

COS NUV TA1 Mirror Specification

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Prepared By: _____
E. Wilkinson, COS Instrument Scientist, CU/CASA _____

Reviewed By: _____
R. Cahill, Optical Design, CU/CASA _____ Date _____

Approved By: _____
D. Hood, Program Manager, BATC _____ Date _____

Approved By: _____
D. Ebbets, Calibration Scientist, CU/CASA _____ Date _____

Approved By: _____
J. Andrews, COS Experiment Manager, CU/CASA _____ Date _____

Approved By: _____
J. C. Green, COS Principal Investigator, CU/CASA _____ Date _____

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Center for Astrophysics & Space Astronomy
University of Colorado
Campus Box 593
Boulder, Colorado 80309

Table of Contents

1.	Purpose	1
2.	Applicable Documents & Drawings	1
2.1	Applicable Documents	1
2.2	Applicable Drawings & Sketches	1
3.	Requirements	1
3.1	Item Description & Definition	1
3.2	Optical Requirements	1
3.2.1	Figure Error	1
3.2.2	Clear Aperture	2
3.2.3	Surface Roughness	2
3.2.4	Scratch And Dig	2
3.2.5	Back Side Surface Quality	2
3.2.6	Unspecified Surfaces	2
3.3	Mechanical	2
3.3.1	Substrate Material	2
3.3.2	Dimensions	2
3.3.2.1	Dimensional Knowledge	2
3.3.3	Fiducials	3
3.3.4	Serialization & Marking	3
3.4	Environmental Requirements	3
3.4.1	Operating:	3
3.4.2	Storage/Handling:	3
3.4.3	Solvents	3
3.4.4	Silicones	4
3.5	Shipping & Handling	4
3.5.1	Handling	4
3.5.2	Shipping	4
4.	Acceptance & Verification Testing	4
4.1	Acceptance Test Procedure	4
4.2	Acceptance Test	5
4.2.1	Specification Verification Matrix	5
5.	Witness Samples	6

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 and the coating performance requirements for the Hubble Space Telescope (HST) Cosmic Origins Spectrograph (COS) TA1 NUV mirror. 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-1011 TA1 Mirror Substrate

3. REQUIREMENTS

3.1 ITEM DESCRIPTION & DEFINITION

The TA1 mirror is a flat, fused silica mirror 40 mm in diameter with an Al/MgF₂ optical coating to optimize performance of the NUV imaging capability of the COS NUV channel. The mirror shall be delivered to CU/CASA by the contractor. The substrate dimensions, clear aperture, material, and fiducial marks are presented in drawing CASA-COS-1011. The optical coating shall be applied per COS-08-0008 by Goddard Space Flight Center.

3.2 OPTICAL REQUIREMENTS

3.2.1 Figure Error

The fused silica mirror substrate shall have a surface figure of $\leq \lambda/100$ 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-1011.

3.2.3 Surface Roughness

The clear aperture of the TA1 mirror 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 $\lambda/4$ at 6328\AA . 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 mirror blanks shall be fabricated from fused silica, Corning 7980, inclusion class 0 or better.

3.3.2 Dimensions

Physical dimensions of the mirror substrates shall be per Drawings CASA-COS-1011.

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-1011. Fiducials may be scribed, lithographically applied, 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 mirror substrates shall be identified by a serial number to retain identification. The serial number shall be sand blasted on the side of the finished element in the location shown on drawings CASA-COS-1011. Since the mirror substrates will be subjected to a vacuum environment, the marking method shall not outgas in this environment. Marking method shall be approved by CU prior to application. Witness samples are to be scribed on the backside with the letters CWT- followed by a simple number, i.e. CWT-23.

3.4 ENVIRONMENTAL REQUIREMENTS

Performance of the mirror and coating 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	8×10^2 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	8×10^2 Torr to $<1 \times 10^{-5}$ Torr

3.4.3 Solvents

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

Radiation Susceptibility

The mirror 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.

3.4.4 Silicones

The exposure of the mirror 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 TA1 mirror, when complete, will be bonded into its mount prior to final alignment. Since removal of silicones is extremely difficult the exposure of the mirror substrates to silicones shall be minimized where practical.

3.5 SHIPPING & HANDLING

3.5.1 Handling

Once fabricated and coated, the TA1 mirror 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 TA1 mirror shall be shipped in a shipping container provided by CU/CASA. The mirror can only be shipped with the container backfilled with high purity gaseous nitrogen. GN2 from an LN2 boil-off system is acceptable provided the GN2 from the distribution system has been certified to be 99.999% GN2 with < 25 ppm hydrocarbon content.

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 mirror 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

Section	Description of Requirement	Method of Verification	Verification of Deliverable
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 five witness samples with each mirror delivered 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 (≤ 30 Å rms goal)