

	LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY		E020389 -01- D
	SPECIFICATION		Drawing No    Rev.    Group
			Sheet 1    of    2
Sapphire Substrate, LASTI Test Mass, R&D			

AUTHOR:	CHECKED:	DATE	APPROVALS		
			DCN NO.	REV	DATE
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Scope

The substrates defined by this specification are to be used in research as first article Test Masses. These substrates should be manufactured using all processes intended for production quantity LIGO Test Masses. Final polish of the optical surfaces will occur in the next phase of manufacturing.

Applicable Documents

LIGO-D020150   Substrate, LASTI Test Mass

Requirements

Physical Configuration

According to  
LIGO-D020150   Substrate, LASTI Test Mass

Material

A-Axis Sapphire

Absorption

Lower than 40 ppm/cm within the central 120 mm diameter.  
Best effort

Optical Homogeneity along the A-Axis

< 5 x 10 <sup>-7</sup> peak to valley at λ = 632.8 nm within the central 120 mm  
< 2.5 x 10 <sup>-6</sup> peak to valley at λ = 632.8 nm within the central 225 mm  
Best effort

Bubble and Inclusion cross-section

The sum of cross sectional area of all defects within the central 120 mm diameter shall not exceed 170 X 10<sup>3</sup> square micrometers.  
There shall be no defect of radius greater than 150 micrometers within the central 60 mm diameter.  
Defects of radius less than 10 micrometers are disregarded.

### Part and Serial Number

The Serial number shall be of the format:  
ETM XX Where XX is incremental for each optic.

### Registration Mark

The four registration marks shall be etched, ground or sandblasted per LIGO-D020150 Substrate, LASTI Test Mass .

### Side and Bevel Polish

Sides and Bevels shall appear transparent with no gray, scuffs or scratches visible to the naked eye when viewed in normal room light against a black background.

### Scratches and Point defects

An 80/50 or better scratch/dig finish on mounting flats and surfaces.

### Mounting Flat Surfaces, measured over the central 6.8cm x 6.8cm area

**Figure:** Flat.

**Figure Error:**  $\sigma_{\text{rms}} < 10 \text{ nm rms}$

### Surface 1, measured over the central 80% diameter

**Figure:** Flat.

**Figure Error:**  $\sigma_{\text{rms}} < 100 \text{ nm rms}$

**Microroughness:**  $\sigma_{\text{rms}} < 0.4 \text{ nanometers}$

Measured at the center of the surface.

### Surface 2, measured over the central 80% diameter

**Figure:** Flat.

**Figure Error:**  $\sigma_{\text{rms}} < 100 \text{ nm rms}$

**Microroughness:**  $\sigma_{\text{rms}} < 0.4 \text{ nanometers}$

Measured at the center of the surface.

Root mean square standard deviation ( $\sigma_{\text{rms}}$ ) values are calculated from the phase maps that are to be provided with each substrate.  $\sigma_{\text{rms}}$  is defined as the square root of the mean of the square of each pixel value. Known bad pixels may be excluded from this calculation.

Table 1 Certification Data Requirements

Specification	Test Method	Data Delivered
Physical Dimensions	Visual Inspection	Diameter, Thickness, Wedge angle.
Side and Bevel Polish	Visual Inspection	Inspection Report included with Certification
Mounting Flat Figure	Interferometry	Surface Map for each surface
Surface Errors - High Spatial Frequency	High resolution Surface Map	Numerical values included with Certification

Certification Data shall be delivered according to Table 1.