Characterization of Samples for Optimization of Infrared Stray Light Coatings

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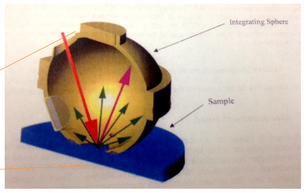
Background

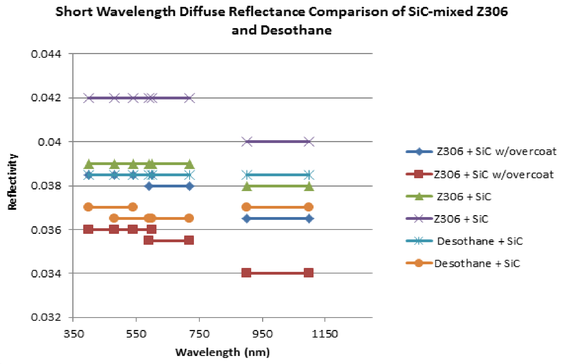
The Stratospheric Observatory for Infrared Astronomy (SOFIA) is a 2.5-meter telescope on board a Boeing 747-SP. Special black and highly diffuse coatings cover most surfaces that are visible to the telescope optics in the aircraft cavity to eliminate radiation noise from the glow of background sky, aircraft exhaust, and other sources.

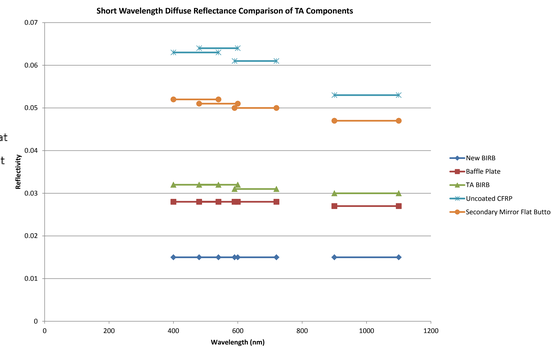
Many telescope structures are covered with Ball Infrared Black (BIRB). The new BIRB formulation, however, is less tough. There is a concern that it can be too easily damaged and cause contamination elsewhere in the cavity.

My goal was to characterize a variety of different infrared stray light coatings in terms of their ability to absorb and scatter stray light and compare them to the current BIRB.



Each of the reflectometer tools has an integrating sphere (above right), which is pressed directly against the surface to be measured. The round opening at the "end" of the sphere is a port for visible/infrared light (red arrow) to illuminate the measured surface and for returned light scattered (green arrows) and/or reflected (purple arrow) by the measured surface. Voltages measured at the detectors are directly proportional to the reflectance of the samples, which included a variety of new coatings as well as coatings currently found on the telescope assembly (TA).

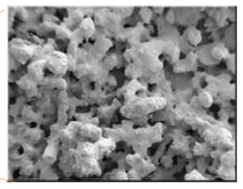




At shorter wavelengths, the plot above left shows slightly lower overall diffuse reflectance with wavelength for the Z306. Neither the Desothane nor the Z306 samples showed appreciable specular reflectance to the limit of the instrument.

When compared to the plot above left, the plot above right shows that at all wavelengths in the range 300-1200 nm, the new BIRB out-performs the old BIRB.

SOFIA's open upper rigid door reveals the telescope assembly (TA) cavity.

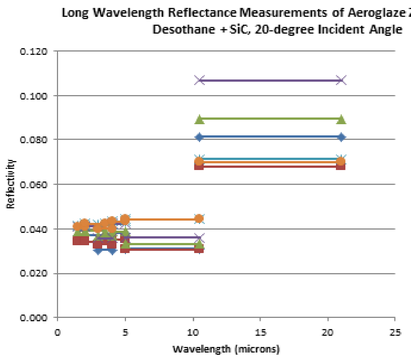


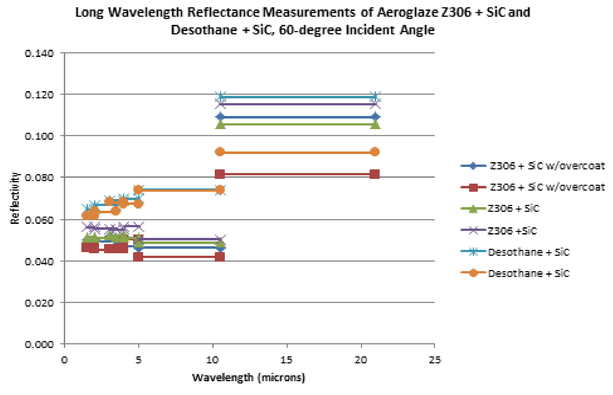
Scanning electron micrograph image of BIRB coating reveals its unique morphology and extremely high surface area.

Materials

An InspectIR~Vis Reflectometer (being used in center left photo) and an ET 100 Emissometer were used to measure and compare an array of different coatings in terms of diffuse and specular reflectance over a number of wavelength bands from the visible to 21 µm in the infrared. At the longer wavelengths two incidence angles (20° and 60° from normal) were used to assess diffuse properties.

Results

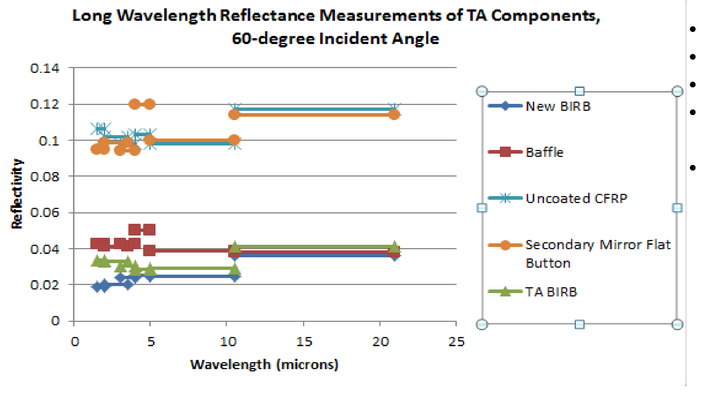




The plot above left shows the low reflectance performance of the Aeroglaze Z306 when compared with the Desothane samples and that although both mixtures included SiC grit, the Z306 formulation shows better (lower) reflectance variation with angular incidence change.

The above plots show that at longer wavelengths, the new coatings perform better at a "near normal" (rather than "near grazing") angle of incidence.

When compared to the far upper right plot, the plot at right shows that the current BIRB has better (lower) reflectance at shorter wavelengths.



Future Work

- Continue to test industry options for stray light coatings until performance level of new BIRB is reached
  - Nextel suede is possibly a good candidate
- Analyze effects of each ingredient in new formulas
- If need be, invent new stray light formula

References

- B. Eney (USRA)
- C. Koerber (USRA)
- Photo of TA cavity: nasa.gov
- Image of BIRB: ballaerospace.com
- Image of integrating sphere: Surface Optics Corporation, InspectIR~Vis manual (Model 0410-0030 & 0410-0037)

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