

Optical characterization of reflective coatings for astronomical telescope mirrors

T. Döhring¹, C. Rödling¹, K. Kimmel¹, S. Zeising¹, J. Stadtmüller¹, M. Stollenwerk¹, S. Verma², P. Rees²

¹ Faculty of Engineering Sciences, TH Aschaffenburg - University of Applied Sciences, Aschaffenburg, D

² National Facility for Ultra Precision Surfaces, Wrexham Glyndwr University, UK

Summary: With ground based optical telescopes astronomers observe celestial objects over a wide spectral range. As usually three or even more reflections at telescope mirrors are involved, good reflection properties of the mirror coatings are important. The aluminum evaporation technique has been - and is still - the standard solution for the reflective coatings of large astronomical mirrors. Such coatings have excellent reflectivity in the ultraviolet and in the visible, but perform poorly in the infrared. Silver is the metal having highest reflectivity for wavelengths longward of 400 nm, but isn't the best choice for reflectivity in the ultraviolet and for blue light. To avoid degradation by oxidation, durable silver coatings need to be protected by transmitting overcoating layers. In the presented study, different metallic coatings – including unusual ones like sputtered iridium - are characterized to identify a coating that is most suitable for the spectral range from ultraviolet to infrared. Experimental results are compared to simulations based on the complex refractive indices of these materials. Thereby dependence of incidence angle and polarization is also considered.

Background:



In this study, different metallic coatings, including an unusual one like sputtered iridium, are characterized to identify a coating that is most suitable to cover the spectral range from ultraviolet to infrared. The application behind are mirror coatings for astronomical telescopes on ground and in space. The work was part of a recent Bachelor's Thesis at Aschaffenburg University.

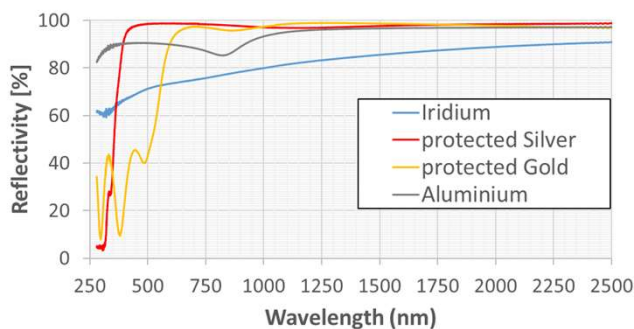
Example: Ø1.3m telescope at the Skalnaté Pleso observatory in Slovakia

Problem:

- Classical coating materials for astronomical mirrors are aluminum, protected silver and sometimes gold.
- These classical coatings have a limited usability for broadband applications

→ There is room for the development of new coatings

Measurement results:

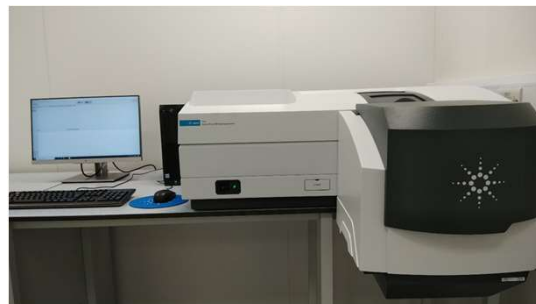


Measured reflectivity of four different coatings at 6° AOI

Acknowledgement:

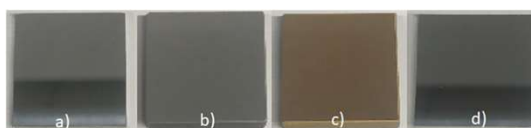
The work within the Aschaffenburg Competence Center for Astronomical and Space Instrumentation (ACCASI) has been supported by a grant from the Bavarian Ministry for Sciences and Art.

Measurement method: Spectrophotometer



Measurement set-up at Wrexham Glyndwr University

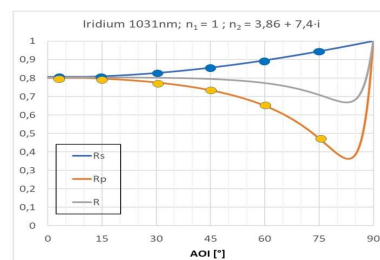
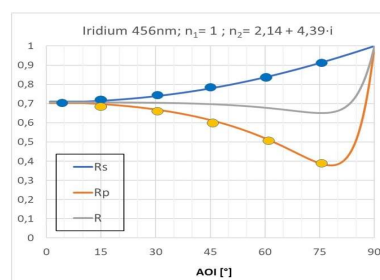
Pictures of four characterised mirror coatings:



a) Al b) protected Ag c) protected Au d) Ir



Interior of the used Agilent Cary 7000 spectrophotometer



Measured s- and p-reflectivity for different incidence angles of iridium at $\lambda=456\text{nm}$ and at $\lambda=1013\text{nm}$, compared with simulations based on the Fresnel equations and the complex refractive index of Iridium

Instrument specification:

Spectrophotometer Cary 7000

- Measurement of transmission, reflection, and absorption from UV to NIR across a wide angle range.
- Wavelength range: 175nm – 3300nm
- Multi-angle specular reflectance and transmittance
- Measurement of direct transmission, reflection, and absorptance

Summary of learnings:

- The reflectivity of four different mirror materials have been measured from UV to NIR.
- The reflectivity of iridium increases gradually with wavelength and it seems to be suitable for the near infrared and the mid infrared range.
- The measured reflectivity for polarized light fits to simulations.
- Iridium is an interesting coating material due to its high resistance to heat and chemical solvents, even without protective coatings.