Aerospace & Advanced Composites GmbH

Viktor-Kaplan-Straße 2
2700 Wiener Neustadt, Austria
Tel: +43 (0) 2622 – 90550 - 360
email: roland.holzbauer@aac-research.at
www.aac-research.at

Advanced Outgassing

This test is used in extension to ECSS Q-ST-70-02C (standard outgassing) and in accordance to ECSS-Q-TM-70-52A (kinetic outgassing of materials for space).

The sublimation test with high sensitivity, is used for a detailed investigation of the mass transport of materials (mass-loss due to sublimation, evaporation, outgassing of evaporated particles) under thermal vacuum. Since a vacuum microbalance records mass changes online, this test is commonly used in extension to the screening test ECSS Q-ST-70-02C (mass change by weighing in air before and after vacuum exposure).

Mass loss by sublimation, outgassing, evaporation are measured by weighing (ESTEC-standard) in an apparatus built according to the ESTEC-design. - This sublimation test is done according to an in-house-standard agreed with ESTEC.

Smallest mass changes can be determined and accelerated tests can be carried out. By online mass spectroscopy the species of the outgassing or evaporated particles can be analysed.

Different test procedures are available:

a) Dynamic test: The temperature is increased with constant rate until heavy mass loss is gained.

b) Static test: Temperature is increased as fast as possible to a certain level and then held constant, until a constant sublimation rate is gained.

c) Kinetic outgassing test: Stepwise increase of temperature: In steps of e.g. 25°C the temperature is increased and held constant for e.g. 24hours for long-term TML prediction (ECSS-Q-TM-70-52A)

d) Vapour pressure test: The vapour pressure of an outgassing material is calculated using Langmuir's equations. For low temperatures only poor accuracy is obtained (detection limit: 5.10^{-10}mbar) but temperatures up to 800°C are available.

Inside the vacuum chamber, a water-cooled copper cylinder prevents outgassing of the vacuum chamber. Inside the copper cylinder, a ceramic heater in cylindrical shape heats the sample by irradiation. Evacuation is done with a rotary pump and a turbo molecular pump. The mass of the sample is measured online with a balance. The sample temperature is measured with a thermocouple ("TC") with a small plate at it's end to gain the same irradiation as the sample.

With this setup accuracy of sample temperature of ±1°C in the range from RT up to 300°C and ±2°C from 300°C up to 800°C is gained. Mass loss is measured with an accuracy of 1µg.

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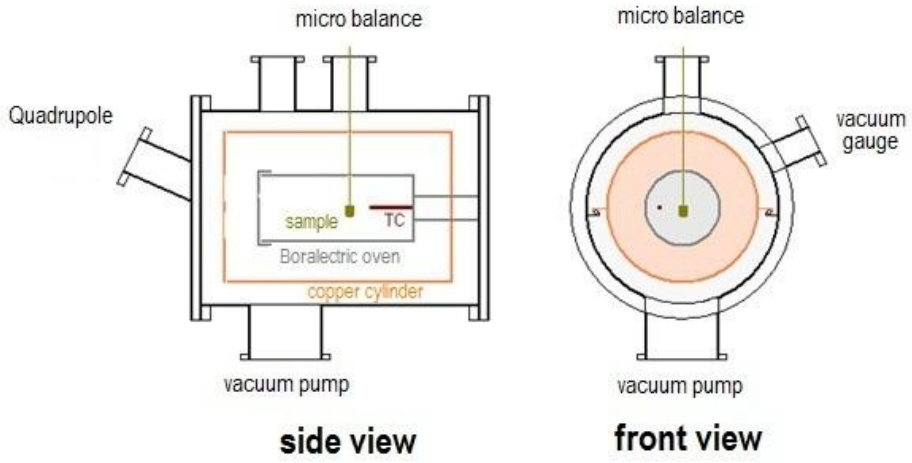

Scheme of Sublimation test facility

On top of the vacuum chamber the balance is mounted. The sample is in the centre of the ceramic heater. Holes in the cylindrical heater and the copper shield let the quadrupole "look directly" onto the sample. On the bottom of the chamber the vacuum pumps are mounted.

Specifications	
Test	online measurement of • mass loss as function of time / temperature • residual gas analysis (mass spectrometer of outgassing particles)
Temperature	from RT up to + 800 °C, thermal cycles available
Vacuum	< 10^{-4}Pa (< 10^{-6}mbar)
Samples	max. 25 g, different geometries (spherical shape max diameter 80 mm)
Temperature control	by irradiation
Accuracy	vacuum-balance: ±1µg time drift of vacuum-balance: < 5.10^{-7} g/h sample temperature: ±1°C (from RT to 300°C); ±2°C (from 300°C to 800°C)

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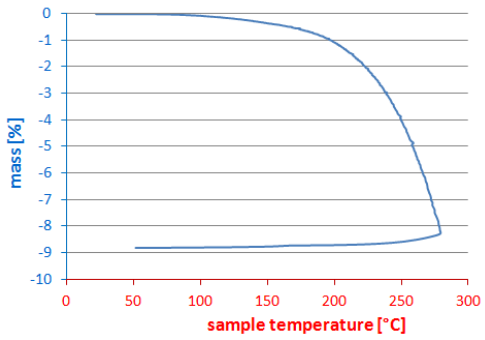
Sublimation test facility
vacuum-balance (on top),
vacuum chamber,
quadrupole (left),
turbo-pump (bottom)

(a)



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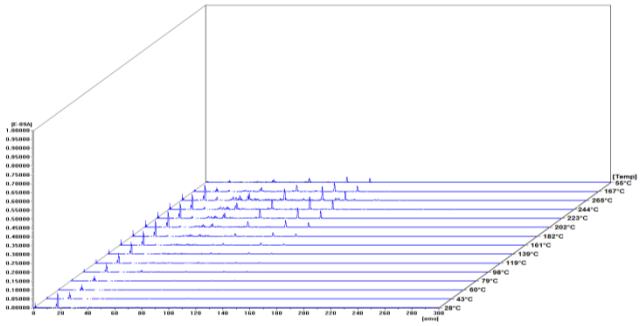

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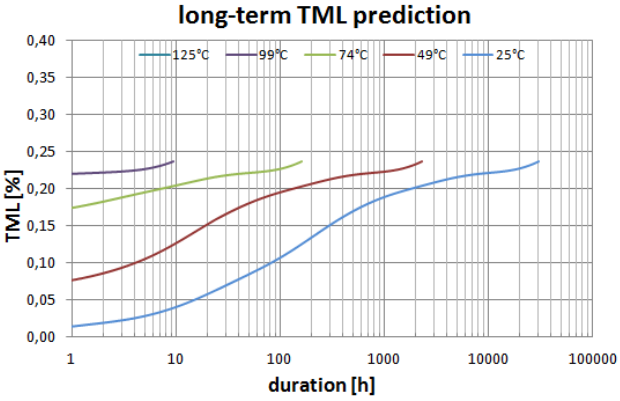

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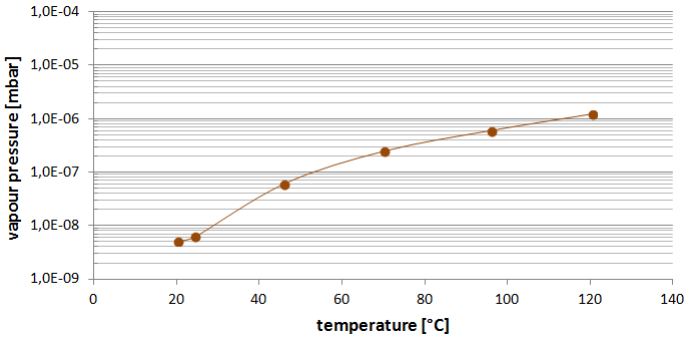

Example of test results: (a) dynamic test, (b) residual gas analysis, (c) long term TML prediction (kinetic outgassing test), (d) vapour pressure test