Antireflective coatings for the red camera of WEAVE

R. Ortiz*[a], E. Carrasco[a], G. Páez[c], J. Reyes[a], Andrea Hidalgo[a,c], Gavin Dalton[c,d], Scott Trager[e], J. Alfonso L. Aguerri[f], Piercarlo Bonifacio[g], Antonella Vallenari[h], Don Carlos Abrams[i] and Kevin Middleton[d]

INTRODUCTION

In this work we present the coatings of the spectrograph red camera of WEAVE -the new multi-object survey facility for the 4.2m William Herschel Telescope. The initial requirements of WEAVE red camera lenses, with reflectances as low as 0.4% through the wavelength interval from 590 nm to 959 nm at angles of incidence of 18° +/- 17° represented a challenge for both design and production.

AR coating AOI specification

A detailed analysis was carried out regarding the AOI specification of the cameras coatings. Based in Zemax ray tracing, RAL Space provided histograms of the AOI of different rays at each interface air/glass for the spherical camera lenses.

Element	Surface	# hits	Interval Max (°)	Average CV (°)	Average Min (°)	Average Max (°)	Average (°)	SD
Lens 2	Right	73660	21-24	18.0	16.5	19.5	18.0	1.5
	Left	72850	12-15	15.0	13.5	17.0	15.2	1.7
Lens 3	Right	72800	15-18	13.1	11.6	14.6	13.1	1.5
	Left	73900	12-15	14.7	13.2	16.2	14.7	1.5
Lens 4	Right	73600	12-15	17.0	15.5	20.9	17.8	2.8
	Left	73600	15-18	14.1	12.6	15.6	14.1	1.5
Lens 5	Right	72900	18-21	15.2	13.7	16.7	15.2	1.5
	Left	73050	12-15	14.6	13.1	16.4	14.7	1.6
Lens 6	Left	73100	6- 9	8.7	7.2	10.2	8.7	1.5
	Right	74250	15-18	16.2	14.7	17.7	16.2	1.5
Lens 7	Right	71950	12-15	11.7	10.2	13.2	11.7	1.5
	Left	72350	15-18	13.7	12.2	15.2	13.7	1.5
Lens 8	Right	72100	9-12	13.0	11.5	14.5	13.0	1.5
	Left	73650	12-15	15.6	14.1	17.2	15.7	1.5

Table 1. Ray tracing over the different surfaces of the spectrograph optics.

Designs

Several designs were developed and the advantages of each were evaluated. The teams of INAOE and CIO collaborated very closely to achieve the best solutions.

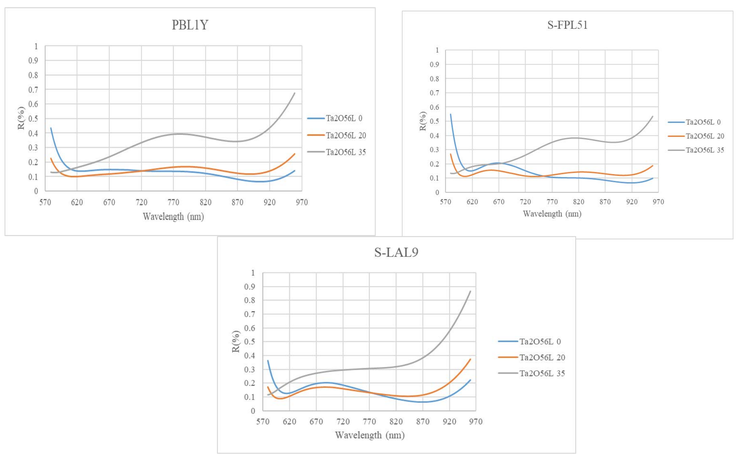

Figure 1. Six layer coatings for different substrates

DATA ANALYSIS

The coating evaporations were performed at CIO in the Integrity 39 Denton Vacuum Deposition System. In all the depositions at least a witness samples is included to evaluate the coating quality by measuring afterwards the transmittance of the sample(s).

To be able to calculate the reflectance at other AOI it is indispensable to find the design corresponding to the actual reflectance measured experimentally. A re-optimization through damped least squares of the design is done, using the experimental data as boundary to fit a theoretical model.

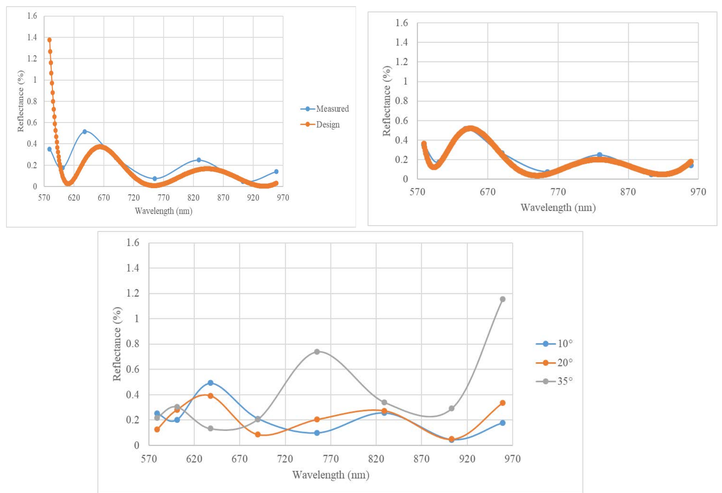

Figure 2. Top left: experimental data and theoretical reflectance, after removing Fresnel reflections from the second surface. Top right: Re-optimized design that fits the experimental data. Bottom: data extrapolation to non-normal AOI.

Repeatibility

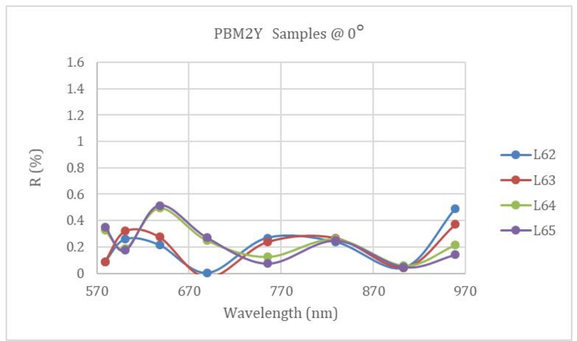

Figure 3. Reflectance obtained in different coating runs.

Reflectance results for two PBM2Y witness samples in two different depositions for the same coating prescription. Samples L62 y L64 were coated in the first run and L63 y L65 in the second one.

FINAL COATINGS

Lens 6 and Lens 7 (PBM2Y)

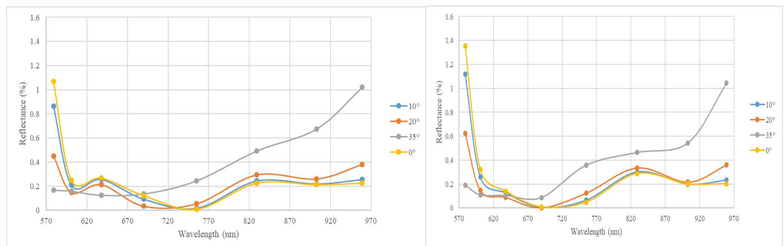

Figure 4. Reflectance obtained for PBM2Y Lens 6 and Lens 7. Surface 1. .

Figure 5. Reflectance obtained for PBM2Y Lens 6 and Lens 7. Surface 1.

Lens 4 (PBL1Y)

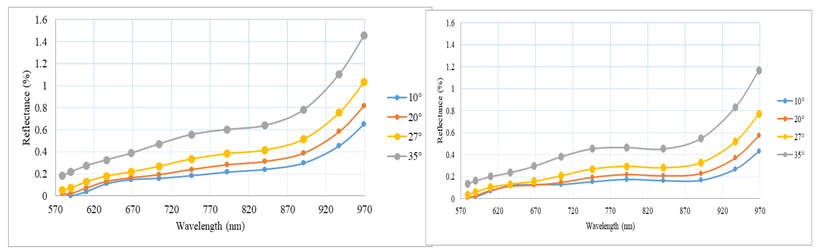

Figure 6. Reflectance obtained for PBL1Y Lens 4. Surface 1.

Figure 7. Reflectance obtained for PBL1Y Lens 4. Surface 2..

Lens 8 (SLAL-9)

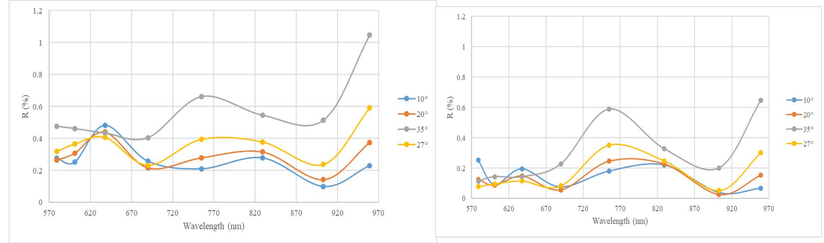

Figure 8. Reflectance obtained for SLAL-9 Lens 8. Surface 1.

Figure 9. Reflectance obtained for SLAL-9 Lens 8. Surface 2.

CONCLUSIONS

Great amount of R&D has been done in the determination of the most suitable material combination and optimal optical properties of AR coatings for the specific case of WEAVE. The requirements are large AOI and a medium size spectral range. Red Camera coatings are soon to be finished and the Blue Camera along with its AR coatings are under development.

[a]Instituto Nacional de Astrofísica, Óptica y Electrónica (Mexico), [b]Centro de Investigaciones en Óptica (Mexico), [c]Department of Physics, University of Oxford (UK), [d]STFC Rutherford Appleton Laboratory (UK), [e] Kapteyn Institut, Rijksuniversiteit Groningen (Netherlands), [f]Instituto de Astrofisica de Canarias (Spain), [g]GEPI Observatoire de Paris, CNRS (France), [h]Osservatorio Astronomico di Padova INAF (Italy), [i]Isaac Newton Group (Spain)
rortiz@inaoep.mx