High Reflectance of Roughened Surface for the Integrating Sphere of SAFARI Calibration Source

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The SPICA mission (SPace Infrared telescope for Cosmology and Astrophysics) is a proposed satellite equipped an infrared space observatory with a large, cryogenically cooled telescope which will provide infrared spectroscopy with the wavelength range of mid- (12~36 μm, SMI) and far-infrared (34~250 μm, SAFARI) and far-infrared polarimetry in 3 bands (110 μm, 220 μm, 350 μm, B-BOP). SAFARI (SpicA FAr-infraRed Instrument) is an imaging Fourier transform spectrometer with a 2'×2' instantaneous field of view for 34~250 um. It will offer the sensitivity of the R ~300 (SAFARI/LR mode) about 5×10^{-20} Wm^{-2} (5σ/1h) assuming a TES (Transition Edge Senor) detector NEP (Noise Equivalent Power) of 2×10^{-19} W/√Hz [1]. A calibration source assembly is coupled to SAFARI to perform absolute calibration. The output signal of calibration source is geometrically diluted by an integrating sphere (IS). Our design of calibration source assembly consists of two microlamps and IS. The output signal of IS is expected to be a blackbody radiation and be homogeneously illuminated. The inner surface of IS must be rough to randomly scatter the THz light in the sphere. The loss of roughened surface has to be as low as possible to prevent the degradation of output power of IS. Here we will present the progress of IS for SAFARI calibration source assembly.

We have created rough surface on the inner side of aluminum semi-sphere with various methods. To increase the reflectance, we deposited Au film of 1 μm after surface is roughened. We measured the output spectrum of 5cmϕ IS at room temperature in FTS (Fourier transform spectroscopy) with commercial InSb cryogenic detector made by QMC Instrument Ltd. Similar to SRON's early result [2], the loss of sandblasted surface is high. We attribute such loss to the highly twisted surface after bombardment. The estimated reflectance is only about 0.63 if the reflectance of smooth surface is 0.96. This issue was solved by adding the aluminum wet etching process after sandblasting. Figure 1 compares the output spectra of IS with smooth (red line) and roughed (black line) surfaces in the wavelength range of 30-300 μm. The IS with roughened surface has a slightly low output intensity at short wavelength region (< 100μm). The ratio of their intensity is about 1.4. The estimated reflectance of roughened surface is 0.93 if the value of smooth surface is 0.96. In long wavelength region, the output intensity difference between two ISs is negligible. Our result indicates the loss of is significantly reduced if the sandblasted surface is treated by aluminum wet etching process additionally. The spatial uniformity of IS output power was measured. The measured pattern agrees the calculated pattern based on blackbody radiation assumption. The detail will be present in this paper.

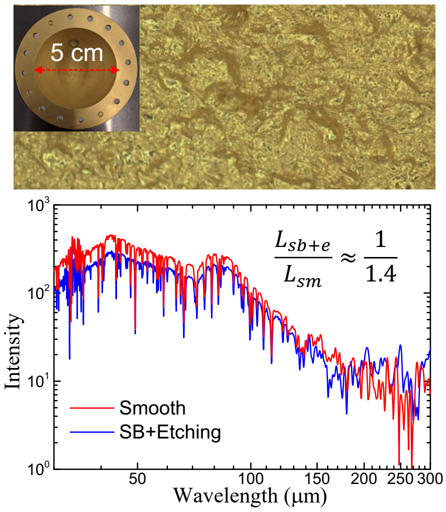

Fig. 1. Upper: The photo of roughened surface of integrating sphere. Lower: The comparison between the output spectra of integrating spheres with smooth (red) and roughed (black) surfaces. Their intensity ratio is about 1.4 at wavelength shorter than 100 μm and close to 1 at long wavelength region. The estimated surface reflectance of roughed surface is about 0.93 if the value of smooth surface is 0.96.

References

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