Stand-off LIBS in space exploration. New facility for the simulation of different planetary conditions

C. Alvarez-Llamas, P. Purohit, J. Moros, J.M. Vadillo, J. Laserna[a]

[a] UMALASERLAB Dept. of Analytical Chemistry, U of Málaga, Málaga (Spain)

alvarez.cesar@uma.es

Keywords. LIBS, Mars, Stand-off, Acoustic

The availability of facilities capable of simulating extraterrestrial environments represents a need in today´s planetary research to design, simulate and optimize those experiments carried out outside of Earth[1,2]. A thermal vacuum chambers (TVC) must be capable of operate under representative conditions (temperature, pressure, gas composition, radiation flux …) of space exploration targets, but also have a useful volume compatible with the performing experiments and the testing of equipment under mimicked scenarios.

Stand-off spectroscopies and connected techniques have gained a proper niche within the modern tools in in situ compositional analysis for space exploration using rovers. The latest missions sent for space geo-exploration, e.g. NASA's Mars 2020 mission, are showing that Laser-Induced Breakdown Spectrometry (LIBS) is currently one of the key tools in the understanding of mineralogy and geochemistry of planetary surface as they obtain to date real-time information at distances up to 12 meters, together with other techniques such as RAMAN or VIS-IR spectroscopy[3].

The convenience of a TVC capable of performing stand-off spectroscopies under the current analysis range allows reproducing the results obtained in the rovers, gaining insights about data treatment and data modelling, and also anticipating experiments on Earth before being commanded.

This work presents the TVC available in the UMALASER lab and the stand-off LIBS experiments carried out at different atmospheric conditions up to 12m. Furthermore, the versatility of this camera in the field of stand-off analysis will be demonstrated combining LIBS analysis with Laser-Induced Acoustics detections or other spectroscopic techniques (i.e. Raman). This array of remote analysis techniques has been applied for the compositional analysis of geological samples under Martian atmospheric conditions of pressure (8 mbar), composition (CO_2 rich atmosphere) and air temperature (250 K).

Fig. 1. Panoramic view of the simulation chamber at UMALASERLAB facilities.

[1] Mateo-Martí E. et al A chamber for studying planetary environments and its applications to astrobiology (2006) Meas. Sci. Technol.(2006) 17 2274 DOI: 10.1088/0957-0233/17/8/031

[2] Rabow E et al.- The Planetary and Space Simulation Facilities at DLR Cologne, Microgravity Sci. Technol. 28, 215. DOI: 0.1007/s12217-015-9448-7

[3] S. Maurice et al. The SuperCam Instrument Suite on the Mars 2020 Rover: Science Objectives and Mast-Unit (2021) Description Space Sci Rev 217:. DOI: 10.1007/s11214-021-00807-w