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MEMS PLASMA SPECTROMETER FOR SMALL MISSIONS

Abstract

Development of MEMS plasma spectrometer with optical signals detection (MEMS-PS) for small and CubeSat missions is presented. The MEMS-PS is dedicated to analyze overall contents of gaseous atmospheres, but especially the atmospheres on planets, moons and comets. Due to the small dimensions of the instrument, contained in the volume of 1U, low weight 0.4 kg and low power consumption, it is one of the few - if not the only - solution that can be mounted on small rovers or flying drones.

The basic configuration of the MEMS-PS consists of: MEMS vacuum micropump playing in parallel a role of plasma generator, MEMS optical spectrometer and electronic circuitry. Gamma quant entering MEMS ionizator starts ionization of gas mixture trapped inside, leading to avalanche ionization effect and forming of plasma. Light coming from glowing plasma is analyzed spectrally by MEMS optical spectrometer. VIS/NIR spectrum contains light peaks coming from ionized atoms or particles. Gas sample ionization is obtained for sample pressure from 1 hPa to 10e-5 hPa. This is suitable for studying e.g. the Martian atmosphere, without additional systems supporting the generation or maintenance of the indicated pressure range. An instrument with the above-mentioned features is ideal for placing it on a rovers or suspending it under a helicopters. A single measurement lasts no longer than 60 s., which enables dense mapping of trace gases on the surface of Mars, but also in craters, fissures or caves, which has not been possible so far due to the lack of miniature measuring instruments. Applying the sample pre-concentrator, MEMS-PS applications are extended to the possibility of detecting ultra-low substance concentrations (ppb level), for example detecting methane on Mars and determining its origin (biotic/abiotic). This issue is currently developed by the authors. In a similar configuration, the instrument makes it possible to study the residual atmosphere on the Moon, other moons (Enceladus, Europa) or comets.

The MEMS-PS enables screening of the atmosphere, with detection thresholds as low as ppm. After the introduction of the sample preparation system, the instrument gains a wide range of applications for studying the atmospheres of moons, comets and planets with harsh environments. To the best of the authors' knowledge, it is the only miniature solution that enables conducting innovative research in areas not yet discovered.