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Spectrometer ISEM for ExoMars-2020 space mission: ground measurements and tests

Yury Dobrolenskiy (1), Oleg Korablev (1), Anna Fedorova (1), Sergey Mantsevich (1,2), Yury Kalinnikov (3), Nikita Vyazovetskiy (1), Yuriy Ivanov (4), Ivan Syniavskyi (4), Andrey Titov (1), Alexander Stepanov (1,2), Alexander Sapgir (1), Ilya Dzyuban (1), Nadezhda Evdokimova (1) and Ruslan Kuzmin (1,5)

(1) Space Research Institute of Russian Academy of Sciences, Profsoyuznaya 84/32, 117997 Moscow, Russia

(2) Faculty of Physics, M. V. Lomonosov Moscow State University, Vorob'evy Gory, 119991, Moscow, Russia

(3) G. Ya. Guskov Scientific Research Institute of Microdevices, Konstruktora Guskova 1, 124460, Zelenograd, Moscow, Russia

(4) Main Astronomical Observatory of National Academy of Sciences of Ukraine, Akademika Zabolotnogo str. 27, 03143, Kyiv, Ukraine

(5) V. I. Vernadsky Institute of Geochemistry and Analytical Chemistry of Russian Academy of Sciences, Kosygina 19, 119334, Moscow, Russia

Abstract

Robust design, small dimensions and mass, the absence of moving parts in acousto-optic tunable filters (AOTFs) make them popular for space applications [1]. Here we present the new laboratory calibrations and tests of a pencil-beam near-infrared AOTF-based spectrometer ISEM (Infrared Spectrometer for ExoMars) to be deployed on the mast of ExoMars 2020 rover. The instrument is designed for: mineralogical studies of Martian surface in the vicinity of rover; context assessment of the surface mineralogy for PanCam instrument and drilling; atmospheric studies in the surficial atmosphere layer [2,3].

ISEM spectrometer

The instrument works in the spectral range of 1.15–3.3 µm with the spectral resolution of ~25 cm-1 and is intended to study mineralogical composition of the uppermost regolith layer and to estimate the H2O/OH content. Due to the spectral range and spectral resolution the instrument is able to detect the minerals which are extremely important for geological and astrobiological studies: hydrated minerals (i.e. phyllosilicates, sulfates, hydroxides, opal) and other minerals, including ones formed in the aqueous environments, i.e. carbonates. Besides, it will help in real-time assessment of surface composition studies in selected areas, in identifying and selection of the most promising drilling sites, and in a atmospheric lower layers studies.

The instrument (Fig. 1) consists of two parts: Optical Box and Electronic Box. The optical scheme includes entry optics, the AOTF, focusing optics, and a Peltier-cooled InAs detector. A wide-angle acousto-optic tunable filter manufactured on the base of TeO_2 crystal is used. Incident optical radiation has ordinary polarization and the diffracted optical beam has the extraordinary polarization. The angle between the passed and diffracted optical beams is 6° at the output of the AO crystal. A pair of polarizers with crossed polarizing planes is used to filter out the non-desired zero diffraction order.

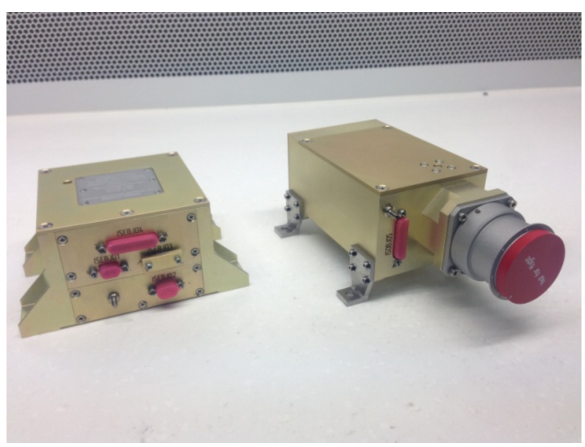

Figure 1: ISEM spectrometer: Optical Box (on the right) and Electronic Box.

Two qualification models of the instrument were manufactured. One of them has passed qualification tests including thermal-vacuum tests down to -130°C.

The second one is delivered to ESA for integration into ground-test model of the rover.

In 2018, flight model of the instrument was manufactured, tested and delivered to ESA. At present, instrument integration and test campaign at rover level has started. Flight spare model of the instrument is being manufactured.

We present here the spectra of a few different monomineral samples measured in the laboratory using ISEM Qualification Model. Considering minerals are correspond to the goals of the experiment. For these measurements we used laboratory infrared light source.

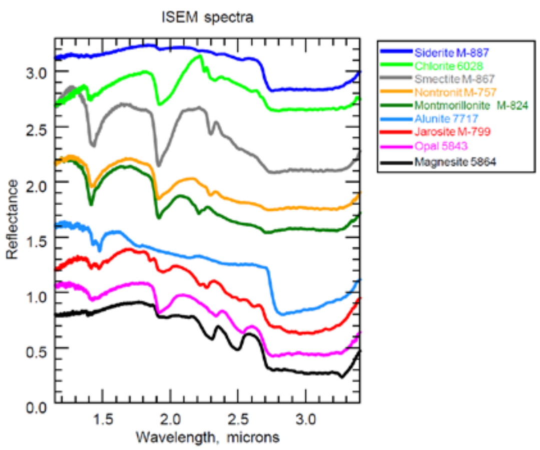

Figure 2: Spectra of different monomineral samples measured with ISEM (smoothed).

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References

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