SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 2 (2B)

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THE LIBS INSTRUMENT FOR CHANDRAYAAN-2 ROVER: ENGINEERING MODEL DEVELOPMENT ASPECTS

Abstract

Rapid and reliable analyzing capability for simultaneous multi-element determination of matter in any of its diverse forms, namely, solid, liquid or gas using an intense nanosecond pulse duration of laser beam makes laser induced breakdown spectroscopy (LIBS) a potential tool for planetary surface exploration via both in-situ and stand-off measurements. India's second moon mission i.e., Chadrayaan-2 in addition to the orbiter spacecraft will carry a lander that is housed with a 6 wheel rover in order to investigate the lunar surface at a close proximity in the vicinity of roving area. One of the two selected rover scientific instruments, named, LIBS (Laser Induced Breakdown Spectroscope) is currently under development at LEOS for multi-element composition analysis of lunar regolith from an in-situ distance of 200mm from the surface. The conceptualization, design and development aspects of proto-LIBS were presented elsewhere. Nevertheless, design and development aspects of Engineering Model LIBS (EM-LIBS) instrument are gone through a series of iterations to overcome issues those had faced during the development phases of proto-LIBS. The tailored EM-LIBS comprises a Yb:Er:Phosphate glass laser operating at 1534nm wavelength with pulse energy of 2-3mJ. A multi-lens element Focusing-Optics-Unit (FOU) to generate the laser plasma on the target surface at the targeted in-situ distance with the ability to overcome the surface undulations (within +/-20% of the 200mm) is being developed. The plasma emission emanating from the target surface is collected by a chromatic aberration corrected Collection-Optics-Unit (COU) and spectra are acquired using an aberration corrected concave holographic grating and linear-CCD based spectrograph. The spectrograph supports variable time delay in range of 1μs to 5μs and integration time of 8μs to 1ms. Suiting the mission constrains such as weight, size, power and available target distance beneath the rover; the instrument is realized with the weight of 1.2kg, power consumption of <5W and a footprint of 180mm x 150mm x 80mm. Algorithm towards the accomplishment of reliable qualitative is realized; while the algorithm of precise quantitative analysis is based on Calibrated-Free LIBS (CF-LIBS) methodology. Elemental abundance estimations are currently in progress on the acquired spectra resulted

from various standard/reference samples including lunar regolith simulant (JSC-1A). Through this paper, authors shall discuss challenges faced in proto-LIBS realization, EM-LIBS design improvisations, modes of operations and calibration aspects of in-house developed spectrograph along with preliminary performance test results.