LABORATORY SPECTRAL CHARACTERIZATION OF THE DIDYMIUM AND POLYSTYRENE FILTERS USED IN THE INTERNAL CALIBRATION UNIT OF MAJIS

S. Stefani[1], G. Piccioni[1], D. Biondi[1] and A. Boccaccini[1]
[1]IAPS-INAF, via del fosso del Cavaliere 100, 00133 Rome Italy
e-mail: Stefania.stefani@inaf.it

Introduction:
MAJIS (Moons and Jupiter Imaging Spectrometer) is the hyperspectral imager on board the ESA's JUICE (JUpiter ICy moons Explorer) mission, launched in April 2023. MAJIS [1] is the next generation advanced imaging spectrometer based on the heritage of the previous successfully flown instruments dedicated to other planetary missions like VIRTIS for Rosetta [2] and Venus Express [3], VIR for Dawn [4], JIRAM for Juno [5], VIHI for Simbio-Sys [6]). A scan mirror placed at the entrance slit of the spectrometers allows to acquire the signal from the Internal Calibration Unit (ICU) located on the telescope's baffle and designed to monitor the instrument's performance during the entire lifetime. The ICU is composed of two sources, one dedicated to the VIS-NIR channel and another to the IR, both illuminating a shared diffusing screen but not necessarily at the same time. Two transmission filters are mounted at the exit of each source to introduce absorption features important for the spectral calibration monitoring of MAJIS. The spectral features will be indeed used to compare the instrumental spectral response in-flight with that acquired with the same filters during the on-ground calibration. In this work we present the results of the characterization of the didymium and polystyrene filters, respectively used for the VIS-NIR and IR sources, at the cold operative conditions of MAJIS.

Experimental Set-up:

In order to study the band shift due to the temperature effect, a dedicated facility was realized. The experimental setup consists of a cryogenic optical cell coupled with a Fourier Transform InfraRed (FT-IR) spectrometer, as shown in ***Figure 1***.

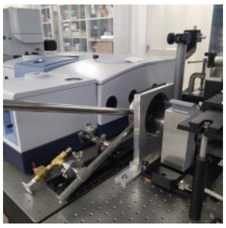

Figure 1: FT-IR (on left) coupled with the cryogenic cell (on right).

The cell, if flushed with the helium, can operate at 6 k, while if flushed with liquid nitrogen can reach an operative temperature of about 100 K. Alternatively, the cell might be heated up to 475 K. The temperature is read by a silicon diode sensor and controlled by a lake shore system which ensures stability of ± 0.5 K. The transmittance was acquired at four representative temperatures, 137-126-110 K and ambient temperature. To cover the whole MAJIS spectral range, different detectors, sources, and beamsplitters for the FTIR have been used. In the range from 0.45 to 0.95 mm a Si detector, a CaF2 beam splitter, and a QTH NIR lamp were used; from 0.95 to 1.5 mm, the Si detector was replaced with an InGaAs. Finally, from 1.5 to 6 µm a MIR source, a KBr beam splitter, and a MCT detector were employed.

Results and discussions:

To determine the transmittance of both filters, a preliminary background radiance was measured for each temperature chosen for testing. ***Figure 2*** shows the didymium transmittance obtained merging the Si (0.45-0.95 µm), the InGaAs (0.95-1.5 µm) and the MCT (1.5-6 µm).

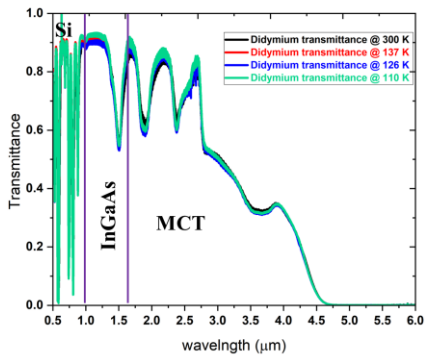

Figure 2: *Didymium transmittance acquired @ room T (black curve), 137 K (red curve), 126 K (blue curve) and 110 K (green curve) employing Si (top panel on left), InGaAs (top panel on right) and MCT (lower panel) detectors.*

In Figure 3 the polystyrene transmittance obtained, merging the Si (0.45-0.95 µm), the InGaAs (0.95-1.5 µm) and the MCT (1.5-6 µm) is plotted.

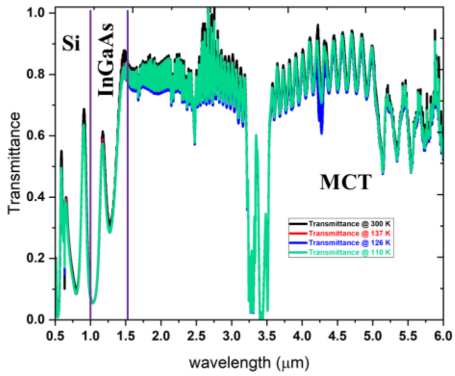

Figure 3: *Polystyrene transmittance acquired @ room T (black curve), 137 K (red curve), 126 K (blue curve) and 110 K (green curve) employing Si (top panel on left), InGaAs (top panel on right) and MCT (lower panel) detectors.*

Preliminary analysis indicates that, for the both filters, a small intensity variation was observed in between room temperature (black curves in figure 2 and 3) and 110 K (green curves in figure 2 and 3). For intermediate temperatures (137-126 K) the intensity does not appear to vary significantly. In order to study the band shift due to the temperature effects, initially the position of the characteristic bands of the two materials was calculated and subsequently the shift at the different temperatures. For the didymium, variation less than of 0,3 nm was calculated while, of about 3 nm for the polystyrene.

Conclusions:

For both spectral filters the transmittance are measured at ambiente temperature, 136 K, 126 K and 110 K and in the whole MAJIS spectral range (0.5 - 6 μm). Small intensity variations were observed in between room temperature and 110 K, but none at intermediate tempertaures. For the didymium in between 0.5-1.55 μm and for the ΔT= (137-110)K, a band shift less than 0.3 nm was calculated. For the polystyrene, in the same step of temperature and in the region [1.5-5.6] μm, a band shif of 3 nm or less, was calculated. These results led us to conclude that these values are margianlly detectable in the full operative temperature range of MAJIS.

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