Miniaturized low power LIBS system for in-situ exploration of Solar System bodies without atmosphere

S. Kubitza[1], K. Rammelkamp[1], D.S. Vogt[1], S. Frohmann[1], P.B. Hansen[1], S. Schröder[1], H.-W. Hübers[1,2]
[1]German Aerospace Center (DLR), [2]Humboldt-Universität zu Berlin

LIBS is a very useful tool for robotic in-situ space exploration because of its remote capability and the omission of sample preparation, and was extraterrestrially employed for the first time on NASA's Mars Science Laboratory [1]. Space missions have severe constraints on size, mass and power consumption limiting the capabilities of the instruments on board in comparison to laboratory instrumentation on Earth. The German Aerospace Center is currently developing a miniaturized LIBS instrument of ~1 kg in mass with a low power laser of approximately 5 mJ pulse energy for pioneering missions to explore planets, moons and asteroids in the Solar System. While Martian atmospheric conditions are close to ideal for the LIBS technique, low pressure environments such as on most of these bodies are more challenging [2,3]. The instrument has to provide sufficient irradiance to create a suitable plasma for scientific analysis while still meeting the aforementioned limitations on mass and energy.

With a prototype miniature LIBS setup, measurements on different materials were conducted. Regolith simulants for the Earth's moon and the Martian moon Phobos [4] were investigated as well as pure salts to test the capabilities for major element detection as well as for volatiles. All experiments were performed at pressures of <1 Pa using a Nd:YLF prototype laser originally developed for ESA's ExoMars mission and operating at 1053 nm wavelength and 1-4 mJ pulse energy. The collected plasma light was separated into four spectral ranges with dichroic mirrors and analysed with four commercially available compact and uncooled symmetric Czerny-Turner spectrometers to cover a large wavelength range. The performance of the setup is evaluated and discussed for different possible mission scenarios.

[1] S. Maurice et al., J. Anal. At. Spectrom., vol. 31, p. 863 (2016)

[2] D. A. Cremers and L. J. Radziemski, "Handbook of laser-induced breakdown spectroscopy," John Wiley &Sons Ltd., Chichester, England (2006)

[3] J. Lasue et al., J. Geophys. Res., vol. 117, E01002 (2012)

[4] H. Miyamoto et al., LPI Contrib., no. 2083, id. 1882 (2018)