VISTA, A MICRO-THERMOGRAVIMETER TO MEASURE WATER AND ORGANICS CONTENT IN PLANETARY ENVIRONMENT. E. Palomba[1], A. Longobardo[1], F. Dirri[1], E. Zampetti[2], D. Biondi[1], A. Boccaccini[1], B. Saggin[3], D. Scaccabarozzi[3], A. Bearzotti[2], A. Macagnano[2], [1]IAPS-INAF, via Fosso del Cavaliere 100, 00133 Rome, Italy (ernesto.palomba@iaps.inaf.it), [2]IIA-CNR, Rome, Italy, [3]Politecnico di Milano, Milan, Italy.

Introduction: VISTA (Volatile In Situ Thermogravimetry Analyser) is a thermogravimeter developed by a consortium of Italian institutes, which aims to perform planetary in situ measurements. Its specific applications depend on the planetary environment under study, but the main goal is usually related to the water and organics detection in dust or aerosols, which can be linked to the habitability of the planetary body.

It is based on Thermogravimetric Analysis (TGA), a widely used technique to investigate condensation/sublimation and absorption/desorption processes of volatile compounds (e.g. [1,2]) . The core of a thermogravimeter is a Piezoelectric Crystal Microbalance (PCM), which converts mass in frequency variations, according to the Suerbrey equation [3].

The PCM temperature can be increased by an appropriate heater and when this occurs, the volatile component of the analysed sample desorbs, resulting in a frequency change. This frequency variation allows to infer the abundance of evaporated compound, whose composition can be determined by its desorption temperature.

Technical characteristics: VISTA is based upon a lab-on-chip miniaturised sensor philosophy (Figure 1), since it has very small mass/volume and power requirements and needs a quite small amount of material for the analysis, i.e. less than 1 mg. The main innovation introduced by VISTA concerns the special design of the thermogravimeter, equipped with a built-in heater and a built-in thermistor, both controlled by proximity electronics. The thermistor can act as additional heater in parallel to the other: this special design dramatically reduces the total mass and the power required to perform thermal cycles. The VISTA overall technical characteristics are summarised in Table 1.

Applications: VISTA has different applications in planetary in-situ measurements. Currently, it has been selected in the scientific payload of MarcoPolo-R, a proposed ESA mission aiming to return a sample from a primitive asteroid. In this scenario, VISTA plans to measure the volatile content in the asteroid regolith. In particular, it will allow detecting water and organics, in order to give more physical insights about the astrobiologic potential of the primitive asteroid [4].

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 [5].

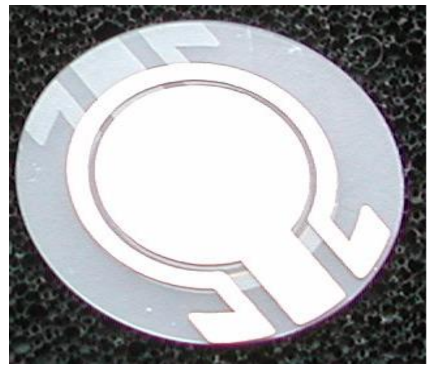

Figure 1: PCM equipped with built-in heater and built-in thermistor produced at IIA-CNR Facility Center.

VISTA technical characteristics	
Mass (g)	40
Volume (cm^3)	7
Resonance Frequency (MHz)	5.8
Accuracy (Hz)	4
Sampling rate (s^{-1})	5
Sensitivity (ng/Hz)	0.3
Saturation mass (µg)	~10
Crystal Diameter (mm)	14
Thickness (mm)	0.2

Table 1: VISTA technical characteristics

Moreover, VISTA can find application on in-situ missions on Mars, where it can measure dust and ice settling rate, water content in dust and humidity [6]. VISTA is suitable to study the Moon, i.e. for water ice detection and water/organics content in regolith [7], or Venus, where it would infer the dew point of cloud condensable species and the composition of refractory component of clouds [8]. Finally, VISTA has potential application on Titan, in order to measure the methane dew point and the organics content in near-surface aerosols [9].

Tests: We developed a laboratory set-up (shown in Figure 2) in order to test the capability of the VISTA breadboard to measure the enthalpy of sublimation ΔH, i.e. the amount of energy absorbed or released during a chemical-physical process, of different carboxylic acids (i.e. adipic, oxalic, succinic, azelaic). Because of similar desorption temperatures of several volatile species, to measure this thermal property is necessary to characterize a volatile compound.

The sample and the PCM were placed inside a vacuum chamber, which would simulate an asteroidal environment. Then, the sample (contained in an effusion cell) was heated by means of a resistor and degassed, while the PCM was cooled down to about -74°C by a cold finger (i.e. copper plate in contact with a liquid nitrogen coil), in order to allow the deposition of the gas molecules produced by the sublimation process.

By measuring the deposition rates on the PCM at different temperatures, it has been possible (by Van't Hoff relation [10]) to infer the enthalpy of sublimation ΔH of the sample. The obtained results are in good agreement with literature, demonstrating the VISTA ability to measure enthalphy of sublimation [11].

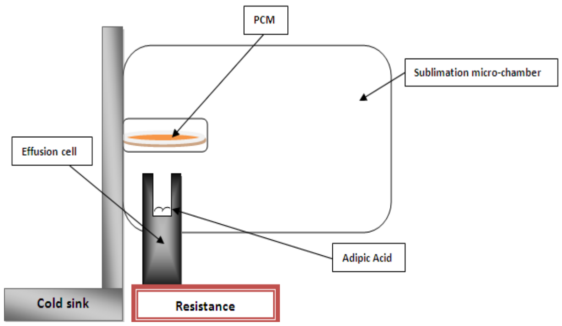

Figure 2. Schematic representation of the set-up used to measure the enthalpy of sublimation of dicarboxylic acids.

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