Improved silver mirror coating for ground and space-based astronomy

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INTRODUCTION

Protected silver coatings for space-based astronomy have been researched by the US government since the 1960's. Silver is highly reflective, but often easily damaged by humidity and sulfur in the atmosphere. Protective over-coat layers are added to increase silver's durability, but may absorb significant energy in the blue region and cut off reflectance in the UV. Astronomers desire to extend the reflectance of silver-based designs into the UV (320-nm to 400-nm).

New research at ZeCoat Corporation has resulted in a UV-enhanced, durable silver coating with an average reflectance greater than 96.5% from 350-nm to 1,000-nm, with minimum reflectance greater than 94% (min @ 350-nm) at near normal incidence.

METHODS

- Experiments were conducted under high-vacuum to evaluate several unique designs involving metal-oxides, metal-nitrides and metal-fluorides of multiple types, sequences, and layer thicknesses.
- A harsh 10-day, 80% RH/ 80° C, **environmental exposure test** narrowed down the study samples to the two most durable designs.
- The two best sample types were subjected to a 12-day **accelerated space radiation test** (representing approximately 3-years at GEO) at NASA Goddard Space Flight Center.
- **Polarized angular reflectance measurements** of non-irradiated samples were obtained for 8° and 45° angles of incidence.
- **IR reflectance measurements** were collected from 2-microns to 20-mircons.

RESULTS

Avg. (s,p) Reflectance @ 8 and 45 degrees AOI

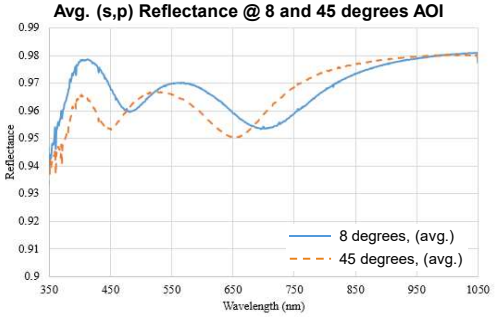

Fig. 1. Polarized angular reflectance measurements of non-irradiated UV-enhanced protected silver coating samples show average reflectance for 8 and 45 degrees AOI between 350-nm and 1050-nm.

Reflectance before and after GEO exposure

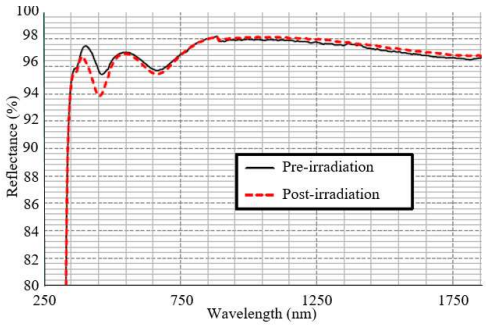

Fig. 2. Radiation testing of UV-enhanced, protected silver coating reveal that minimal reflectance degradation occurred in the 350-nm to 500-nm region, but no significant degradation occurred outside this region.

Polarized reflectance (s,p) @ 45 degrees AOI

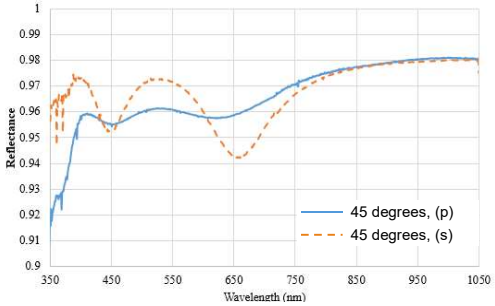

Fig. 3. Polarized angular measurements show reflectance of s and p polarizations at 45 degrees for UV-enhanced protected silver coating.

CONCLUSIONS

1. **UV-enhanced, protected silver coating design raises reflectivity in the UV while enduring stringent durability requirements.**
2. **Passes 10-day humidity test.**
3. **Passes radiation test.**
4. **Passes reflectivity requirements of R>96% at 8° AOI.**
5. **Adjustable for 45° AOI or low-emissivity**
6. **Coating designed for meter-class mirrors and process is readily scalable to mirrors several meters in diameter.**
7. **Greater UV performance for ground-based and space-based observatories**

UV-enhanced Ag design applied to KCWI FM1 mirror

Fig. 4. Inspection of silver coating at ZeCoat Corporation

REFERENCES

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