

ETpathfinder TM Specification

Version: 2

Date: February 1, 2022

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1 Description

The aim of this document is to describe the technical specifications of the ETpathfinder test mass substrates. It should be viewed in combination with the technical drawing, ET-0345A-21.

2 Material

The test mass substrates shall be fabricated from twelve silicon blanks provided by the customer. These blanks are made of pure, un-doped float zone silicon with an expected etch pit density of zero, as is the default of float zone silicon. The S1 surfaces have a crystal orientation of $\langle 100 \rangle$. Dimensions of the provided blanks are 82mm thick, with an outer diameter (OD) varying from 152mm to 156mm. Smaller samples made from the same ingots will also be provided by the customer, to be polished using the same procedure and used as witness samples.

3 Dimensions

The substrate dimensions shall be shaped according to the dimensions called out in the technical drawing provided with this specification; ET-0345A-21. All dimensions are in mm.

4 Lateral Flats

The substrate shall have 2 flat faces on the barrel, S3 and S4. The dimensions and parallelism of the flat faces are noted in the attached drawing, ET-0345A-21. To be compatible with silicate bonding, they shall have a roughness of (<1 nm) RMS and a flatness PV of <60 nm over the cross-hatched areas indicated as per the attached drawing, ET-0345A-21.

5 Serial numbers and fiducial markings

The serial numbers and fiducial markings shall be laser engraved/sandblasted in the locations indicated in the attached drawing, ET-0345A-21. Each optic will have a serial number of the format TMXX, laser engraved/sandblasted onto of the barrel of the optic, where XX is the number provided by the customer. An arrow indicating the front surface (S1) shall be laser engraved/sandblasted in the same location as the arrow on the blanks supplied by the customer.

6 Bevels

Bevels for safety shall be added as per the attached drawing, ET-0345A-21.

7 Barrel, sides, and bevel finish

All surfaces on the optic except for S1 and S2 shall be finished via polish or acid etch. All surfaces shall appear shiny with no grey, checks or fractures visible to the naked eye when viewed in normal room light. The cross hatched bonding areas on S3 and S4 shall also appear shiny with no cracks, scuffs or scratches visible to the naked eye when viewed in normal room light.

8 Specification Zones (S1 and S2)

We define the following three zones on surfaces S1 and S2, indicated on the second page of the technical drawing ET-0345A-21.

- **Zone A:** surface inside the central 40 mm diameter aperture;
- **Zone B:** ring from 40 mm diameter to 100 mm from centre;
- **Zone C:** ring from 100 mm diameter to mirror edge.

9 Handling and exclusion areas

Some areas on the flat surfaces of the mirror (S1, S2, S3, and S4) can be handled or contacted with tooling and some cannot. The areas which can be contacted by tooling are referred to as handling areas, and the areas which must be excluded from handling or tooling contact are referred to as the exclusion areas. Both areas are indicated on page two of the attached drawing ET-0345A-21, where the exclusion areas are unmarked and the handling areas indicated in green crosshatching. Although all of Zone C on S1/S2 is marked as a handling area, it would still be preferable to contact this area as far away from the center as possible. There should not be any subsurface damage to the substrate in any of these zones caused by tooling or handling.

10 Polish of optical surfaces

The polish ingredients used on S1 and S2 shall not include ingredients known to increase the optical absorption of polished silicon surfaces, where possible. The mechanisms that cause higher surface absorption after polishing are largely unknown, however the use of diamond grit and aluminium slurry has been correlated to higher surface absorption, so those two compounds should be avoided where possible. All surfaces shall appear shiny with no cracks, checks or fractures visible to the naked eye when viewed in normal room light.

11 Wedge

A horizontal wedge of $0.007^{\circ} \pm 0.002^{\circ}$ ($122\text{urad} \pm 35\text{urad}$) shall be added to the substrates.

12 Radius of curvature

Refer to the sketch in Figure 1 below for an exaggerated visual representation of S1 and S2 ROC.

Surface 1: The ROC of S1 shall be spherical, concave. ROC: $14.5\text{ m} \pm 0.1\text{ m}$.

Surface 2: The ROC of S2 shall be spherical, convex. ROC: $9\text{ m} \pm 0.1\text{ m}$.

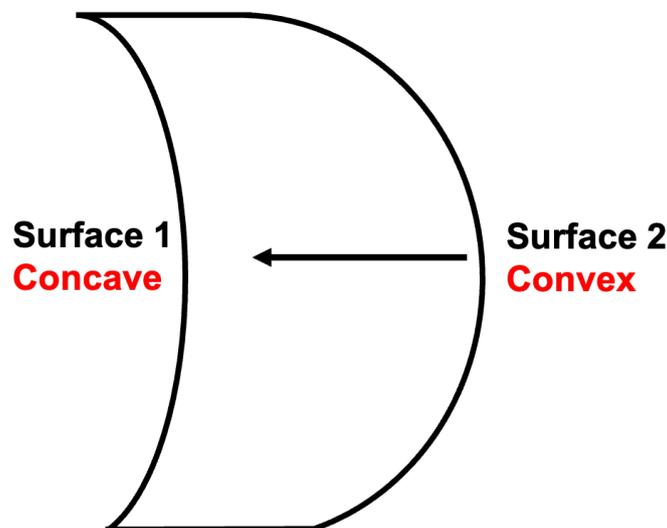


Figure 1: Exaggerated sketch of optic ROC, S1 and S2

13 Surface figure

Surface 1:

- **Zone A:** Surface error shall be $< 1\text{ nm}$ RMS measured over the totality of Zone A; Micro-roughness shall be $< 0.1\text{ nm}$ over the same area (super polish).
- **Zone B:** Micro-roughness shall be $< 5\text{ nm}$ over Zone B, no surface error requirement.
- **Zone C:** No surface error or microroughness requirement.

Surface 2:

- **Zone A:** Surface error shall be $< 2\text{ nm}$ RMS measured over the totality of Zone A; Micro-roughness shall be $< 0.1\text{ nm}$ over the same area (super polish).
- **Zone B:** Micro-roughness shall be $< 5\text{ nm}$ over Zone B, no surface error requirement.
- **Zone C:** No surface error or microroughness requirement.

14 Surface defects: Scratch/Dig

Best effort/quality point for getting as close as possible to this. The Scratch/Dig requirements listed below are defined in accordance with the U.S. Military Performance Specification MIL-PRF-13830B.

Surface 1: Within the central 40 mm diameter aperture: No single point defects or scratches are allowed within the central 40 mm aperture, corresponding to a scratch/dig of 0/0. Outside the central 40 mm diameter aperture, the scratch/dig requirement is 10/5.

Surface 2: For S2 the scratch/dig requirement is 10/5.

15 Shipping

The silicon blanks and witness samples will be shipped by the customer to the polisher. Each part will be packaged and sent to the vendor in special cases that guarantee the substrate integrity during shipment. The polisher shall use the same cases to send the polishes masses back. The high quality polished surfaces (S1 and S2) shall have a customer approved additional layer of protection added by the vendor prior to shipment.

16 Technical data provided by the manufacturer

For each polished test mass substrate, the following shall be measured and documented. This documentation shall include the measurements described below in Table 1: Measurement Matrix.

Format: All Data shall be delivered according to Table 1 in electronic form. In addition to the report, an electronic data set of the phase maps are delivered in either ASCII or Metropro.dat format.

Requirements	Method	Data delivered
Physical dimensions	Measured	Diameter, thickness
Scratches/point defects*	visual inspection	Inspection Report
ROC (S1 and S2)	Interferometric Measurement***	Surface phase maps
RMS flatness, surface error	Interferometric Measurement	Surface phase maps
RMS roughness**	Interferometric Measurement	Surface phase maps
Lateral flats: RMS flatness, RMS roughness	Interferometric Measurement	Surface phase maps

Table 1: Table 1: Measurement Matrix

*The Scratch/Point defect Inspection Report shall be provided in the form of a digital image or scanned hand sketch that includes the dimensions and locations of the scratches/point defects.

**The roughness must be measured in 2 locations on S1 and 2 on S2, one location within the central 20mm aperture and the other location within the central 60mm aperture. Measurement locations must be noted in the data documentation.

***In the case where measurement of the ROC is metrology limited, best effort ascertainment of the ROC should be done.

17 Contacts

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