

Gas Analysis and Vacuum Characterization for Space and Lunar Exploration

Andres Diaz. Ph.D. Research Manager. Emerging Technologies. INFICON. Inc. American Vacuum Society (AVS) Conference. Tampa, Florida, USA. Nov 2024

Abstract

Mankind is always curious and looking for the next frontier. In recent years there has been a sharp increase in all sorts of space activities, from numerous rocket launches to new space vehicles and landers trying to reach orbit, Moon, Mars, and beyond. National government agencies in charge of space activities like NASA, ESA, ISRO, JAXA, DLR, ASI, ROSCOSMOS, CNSA, etc, and commercial entities like Blue Origin, Space X, ULA, Rocket Lab, Sierra Space, Astra Bigelow, CASC, Astrobotics, Intuitive Machines, etc, are speeding efforts to build rockets, spacecraft, probes, space stations, satellites, telescopes, landers, rovers and even drones, to explore space and planets in a rate never seen before.



This new wave is targeting the Moon as a stepping stone for human exploration. Many missions have been launched or are targeted to be launched in the coming years and this brings a need for sensors and instruments that can measure and characterize either the vacuum surrounding the spacecraft while approaching a planet or moon, or the quality of air inside the cabin when transporting humans, or else deployed onboard a lander or a rover to characterize the lunar atmosphere, its surface and subsurface looking for water and volatiles for in situ resource utilization (ISRU) activities.

There have been many unique successful gas analysis instruments that have been flown into space or landed on planets, such as mass spectrometers (MS) and optical emission spectrometers, providing extremely useful gas composition data and vacuum characterization conditions of the exploration target. Nevertheless, in the same way rockets are now being manufactured with orders of magnitude lower cost by commercial rocket companies, this new wave of exploration requires commercial instruments developed by companies, not government agencies, that can provide time and time again, ready-to-use, space-qualified, cost-effective systems to be carried in any space exploration vehicle when vacuum and gas analysis are necessary.

This presentation provides an overview of the different instruments used in gas analysis and vacuum measurements in space exploration over the years, especially targeting planetary and moon exploration. It also includes the most recent developments of commercial-off-the-shelf (COTS) space-ready mass spectrometer planned to be used in different lander missions through the Commercial Lunar Payload Services (CLPS) initiative as part of NASA ARTEMIS going back to the Moon program, as an example of this new approach to do commercial instrumentation for space applications.