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A New Radiometric Calibration Paradigm for the OMPS Nadir Total Column and Profile Instruments

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A fused silica Mie Scattering Diffuser (MSD) has been developed at Ball Aerospace & Technology Corp. that has measured characteristics which could be used to increase the accuracy of the spectral albedo calibration of the OMPS Nadir ozone total column and profile instrument by almost an order of magnitude. Measurements have been made of the optical characteristics on both natural and synthetic forms of fused silica MSDs. Preliminary measurements suggest that MSDs are useable in the solar reflective wavelength region from 250 nm to 3.7 µm. To date synthetic and natural MSDs have been irradiated for 60 hours of UV radiation from a solar simulator, and synthetic MSDs have been irradiated with increasing doses of Co^{60} gamma rays at 30, 500 krads up to 1.5 Mrads, and 30 krads of 200 MeV protons. The principal effects have been small loses in transmittance at wavelengths < 350 nm. The high energy particle irradiation measurements were provided by Neal Nickles and Dean Spieth.

Examples of BSDF and BTDF measurements of natural and Synthetic MSDs are shown in Figures 1 and 2. Measurements of BSDF are shown for PTFE, a.k.a Spectralon™, 3.0 and 10.0 mm thick samples of natural MSDs at 325 nm at a 0° angle of incidence. These measurements were made by K. Younworth using the Ball Optical Test Facility TMA scatterometer. The BSDF and BTDF measurements of the synthetic MSDs were made by Georgi Georgiev using the scatterometer facility at Goddard with an uncertainty of 0.7 %. There are significant advantages to using MSDs in place of PTFE diffusers. Some are: more Lambertian, non-porous, thermal effects and dimensional stability at high temperatures, low susceptibility to contamination, useable in diffuse reflectance and transmittance modes, characteristics can be engineered, useable as a very stable radiometric transfer standard of spectral albedo in the solar reflective wavelength region, etc. The importance of the use of a spectral albedo standard for climate monitoring instruments operating in the solar reflective wavelength region is discussed in the Committee on Earth Studies Report (2000) and Datla, et al. (2010).

The OMPS Nadir instrument calibration plan uses a NIST 1000W FEL lamp spectral irradiance standard which is collimated by an off axis parabolic mirror to illuminate the OMPS solar diffusers to derive the irradiance constants , K(E). The spectral radiance calibration constants , K(L), are derived from measurements of a Spectralon™ panel diffuser that is illuminated by a NIST standard of spectral irradiance which is also used to derive the spectral irradiance calibration constants. The K(L) can also be derived from using the Walker technique for sphere aperture radiance calibration from measurements of the aperture radiance using the FEL lamp used to derive the irradiance calibration constants.

It is proposed that the OMPS Nadir instrument calibrations be derived using the NIST Traveling SIRCUS Facility (NTSF) which would incorporate a Ball fused silica MSD whose BTDF has been measured at Goddard. The NTSF operating in the irradiance mode with a small sphere and a precision aperture would illuminate the OMPS solar diffusers to derive the irradiance calibration constants , K(E). This irradiance mode would be used to illuminate a calibrated MSD that is operated the transmittance mode. This would provide a calibrated spectral radiance source. The source would illuminate the OMPS instrument which is mounted in its goniometric fixture in order to derive the radiance calibration constants, K(L), over the wide field of view of OMPS. The NTSF would also provide K(L) constants which are derived with the NTSF operated in the radiance mode using its 12” Spectralon™ sphere. The MSD uncertainty of 0.7% combined with the 0.2 % (k=2) transfer uncertainty of the NTSF should greatly improve the accuracy of the OMPS albedo calibration, K(L)/K(E), uncertainty when both the NTSF and

MSD are used. This would link the MSD spectral albedo standard to the NTSF, and decrease the MSD calibration uncertainty.

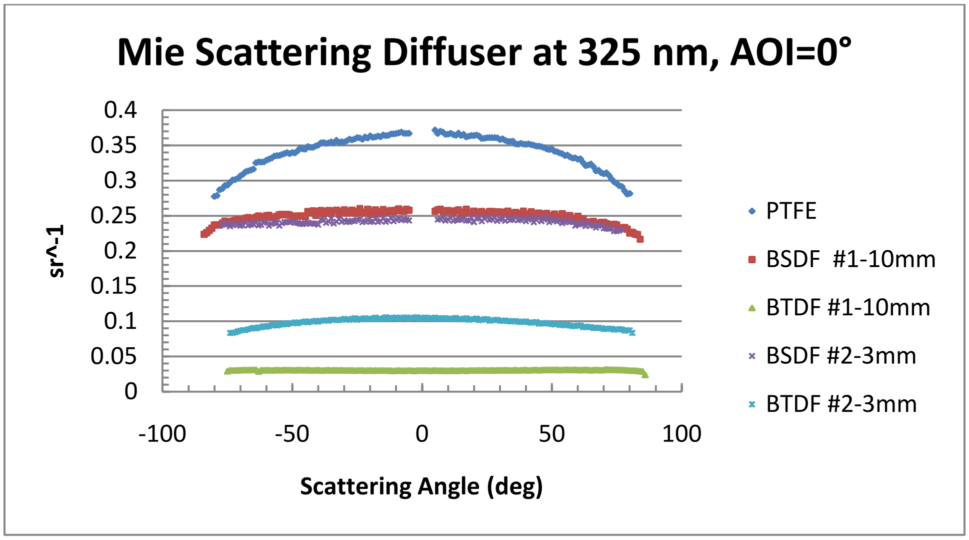

Fig. 1 Comparison of BSDF of MSD with PTF and MSD BTDF @ 325 nm for 3.0 and 10.0 mm thicknesses

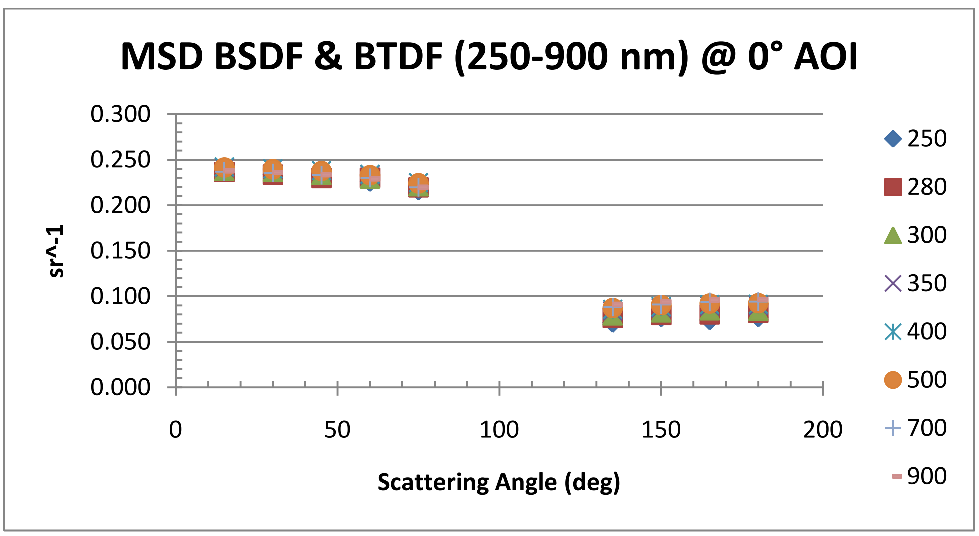

Fig. 2 Wavelength dependence of MSD (3.0 mm thick) BSDF & BTDF with scattering angle

References

Datla, R.U., et al., "Uncertainty analysis of remote sensing optical sensor data: guiding principles to achieve metrological consistency," International Journal of Remote Sensing, 31, 867-880, 2010.

Committee on Earth Studies, 2000, **Issues in the Integration of Research and Operational Satellite Systems for Climate Research Part II. Implementation,** National Research Council, ISBN: 0-309-55820-4. Appendix C, p. 78.