:

σ_{rms} <10 nanometers

High Spatial Frequency Band: Micro-roughness is measured with a commercial microscopic interferometer or surface profiler.

σ_{rms} < 0.4 nanometers

Measured at the following locations:
1. The center of the mirror substrate.
2. Four positions equally spaced along the circumference of a centered, 30 mm diameter circle.

Table 1 Certification Data Requirements

Specification	Test Method	Frequency of Inspection	Data Delivered
Physical Dimensions	Visual Inspection	100%	Certification
Side and Bevel Polish	Visual Inspection	None	None
Scratches and Point defects	Visual Inspection	100%	Certification
Surface Figure	Interferometry	100%	Surface Map
Side 1, Surface Errors – Low Spatial Frequency	Interferometry	100%	Surface Map
Side 1, Surface Errors – High Spatial Frequency	High resolution Surface Map	100%	Certification
Side 2, Surface Errors – Low Spatial Frequency	Interferometry	100%	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.