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

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A COMPACT MICRO-LIBS INSTRUMENT FOR CHANDRAYAAN-2 MISSION: DEVELOPMENT AND PERFORMANCE ASPECTS OF QUALIFICATION MODEL

Abstract

India's second moon mission, viz., Chandrayaan-2 to be launched in the year 2018 will place a lander along with a 6-wheeled rover at the lunar south pole region (in addition to an orbiter in 100km orbit). The rover shall move around the landing area to enable science observations of the surface at a close distance. To meet the defined science objective of identification and abundance estimation of major, minor, trace and volatile (H, C, N, O, P, S, K and OH-) elemental content of lunar surface, a Laser Induced Breakdown Spectroscope (LIBS) instrument is being developed by LEOS. It shall be located below the rover's deck to sample the surface from a distance of 200 mm. The design and development aspects of Engineering Model (EM) version of the instrument were presented elsewhere. Further development and realization of LIBS-Qualification Model (LIBS-QM) has gone through a series of design corrections to overcome challenges faced during testing phase of EM in vacuum environment. The reconfigured LIBS-QM is a light-weighted (< 1.2 Kg), low power consuming (< 5 Watt) compact module that occupies a volume of just 180mm x 150mm x 80mm. LIBS-QM is equipped with a strong Mg-alloy structure that houses optical elements in titanium mounts. The optical modules of LIBS-QM can produce a power density of 12 GW/cm^2 at the investigation site by focusing a 1.54 μm pulsed laser to a spot size of 50 μm and are of capable to register the resulting plasma emission spectrum in the spectral range of 220nm-800nm with a resolution of <1nm. The light throughput of emission collection optics is improved considerably over EM by redesigning and with specialized coatings. Spectrograph module of LIBS-QM is realized through a combination of a single aberration- corrected concave holographic reflective grating element, a rectangular slit and a linear array CCD detector. LIBS-QM, which is designed for an operational temperature range of -20^0C to +55^0C, has successfully undergone space environmental qualification tests such as thermo-vacuum cycling test(temperature range of -40^0 C to +70^0 C) at vacuum levels of better than 5x10^{-6} mbar and withstood vibration levels of up to 20g(RMS). Using this model, a LIBS spectral database using geo-chemical standard/certified reference samples and minerals is being generated to address qualitative and quantitative analysis prospects. Through this paper, authors shall discuss challenges faced during EM testing, LIBS-QM design improvisations, calibration aspects, space qualification test details, observations and results.