LOW TEMPERATURE GAS LOADING OF DEUTERIUM IN PALLADIUM

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ABSTRACT

One of the most established features of the phenomenon known with the name of "Cold Fusion", with reference to the system palladium (Pd) – deuterium (D), is that a condition necessary (even though not sufficient) to be satisfied in order for these phenomena to take place is that the content of D in Pd, called also the D/Pd ratio X, approach the value of 1 (intending by this quantity the atomic ratio between the two species in the Pd lattice). In order to reach such an high value of X, extensive use of electrolysis of heavy water with a Pd cathode has been made.

This experiment is aimed at obtaining high loading ratios of deuterium in palladium without using electrolysis. The idea is to have deuterium gas in contact with palladium. The use of low temperatures has the purpose of increasing the equilibrium loading ratio for a given gas pressure.

A first test experiment, performed at ENEA Frascati in 2002, showed that it was possible to have D/Pd ratios as high as 1 at 150 K with a pressure lower than 1 bar[1]. The experiment has been rebuilt at LNF/INFN and hopefully the first results will be reported.

An anomaly in the process of charging will be also reported.

1. F. Scaramuzzi, *Gas loading of deuterium in palladium at low temperature*, Journal of Alloys and Compounds, 385 (2004), 19-27

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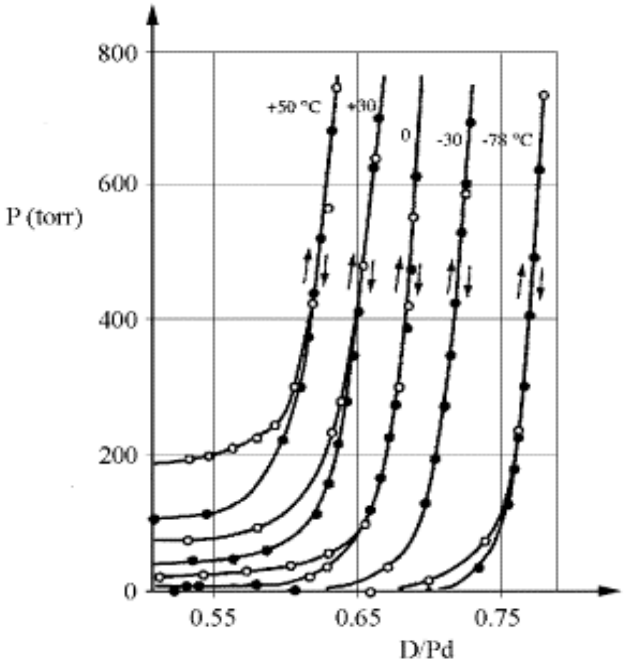
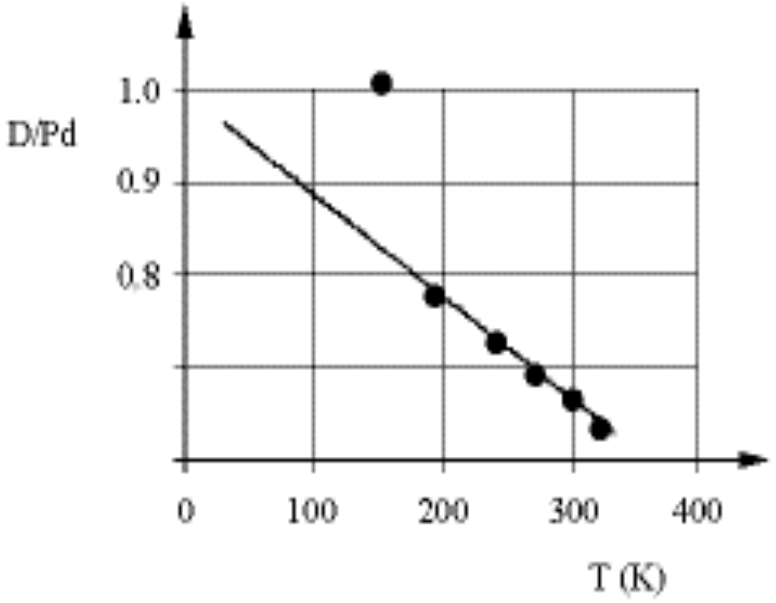
Why low temperature?



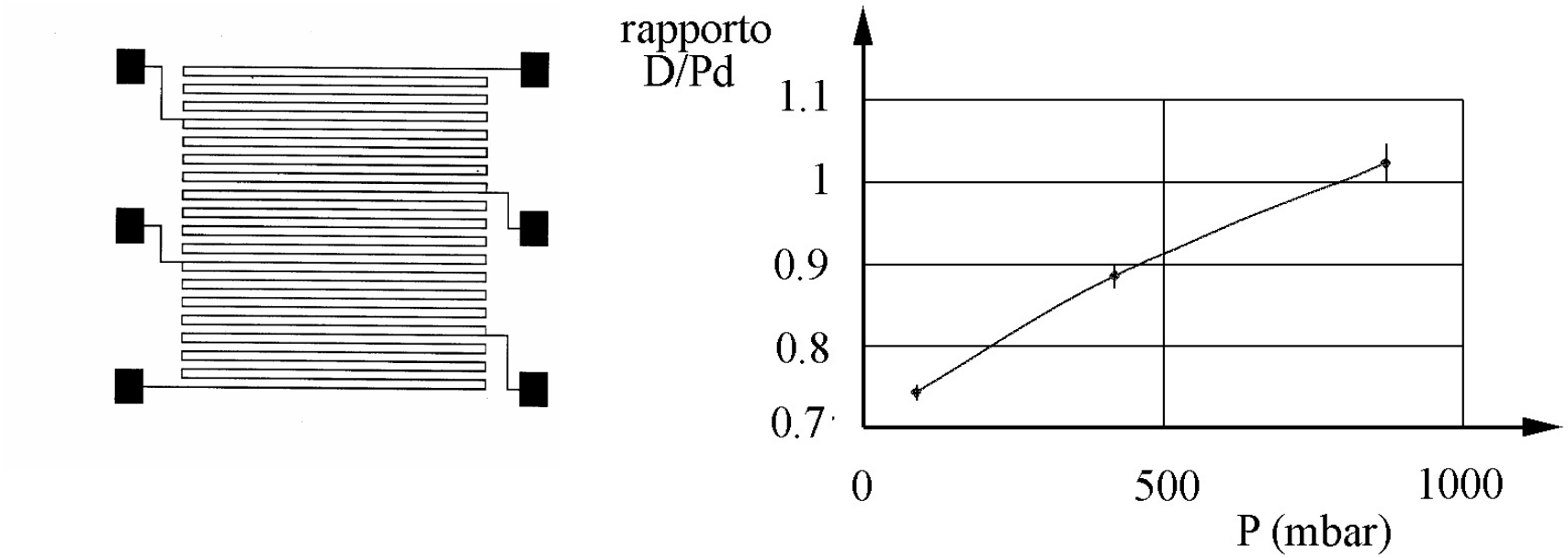
(a)



Everything started from these data

[Von E. Wicke, G.H. Nernst, Ber. Bunsenges. phys. Chem., 68, 224 (1964)]

First Measurement (ENEA Frascati 2002)



Measuring the D/Pd ratio at 150 K as a function of pressure. The sample is roughly 10 mg of Pd, in a film 3 μm thick. It took almost a month to perform the measurement.

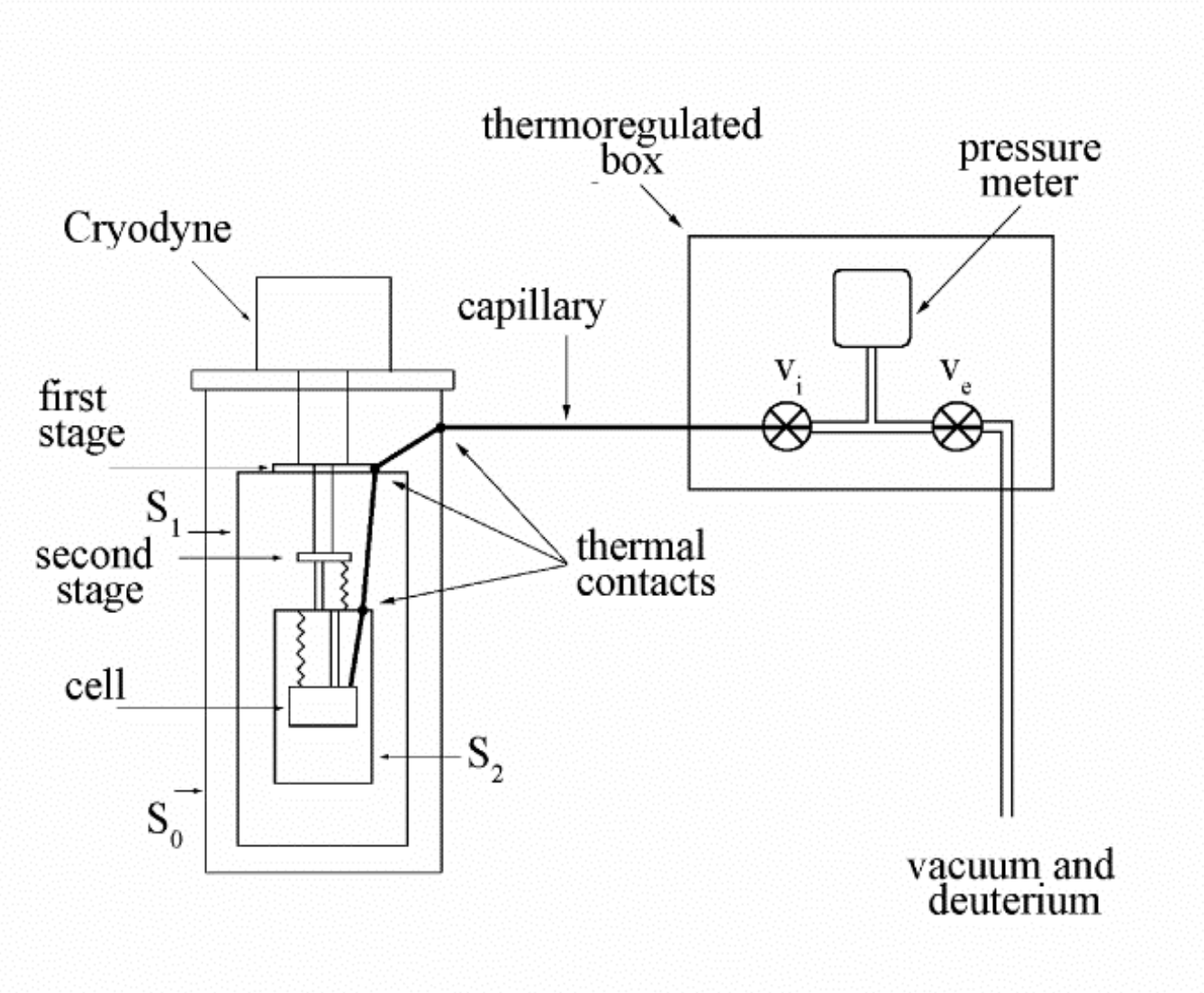
F. Scaramuzzi, **Gas loading of deuterium in palladium at low temperature**, Journal of Alloys and Compounds, 385, 19 (2004).

Objectives of the experiment

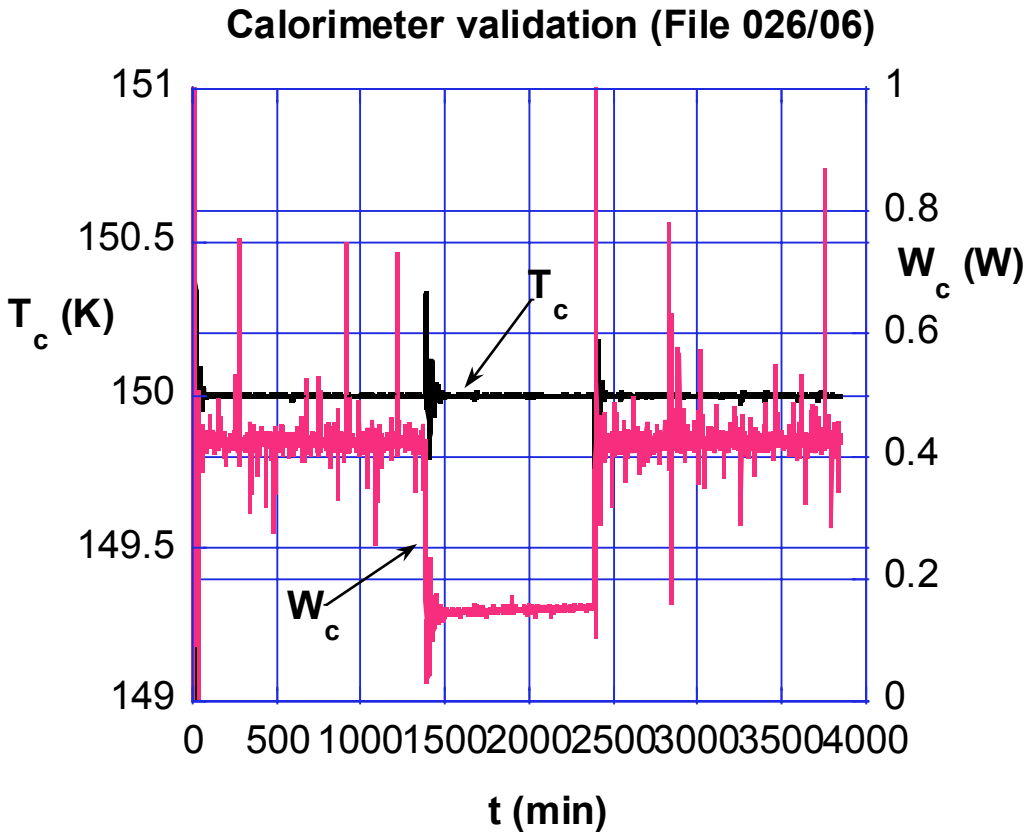
The idea is to realize a conceptually simple experiment, reproducible, and with a straightforward answer:

- To start with, measuring the D/Pd ratio, aiming to high values.
- Possibly detecting excess heat.
- Analyze the gas, looking for ^{4}He.
- Studying the loading dynamics.

The apparatus



Calorimetry



Shield S_2 and cell are thermoregulated. $T_c > T_s$. The power used to keep ΔT is monitored: it is the calorimeter.

The samples

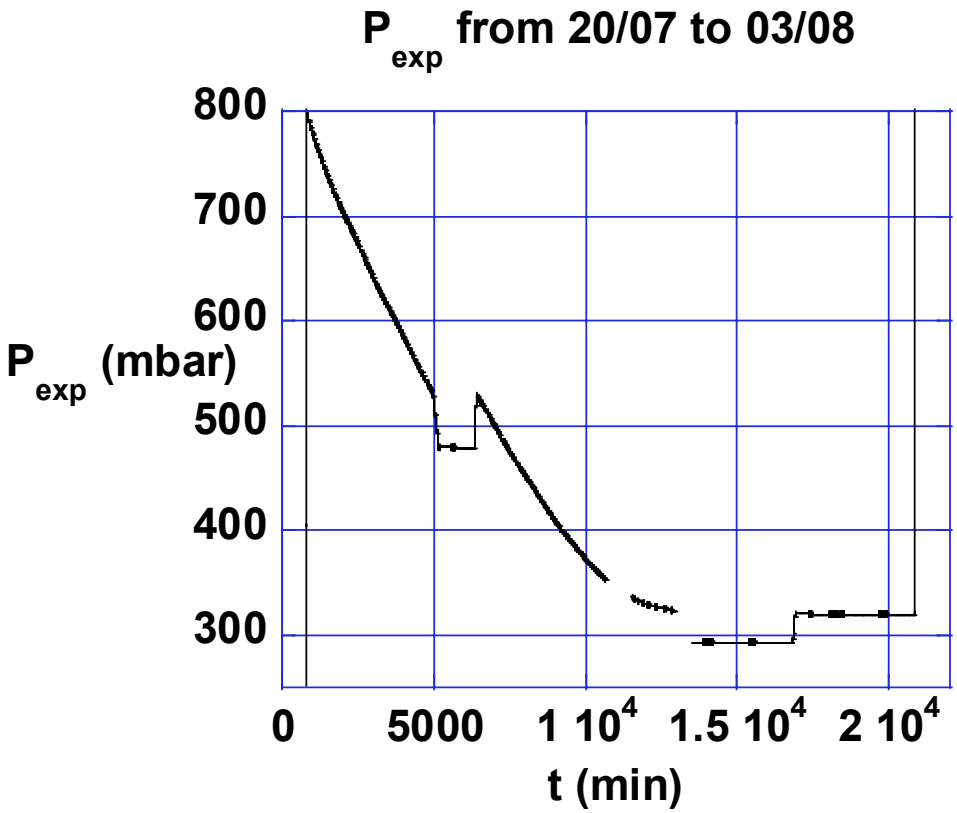
Three types of sample have been used:

- the film shown before (3 μm thick);
- sample from Vittorio Violante (50 μm thick):
- sample obtained by syntherizing Pd powder (< 1 μm).

The most promising is the first: there is a chance that more samples will be realized in a cooperation with NRL (Dr. David Knies).

The syntherized sample looks unsatisfactory: the use of nanoparticles is a very interesting perspective: a possible cooperation is been considered.

A recent result from a 50-μm thick sample of Vittorio Violante: the pressure as a function of time is reported (T = 250 K)

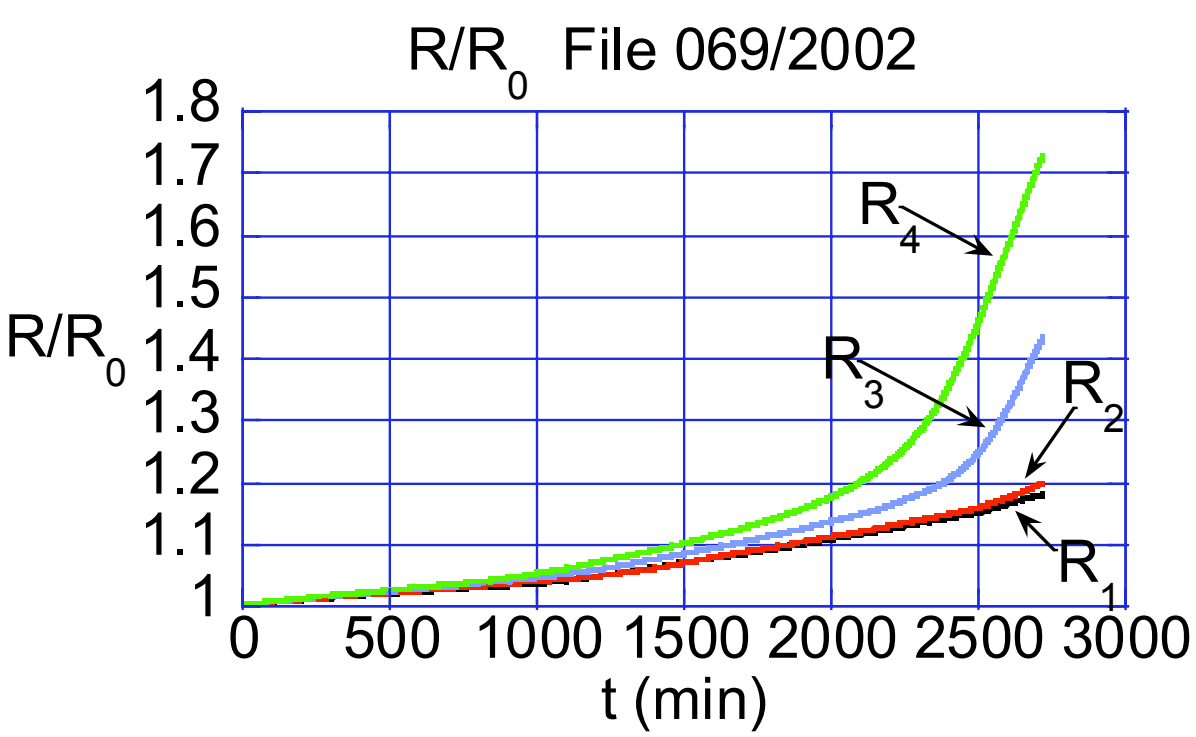


The loading ratio evaluated at the end is D/Pd = 0.70. It is possible that close to the surface it is higher. No heat excess detected.

Loading Dynamics - 1

- The geometry of the first sample allows measuring the electric resistance of each section independently, as a function of time, loading ratio, temperature.
- This has been done, keeping also in mind the “Preparata Effect”.
- The results are quite interesting, but presently rather poor. New samples and new tests are needed.

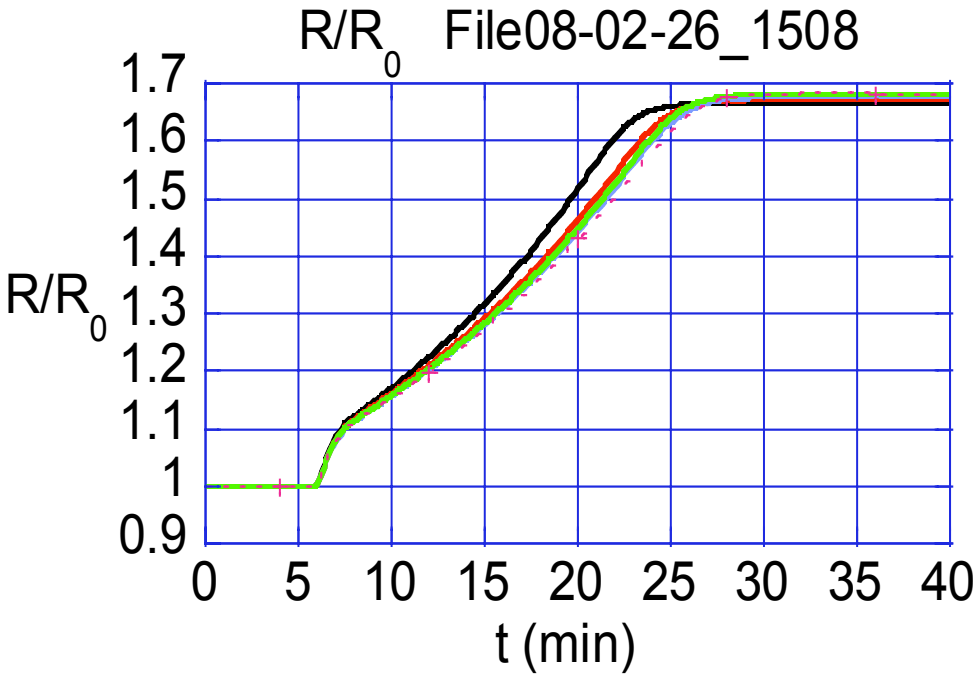
Loading Dynamics - 2

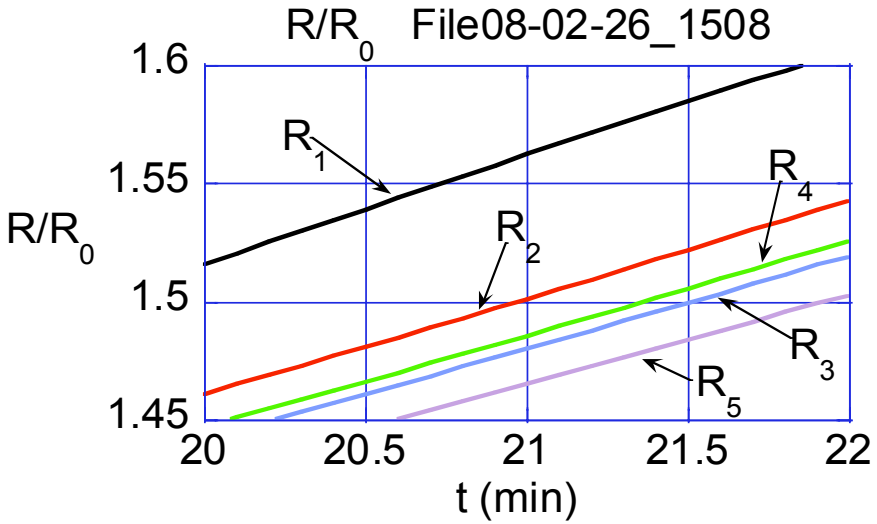


	R/R$_0$	D/Pd
R$_1$	1.18	0.13
R$_2$	1.20	0.14
R$_3$	1.42	0.29
R$_4$	1.75	0.52

The 2002 experiment. T = 150 K. R$_5$ was broken after 1 day. R$_1$ is the most positive, R$_4$ the most negative. The time interval is 2 days. In the table the loading ratio.

Loading Dynamics - 3





An “old” (5 years) sample at room temperature. R_5 is the most positive, R_1 the most negative. In the long term differences are smaller.

Acknowledgements

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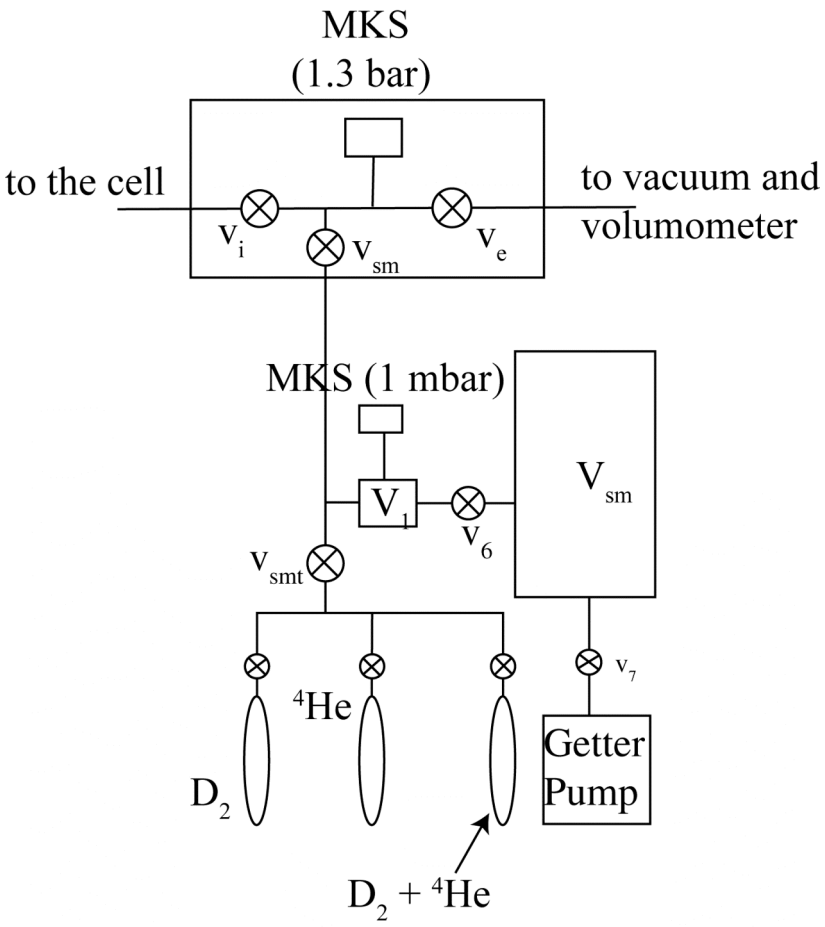
- The Author is grateful to his colleague and friend Ivo Modena for continuous scientific support in the conduction of the experiment.
- He thanks warmly Arturo Moleti, Alessio Rocchi and Filippo Sanjust, who took care of the LabView data acquisition system.
- Thanks are due to ENEA and to Alberto Clozza and Angelo Viticchié for procuring valuable instrumentation.
- The experiment would not have been possible without the skillful help of Franco Campolungo, Mauro Iannarelli and Lorenzo Martinis: also to them goes the Author's gratitude.

The system for the detection of ^4He



Not completed

The apparatus