Advanced LIGO 312 Figure trial – Sample Preparation

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			DCN NO.	REV	DATE
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Background

Heraeus recommends Suprasil 312 as a material that should provide figure stability through the coating and annealing process for Advanced LIGO Fold Mirrors. We have shown that Corning 7980 does not provide stability at the required level of < 8nm change in sag over a 225 mm diameter for an optic of aspect ratio 6 (diameter / thickness) when annealed as appropriate for Ion beam sputtered coatings. Heraeus 3001 does provide the required stability. LMA has experience with one piece of Suprasil 312 that did change figure after coating. (out of the entire initial VIRGO effort) They suspect this may have been a polishing problem where there was some subsurface damage.
LIGO will polish a piece of Suprasil 312 that has never been coated or annealed. This piece is to be polished in the same way as a Fold mirror for Advanced LIGO: D080661-v4 AdLIGO COC FM SUBSTRATE. The piece will be supplied to CSIRO for an annealing test.

Applicable Documents

LIGO-E980019-A-D Substrate, Suprasil 312
LIGO-D080661-v3 AdLIGO COC FM SUBSTRATE

Requirements

Physical Configuration

The vendor is to cut the piece designated ITM11 and described in LIGO-E980019-A, to the aspect ratio of the Advanced LIGO Fold Mirror; 6.167, reference document LIGO-D080661-v3, and finish all surfaces in the same manner as the Fold mirror.

Fabricate from

LIGO-E980019-A	Fused Silica Blank, Advanced LIGO Beam Splitter
LIGO-D960787-B	Input Test Mass Substrate (ITM11 has no wedge)

Registration Marks

Registration marks shall be etched, ground or sandblasted and located per LIGO-D080661-V2

Surfaces, 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.

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Bevel

Bevel for safety per D080661-V2

Serial Number

The existing Serial number should remain, even if cut.

Scratches, Sleeks and Point defects

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

Scratches and Sleeks, Surface 1

The total area of scratches and sleeks within the central 225 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 225 mm diameter on each surface. 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

Surface Figure, measured over the central 225mm diameter

Surface 1: Nominally Flat. < 600 nm of Power
Astigmatism: < 60 nm Amplitude of the Zernike coefficient $Z_{2,2}$ as defined in Born and Wolf pp. 523-525.

Surface 2: Nominally flat. > | 7 Km|

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 $Z_{0,0}$, $Z_{1,1}$, $Z_{2,0}$

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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 200 mm diameter aperture: $\sigma_{rms} < 10$ nanometers

Surface 2 - Frequency Band: $< 1\ mm^{-1}$
Measured over the central 200 mm diameter aperture: $\sigma_{rms} < 40$ nanometers

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

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