100 mm Crystalline Coating Demonstration – Coating Specification

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Name	**100 mm Crystalline Coating Demonstration**
Applicable Documents	
Polish Specification	E1800006-v3
Polish Drawing (Fabricate From)	D1800154-v2
Figure Change Before / After Coating	Over a 90 mm diameter aperture, coating uniformity & stress from the coating process shall not change the Sagitta more than 8 nanometers, and shall not add surface figure Zernike terms higher than second order with amplitude > 0.5 nanometers. **BEST EFFORT**
Optical Performance Uniformity	On both surfaces, the specified single surface reflectance or transmittances at the specified wavelengths must be maintained over a 90 mm diameter aperture.
Coating Deposition Method	Substrate transferred crystalline coating
Coating Area	Coverage to bevel

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Witness Sample Durability Testing	Tested on one witness piece per run, coating to resist: 1. Adhesion test per MIL-C-48497A 4.5.3.1 Adhesion (snap tape). 2. MIL-C-4.5.3.2 Humidity (120F 95% RH for 24 hours), combined with before/after reflectance & transmittance spectrophotometer scans from 350 - 2500 nm in about 1 nm increments, marking the specimen ensure the same area is scanned. The scans will be provided in an Excel spreadsheet as columnar data. There should be no measureable spectral shift. 3. MIL-C-4.5.3.3 Moderate Abrasion (cheesecloth rub). **BEST EFFORT**
Coating Type	High Reflection
Angle of Incidence	Normal
Transmission at 1064 nm	5 ppm +/- 1 ppm
Thermal Stability at 1064 nm	$2\,\lvert(T_1-T_2)/(T_1+T_2)\rvert < 0.01$ T_1 & T_2 = Transmission at 25°C & 40°C. **BEST EFFORT**. Verified by modeling.
Coating Materials	The coating is comprised of epitaxial (single crystal) GaAs alternating with Al(0.92)Ga(0.08)As originally deposited by molecular beam epitaxy
Surface Electric Field 1064 nm	E<0.01 V/m. Vendor must demonstrate through calculation using $E\ [V/m] = (27.46)\ (TP / Re\ (Y))^{1/2}$ with T=6E-6 (6 ppm) surface transmittance, Y the admittance in free space units, and P = 1 W/m^2 as the incident power density. **BEST EFFORT**

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Thermal Noise	Best effort to minimize thermal noise from coating. A full description of coating thermal noise is available in the supporting document T0900161 along with appropriate numerical input values, but a good proxy is minimization of the function $S = (z_{low} + \gamma z_{high})$, where, $z_{high\ (low)}$ = total thickness of the high (low) index coating material in units full wave optical thickness at the reference wavelength. $\gamma = abc/d$ $a = (\varphi_{high} / \varphi_{low})$ $b = (n_{low} / n_{high})$ $c = (Y_{high} / Y_{sub} + Y_{sub} / Y_{high})$ $d = (Y_{low} / Y_{sub} + Y_{sub} / Y_{low})$ $\varphi_{high(low)}$ = loss angle of the high (low) index material in radians. $n_{high(low)}$ = index of refraction of the high (low) index material at the reference wavelength. $Y_{high(low)}$ = Young's Modulus of the high (low) index material. Y_{sub} = substrate Young's Modulus.
Absorption at 1064 nm	< 0.3 ppm **BEST EFFORT**
Max Defect Area inside 90mm diameter of Surface 1. **Note: This is a summation of all defects of dimension greater than 50 µm**	20,000 μm^2
Max Number of Point Defects greater than 4 µm in diameter inside 90mm diameter of Surface 1	10
Max Density of Point Defects less than 4 µm in diameter inside 90mm diameter of Surface 1	1 per 4 sq. millimeter

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Additional Deliverables	
Witness Samples	SURFACE 1: Up to 2 witness parts to be produced from the same HR coating material and transferred to planar, 1 inch diameter, ¼" thick super-polished fused silica substrates (Corning 7980) with a ≥8-mm diameter HR coating; no backside AR coating
Layer Thickness Information	For all layers in the design, measured thickness data from the deposition for each run, designed thicknesses, and measured indices of refraction at 1064 nm for all coating materials (based on individual layers).
Surface 1 Spectral Scans	On a representative witness piece for each run, spectrophotometer scans of reflectance and transmission of Surface 1 (HR coating) from 800-1200 nm. All spectrophotometer data to be provided in Excel spreadsheet format with columnar data in increments of approximately 1 nm.
Surface Defect Analysis By Three Required Methods (Alternative Methods of Analysis may be used with the prior approval of LIGO)	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. METHOD 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 center to edge, then at ten positions around the edge, and ten to fifteen positions near the center. Data to be supplied as a hand sketch from both

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	Methods 1 & 2. METHOD 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. Data to be supplied as digital images.
Durability Test Data & Samples	All samples and data from the durability tests. Data, including transmittance and reflectance spectrophotometer scans of the representative coating are delivered in an Excel spreadsheet with columnar data spaced by approximately 1 nm from 800 - 1200 nm.