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VISTA, a light and cheap sensor to measure volatile amount and dust deposition

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VISTA (Volatile In Situ Thermogravimetry Analyzer) is a micro-thermogravimeter developed by a consortium of Italian institutes, leaded by IAPS-INAF. It is based upon a lab-on-chip miniaturised sensor philosophy, since it has very small mass (i.e. 25g each sensor), volume (i.e. less than 10cm3 each sensor) and power requirements (i.e. <1W) and needs a quite small amount of material for the analysis, i.e. less than 1 mg.
The core device is the Piezoelectric Crystal Microbalance (PCM), which changes its oscillating frequency depending on the mass deposited in its electrode (sensitive region). The PCM can be heated by means of built-in resistor, acting as heater: this allows the desorption of volatile compounds from the sample deposited on the PCM, and the measurement of their amount as mass difference between before and after the desorption. Moreover, VISTA allows to know in real time the current temperature of the crystal, thanks to an additional resistor integrated on the crystal surface and acting as temperature sensor. The temperature sensor can also act as additional heater (in parallel to the other), allowing to dramatically reduce the power needed to obtain a certain temperature increase.

VISTA can perform different planetary in-situ measurements. It has been selected in the scientific payload of the ESA MarcoPolo-R mission, aiming to return a sample from a primitive asteroid. In this scenario, VISTA planned to measure the volatile content in the asteroid regolith. In particular, it would allow detecting water and organics, in order to give more physical insights about the astrobiologic potential of the primitive asteroid.
In addition, VISTA has been studied for Phase A of JUICE (JUpiter and ICy moons Explorer), in the framework of the Penetrator Consortium, in order to perform in-situ measurements on the Europa and Ganymede surfaces, i.e. definition of non-ice materials composition and detection of clathrate hydrates and organics.
Moreover, VISTA has been studied for in-situ missions on Mars, where it can measure dust and ice settling rate, water content in dust and humidity, on the Moon, i.e. for water ice detection and water/organics content in regolith, on Venus, where it would infer the dew point of cloud condensable species and the composition of refractory component of clouds, and on Titan, in order to measure the methane dew point and the organics content in near-surface aerosols.

A VISTA breadboard has been developed and tested in relevant environment (i.e. at pressure down to 10-7 mbar). The following tests have been successfully performed:

- Functionality tests, aimed at studying the behaviour of resonant frequency at changing temperature. A wide temperature range has been considered, i.e. from -150°C to 100°C.
- Performance tests, aimed at verify the VISTA capability
    - To measure desorption of volatiles
    - To measure enthalpy of sublimation of deposited material.