

## COS NUV Grating Substrate Specification

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### ABBREVIATIONS & ACRONYMS

Å	Angstroms
CASA	Center for Astrophysics and Space Astronomy
COS	Cosmic Origins Spectrograph
CU	University of Colorado
HST	Hubble Space Telescope
ppm	Parts Per Million
rms	Root Mean Square
TBD	To Be Determined
TBS	To Be Specified

**1. PURPOSE**

This document specifies the optical parameters requirements for the Hubble Space Telescope (HST) Cosmic Origins Spectrograph (COS) NUV grating substrates. All aspects of the fabrication process will be controlled and conducted by the contractor.

**2. APPLICABLE DOCUMENTS & DRAWINGS**

2.1 APPLICABLE DOCUMENTS

2.2 APPLICABLE DRAWINGS & SKETCHES

CASA-COS-1010                      COS NUV Grating Substrate

**3. REQUIREMENTS**

3.1 ITEM DESCRIPTION & DEFINITION

The grating substrate is a flat, fused silica substrate 40 mm in diameter onto which a diffractive surface will be replicated. The substrates shall be delivered to CU/CASA by the contractor. The substrate dimensions, clear aperture, material, and fiducial marks are presented in drawing CASA-COS -1010.

3.2 OPTICAL REQUIREMENTS

3.2.1 Figure Error

The fused silica substrate shall have a surface figure of  $\leq \lambda/100$  rms over the entire clear aperture measured at 6328Å. This specification shall be met over the following spatial frequencies:

Surface Error Bandwidths	
Surface Errors	Spatial Frequencies
Surface Figure	>1 mm
Surface Roughness	<0.5 mm

3.2.2 Clear Aperture

The clear aperture shall be as specified in drawing CASA-COS-1010.

### 3.2.3 Surface Roughness

The clear aperture of the grating substrate shall have a surface roughness  $< 10\text{\AA}$  rms.

### 3.2.4 Scratch and Dig

The polished clear aperture shall meet or exceed a Scratch & Dig specification of 20-10 per MIL-O-1383OH

### 3.2.5 Back Side Surface Quality

The entire back side, defined as the side directly opposite the mirrored surface, shall be figured to  $\lambda/4$  peak-to-valley at  $6328\text{\AA}$  excluding the region which includes the serial number and fiducial markings. The surface roughness shall be  $< 10\text{\AA}$  rms.

### 3.2.6 Wedge

The wedge between the front and back surfaces shall be  $< 30$  arc sec with a knowledge to 3 arc sec.

### 3.2.7 Unspecified Surfaces

All unspecified surfaces shall be polished for visible inspection of the interior of the substrate. Bevel surfaces are excluded from this requirement.

## 3.3 MECHANICAL

### 3.3.1 Substrate Material

The substrates blanks shall be fabricated from fused silica, Corning 7980, inclusion class 2 or better.

### 3.3.2 Dimensions

Physical dimensions of the substrates shall be per Drawings CASA-COS-1010, current revision.

#### 3.3.2.1 Dimensional Knowledge

Optics diameters shall be measured and recorded to a precision of 0.0025 mm.

### 3.3.3 Fiducials

Fiducials on the substrates shall be provided in the locations shown on drawings CASA-COS-1010. Fiducials shall be applied lithographically or implemented through another technology with prior approval from CU/CASA. Fiducials shall be 0.050mm to 0.100mm wide.

### 3.3.4 Serialization & Marking

The substrates shall be identified by a serial number to retain identification. The serial number shall be sand blasted on the back side of the finished element in the location shown on drawings CASA-COS-1010 with the numbering specified by CU. Witness samples are to be scribed on the backside with the letters CWG- 2XX followed by a simple number, i.e. CWG-223.

## 3.4 ENVIRONMENTAL REQUIREMENTS

Performance of the substrate shall not be degraded when exposed to the following environmental conditions:

### 3.4.1 Operating:

Temperature	15° C to 25° C
Relative humidity	0% to 50 %
Pressure	$8 \times 10^2$ Torr to $<1 \times 10^{-5}$ Torr

### 3.4.2 Storage/Handling:

Temperature	-10° C to 40° C
Relative humidity	0 % to 95 % (55 % after coating)
Pressure	$8 \times 10^2$ Torr to $<1 \times 10^{-5}$ Torr

### 3.4.3 Solvents

The substrate may not come into contact with any solvent or substance which could damage the optic in any way.

#### 3.4.4 Radiation Susceptibility

The substrate must be able to withstand 16 Krad of exposure over an 8 year lifetime with no degradation in the optical or mechanical quality of the substrate or coating.

#### 3.4.5 Silicones

The exposure of the substrate to silicones during any activity during its fabrication process shall be minimized. The presence of silicones in an epoxy bond can drastically reduce the strength of the bonded interface. The COS NUV gratings, when complete, will be bonded into it's mount prior to final alignment. Since removal of silicones is extremely difficult the exposure of the substrates to silicones shall be minimized where practical.

### 3.5 SHIPPING & HANDLING

#### 3.5.1 Handling

Once fabricated and coated, the substrates shall be handled only by gloved and gowned individuals in an environment not exceeding class 10,000 in particulate cleanliness or a high quality test environment with appropriate handling procedures (e.g. use of gloves, frocks, masks, etc.).

#### 3.5.2 Shipping

The substrate shall be shipped in a shipping container(s) provided by the vendor.

## 4. ACCEPTANCE & VERIFICATION TESTING

### 4.1 ACCEPTANCE TEST PROCEDURE

The supplier shall prepare an acceptance test procedure (ATP) including the following as minimum.

The tests shall be adequate to verify that the substrates satisfies the requirements of this specification. This ATP shall be submitted to CU for approval at least four weeks prior to acceptance testing.

### 4.2 ACCEPTANCE TEST



The supplier shall perform an acceptance test, which may be witnessed by the responsible CU optical engineer and QA representative for each flight optic. Data packages must be available for review at the acceptance test but may be submitted to CU within four weeks of acceptance. Other parameters may be verified by data review of previously performed tests and review of as built mechanical data or in process logs. The supplier shall notify CU at least 3 weeks in advance of each acceptance test. Multiple optics may be tested during the same acceptance test.

4.2.1 Specification Verification Matrix

<b>Section</b>	<b>Description of Requirement</b>	<b>Method of Verification</b>	<b>Verification of Deliverable</b>
3.2.1	Figure Error		
3.2.2	Clear Aperture		
3.2.3	Surface Roughness		
3.2.4	Scratch & Dig		
3.2.5	Back Side Surface Quality		
3.2.6	Unspecified Surfaces		
3.2.7	Reflectivity		
3.3.1	Substrate Material		
3.3.2	Dimensional Knowledge		
3.3.3	Fiducials		
3.3.4	Serialization & Marking		
3.4.1	Operating Environments		
3.4.3	Solvents		
3.4.5	Silicones		

**5. WITNESS SAMPLES**

The contractor will provide 20 witness samples to CU/CASA. Each witness sample shall be processed in a manner consistent with the flight optic. In addition, the witness samples shall be coated simultaneously with the flight optic. The witness samples will have the following dimensions:

Diameter	25.4 mm $\pm$ 0.25 mm
Thickness	3.18 mm $\pm$ 0.25 mm
Clear Aperture Diameter	20.32 mm minimum
Bevel	45 deg edge bevel
Surface figure	$\leq 1\lambda$ PV
Surface finish	Best commercial polish ( $\leq 30 \text{ \AA}$ rms goal)