COS Coating Reflectivity Specification

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ABBREVIATIONS & ACRONYMS

Å	Angstroms
Al	Aluminum
ACS	Advanced Camera for Surveys
CASA	Center for Astrophysics and Space Astonomy
CEI	Critical End Item specification
COS	Cosmic Origins Spectrograph
CU	University of Colorado
Deg.	degrees
FUV	Far Ultraviolet : 900-2000Å
GSFC	Goddard Space Flight Center
HST	Hubble Space Telescope
MgF_2	Magnesium Flouride
PV	Peak to Valley
Rms	Root Mean Sum
STIS	Space Telescope Imaging Spectrograph

1. PURPOSE

The purpose of this document is to state the minimum acceptable reflectivity of the optical coatings for the Cosmic Origins Spectrograph. The reflectivity requirements are derived from requirements presented in the Cosmic Origins Spectrograph Critical End Item Specification.

The optical coatings for each COS optic shall be aluminum overcoated with magnesium floride (MgF_2). The thicknesses of the aluminum and MgF_2 shall be chosen to optimize the reflectivity over the operation bandpass of each optic.

2. APPLICABLE DOCUMENTATION & DRAWINGS

2.1 DOCUMENTS

Document #	Title	Revision
STE-63	Critical End-Item Specification for the COS	Current Rev.
	Work Instruction 551-WI-6400.1.1 / Optical Component Handling	Current Rev.
	Work Instruction 551-WI-4520.2.1 / Optical Component Inspection	Current Rev.
	MIL-C-13508C (adhesion section only)	Current Rev.
COS-08-0005	COS NUV Grating Specification	Current Rev.
COS-08-0002	COS FUV Grating Holographic Recording Specification	Current Rev.
COS-08-0001	COS FUV Grating Substrate Specification	Current Rev.
IN0090-111	COS Contamination Control Plan	In Preparation

2.2 DRAWINGS

CASA-COS-1000	Substrate, COS G130M & G160M
CASA-COS-1001	Substrate, COS G140L
CASA-COS-1002	G130M Holographic Recording Geometry
CASA-COS-1003	G160M Holographic Recording Geometry
CASA-COS-1004	G140L Holographic Recording Geometry
CASA-COS-1005	COS NCM1 Correcting Mirror Substrate
CASA-COS-1006	COS NCM2 Collimating Mirror Substrate
CASA-COS-1007	COS NCM3a Mirror Substrate
CASA-COS-1008	COS NCM3b Mirror Substrate
CASA-COS-1009	COS NCM3c Mirror Substrate
CASA-COS-1010	Gratings, COS G185M, G225M, G285M, G230L
CASA-COS-1011	COS TA1 Mirror Substrate

3. PERFORMANCE REQUIREMENTS

Each optic has a unique operational bandpass over which the reflectivity of the Al/MgF_2 shall be optimized. The operational characteristics of each optic are presented in Table 3.1-1 (gratings) and Table 3.1.-2 (mirrors).

Table 3.1-1
Grating Optical Characteristics

Grating	Bandpass	Groove Density (g/mm)	Alpha (deg.)
G130M	1150 – 1450Å	3800	20.1
G160M	1405 – 1775Å	3053	20.1
G140L	1230 – 2050Å	480	7.407
G185M	1700-2000Å	6000	35.21
G225M	2000-2500Å	4800	34.16
G285M	2500-3200Å	4000	36.28
G230L	1700-3200Å	394	3.40

Table 3.1-2
Mirror Optical Characteristics

Mirror	Bandpass
NCM1	1700 – 3200 Å
NCM2	1700 – 3200 Å
NCM3a	1700 – 3200 Å
NCM3b	1700 – 3200 Å
NCM3c	1700 – 3200 Å
TA1	1700 – 3200 Å

3.1 REFLECTIVITY

3.1.1 Minimum Acceptable Reflectivity

The minimum acceptable reflectivity for the Al/MgF_2 coatings is presented in Table 3.2 and is derived from requirements in the COS CEI specification. The reflectivity shall be measured by the vendor using flight witness samples coated simultaneously with the flight optics.

Table 3.2
Minimum Acceptable Reflectivity

Minimum Reflectivity – Optimized at 1216Å	
Wavelength (Å)	**Reflectivity (%)**
1150	60
1216	82
1608	78
2000	80
3000 - 8000	87
8000 - 9000	83

Minimum Reflectivity – Optimized at 1608Å	
Wavelength (Å)	**Reflectivity (%)**
1608	85
1800 - 2000	85
3000 - 7000	87

3.1.2 Coating Thickness

The thickness of the coatings shall be chosen to optimize the reflectivity of each optic over it's operational bandpass. Currently the vendor supports two Al/MgF_2 coatings, one optimized for reflectivity at 1216Å and another at 1608Å. Below is a listing of the coating type for each optic.

Coating	Optic
1216Å Coating	G130M, G160M, and G140L
1608Å Coating	NCM1, NCM2, NCM3a, NCM3b, NCM3c, G185M, G225M, G285M, and G230L, TA1

3.1.2.1 Coating Uniformity

The uniformity of the coating shall be sufficient at all points on the active area to support the minimum acceptable reflectivity.

3.1.3 Coating Active Area

The optical coating shall be applied over the entire polished area of the optical surface excluding a minimum area along the perimeter of the optical surface. The exact exclusion area shall be approved by CU/CASA.

3.2 ADHESION

The coatings shall show no evidence of damage after cellophane tape is firmly pressed against the coated surface of a witness sample, then slowly removed. The adhesion test shall be performed for each coating run. The test shall be conducted in accordance with MIL-M-13508C using a *non-flight* witness sample provided by the vendor.

3.3 VISUAL EXAMINATION

The flight optics and witness samples shall be visually examined for evidence of flaking, peeling or cracking, and other cosmetic blemishes in accordance with test procedures in 551-WI-4520.2.1 / Optical Component Inspection.

4. ENVIRONMENTAL REQUIREMENTS

During the coating of the optics no process or materials shall be employed which would preclude the optic from meeting or exceeding it's operational requirements. During all handling operations of the optics no process or materials shall be employed which would preclude the optic from meeting or exceeding it's operational requirements.

4.1.1 Solvents

The optics may not come into contact with any solvent or substance which could damage the optic in any way prior to or after the application of the optical coating.

4.1.2 Silicones

The exposure of the optics to silicones during any activity associated with the coating process shall be minimized or eliminated. The presence of silicones in an expoxy bond can drastically reduce the strength of the bonded interface. The COS optics will be bonded into mounting hardware. Since removal of silicones is extremely difficult the

exposure of the optics must be minimized or eliminated where practical. Should the optic knowingly be exposed to silicones during the fabrication process, GSFC shall notify CU/CASA in writing.

5. SHIPPING & HANDLING

5.1 SHIPPING

The optics will be delivered to GSFC in clean shipping containers. Unless a contamination event occurs, GSFC will not be responsible for cleaning the shipping containers prior to removing and installing the optics into their shipping containers. GSFC will be responsible for providing high purity (>99.999%) gaseous nitrogen for purging the shipping containers for at least 1 hour prior to pick up of the optics by authorized CU or BASD personnel.

5.2 HANDLING

During all phases of optic coating suitable handling precautions shall be employed to insure that the optic is not damaged, the coating is undegraded, and that high levels of cleanliness are maintained. In general this requirement can be satisfied by following standard cleanroom protocols and the use of masks, gloves, hairnets, and frocks. Standard GSFC practices for handling HST optics is acceptable and are covered in 551-WI-6400.1.1 / Optical Component Handling.

5.3 FIXTURING

Fixturing necessary to hold and/or manipulate the optics during all phases of coating shall be reviewed by appropriate CU/CASA personnel prior to the coating of the first optic. Preferably, review shall take place far in advance of the coating of the first optic to minimize potential schedule impacts.

6. ACCEPTANCE & VERIFICATION TESTING

6.1 ACCEPTANCE TEST REPORT

GSFC shall provide a detailed report describing the coating procedure for each optic. This report shall provide sufficient data to reconstruct the coating process and demonstrate that the coating process was successful. Acceptace tests specified in section 6.2 shall be included in this report.

6.2 ACCEPTANCE TEST

GSFC shall conduct a series of tests to verify certain performance characteristics of the optics. These requirements are specified in section 3.

6.2.1 Specification Verification Matrix

Section	Description of Requirement	Method of Verification	Verification of Deliverable
3.1.1	Minimum Reflectivity	Testing of at least 2 witness samples	
3.2	Adhesion	Witness sample testing	
3.3	Visual examination		

7. WITNESS MIRRORS

CU will provide six witness samples with each optic delivered to GSFC for coating. Each witness sample shall be processed simultaneously with their respective flight optic. The witness samples have the following dimensions:

Diameter	25.4 mm ± 0.25 mm
Thickness	3.18 mm ± 0.25 mm
Clear Aperture Diameter	20.32 mm minimum
Bevel	45 deg edge bevel
Surface figure	≤ 1λ PV
Surface finish	Best commercial polish (≤30 Å rms goal)

At delivery to GSFC 4 of the witness samples will be coated with vapor deposited aluminum with the potential for a chromium underlayer to promote adhesion to the glass. The fifth witness mirror will have undergone identical processing as the flight optic. The process includes application and removal of photoresist, ion etching, and application of the chromium/vapor deposited aluminum coating.