Primary and working standards for spectral total reflectance in Mid-IR region in KRISS

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We present a primary standard for spectral total reflectance in Mid-IR region in KRISS, which is based on the 3rd Taylor method with 8°/d geometry. We also introduce a working standard based on a comparison method using a reflectance reference that is calibrated with our primary standard. Some manufacturing techniques and simulation works are presented as well. This measurement capability has been dedicated to supporting a number of ground reference reflectance targets in Mid-IR region for vicarious calibration of satellite sensors.

INTRODUCTION

Recent climate change study has required more accurate satellite-derived land surface temperature (LST) products that are traceable to SI-based unit, so that highly reliable prediction for global warming can be carried out under global networking [1]. The LST products need calibration/validation on a regular basis against some ground reference targets with spectral emittance measured. Having relationship with research partners in Korea Aerospace Research Institute (KARI) on this study since 2015, we have built primary and working standards for spectral total reflectance to provide a number of the ground reference targets with spectral emittance assigned. The reflectance (R) practically represents the emittance (E) in its simplest form as E = 1 - R according to Kirchhoff's law when materials have no transmittance. In this presentation, we are going to introduce our primary and working standards for spectral total reflectance in Mid-IR region, show some measurement results for different samples, and compare them with those measured in NIST.

PRIMARY STANDARD INSTRUMENT

Our primary standard for spectral total reflectance in Mid-IR region is based on 3rd Taylor method with 8°/d geometry. The measurement instrument includes an integrating sphere with a diameter of 15 cm and an MCT detector combined with a collimator on top of it as shown in Fig.1. The collimator functions as a concentrator used in NIST setup [2], and also defines the field of view of MCT detector in the throughput of the integrating sphere. The integrating sphere has a sample port with a diameter of about 2.5 cm.

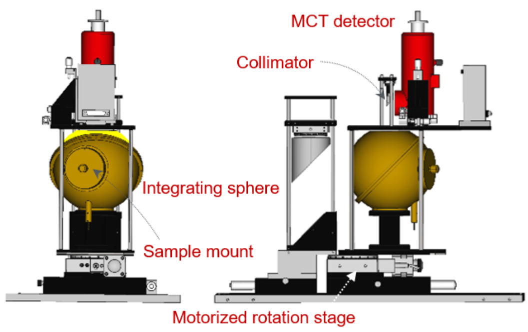

Figure 1. Primary standard instrument

The sample measurements with this instrument are made in a chamber that is integrated with a FTIR spectrometer, allowing operation in either vacuum or purging mode. Measurement on a certain sample was carried out in purging mode in KRISS and NIST by turns, and the comparison of the measurement results is shown in Fig. 2.

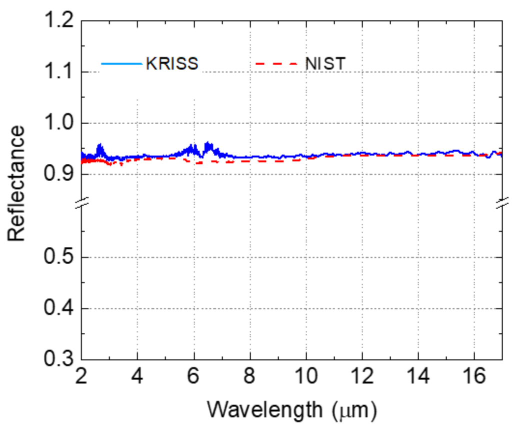

Figure 2. Comparison of KRISS and NIST measurement results

A slight discrepancy between KRISS and NIST were observed, but considering an expanded uncertainty of 3 % in NIST measurement, we believe that it is well agreed with each other. One more thing noticeable here is that we had some noise-like kinks around 2.7 μm and 6.3 μm, which was we thought due to absorption of water vapour still remained in the chamber. The evaluation of our measurement uncertainty is in progress.

WORKING STANDARD INSTRUMENT

Basic configuration of working standard for spectral total reflectance in Mid-IR region is substantially the same as that of our primary standard, but the only difference is in the design of integrating sphere used. It has two ports for sample and reference as shown in Fig 3. The sample mount is designed to be able to hold various shapes of samples with different sizes.

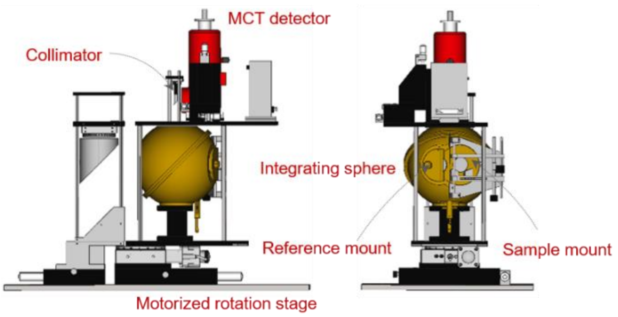

Figure 3. Working standard instrument

This instrument is set in another vacuum chamber that is also integrated with the FTIR spectrometer as shown in Fig. 4

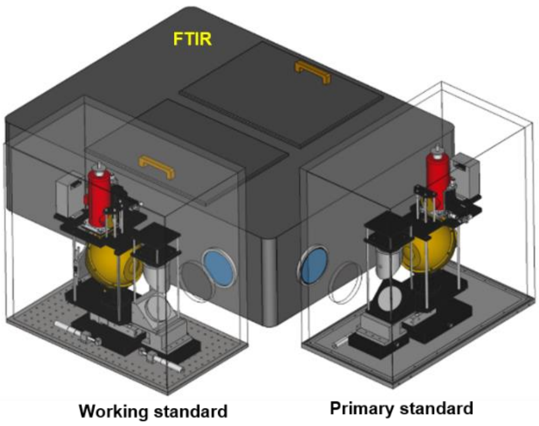

Figure 4. Overall configuration of primary and working standard instruments with FTIR spectrometer

The angular movement of integrating sphere assemblies in primary and working standard instruments and the signal measurement with the FTIR spectrophotometer are controlled and made by a computer program.

REFERENCE PLATES

Diffuse reference plates with a reflectance of more than 95 % in Mid-IR region were fabricated by our own technique. Figure 5 shows some reference Al plates before being electroplated with gold.

Figure 5. Al plates sprayed with different sizes of Al particles on top of it (#, mesh number)

We differentiated surface roughness of the plates to find the best Lambertian reflection condition. We found some plates after being electroplated with gold had a very good Lambertian reflection with a reflectance of more than 95 % over the wavelength range of interest, which is the best performance to our knowledge among others reported so far including commercialized products.

CONCULSION

We have built primary and working standards for spectral total reflectance in Mid-IR region in KRISS. Some samples made in KRISS were measured with KRISS primary standard. The measurement results were compared with those measured in NIST, which has a good agreement with each other. We hope that we can provide SI traceable calibration services for the Mid-IR spectral total reflectance with well-defined uncertainties to industries from 2021.

REFERENCES

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