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Research Article

Abnormal Absorption of Hydrogen in Nickel at Ambient Temperature With Associated Emission of Neutrons

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Abstract

While it is known that nickel at a temperature of a few hundred degrees if in hydrogen can slowly absorb a certain amount of this gas, there is no evidence that this can occur at room temperature and at pressures below 1 bar. On the contrary, by conducting studies and experiments on LENR anomalies in the ARGAL laboratory in Bareggio, Italy, it has been experimentally verified several times that nickel in the form of wire, thin ribbon, foam, if properly covered with a thin layer of palladium, can absorb hydrogen in considerable quantities even at room temperature. Very often the neutron monitoring always active in the lab and close to the active reactor showed a significant rise in the background counts with two distinct peaks in the distribution of n / h (neutrons per hour) as will be better described in the following experiment description.
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Keywords: Nickel, palladium on nickel, neutrons, neutron peaks, room temperature

1. Introduction

The ARGAL laboratory in Bareggio is equipped with several reactors to make experiments on LENR anomalies. The configuration used in the experiments that we are going to describe is depicted in the Figure 1 below.

Reactor 1 consists of a steel chamber with a volume of 290 cubic centimeters inside which is a glass tube wrapped with a resistor that serves as a heater, the material to be tested can be housed in the tube. A Pt100 in contact with the material allows us to follow the trend of its temperature on a PC. We also have a thin film Palladium resistance that allows to check if we have hydrogen or deuterium inside the reactor.

In the figure 3 it is represented the scheme for detecting the pressure inside the reactor. Pressure is the most important parameter for controlling the absorption of hydrogen by the sample [1], [2]. For this purpose we have a piezoelectric sensor that measures the pressure and an interface that displays its value and is connected to the computer that controls the experimental parameters.

Figure 4 is a screen shot showing the most important parameters that allow to follow the progress of the experiment. In particular we have three windows which display the parameters over time, in the top left we have two parameters: the

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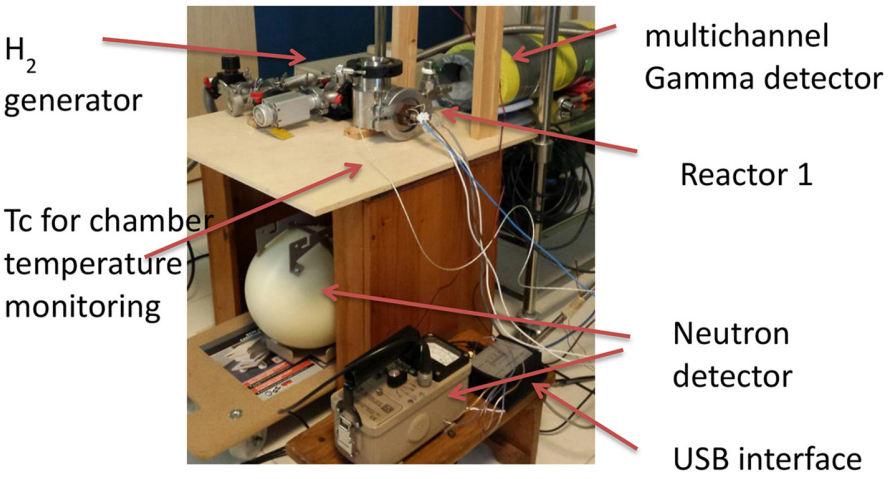

Figure 1. Experiment setup.

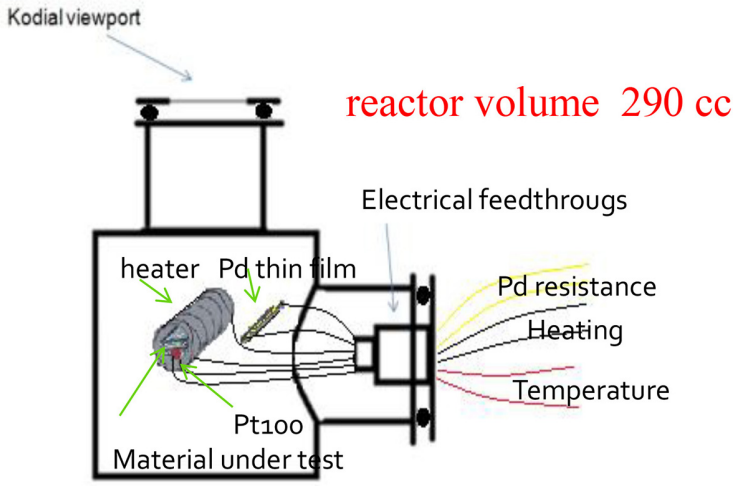

Figure 2. Reactor R1 sketch.

power sent to the heater and the temperature of the sample, in the top right window we have the ambient temperature and the reactor temperature, then in the bottom right window we have two important parameters which are the value of the thin film Palladium resistance which allows to know if we have the correct gas inside the reactor and then the pressure trend inside the reactor. The pressure is the most important parameter for checking absorption.

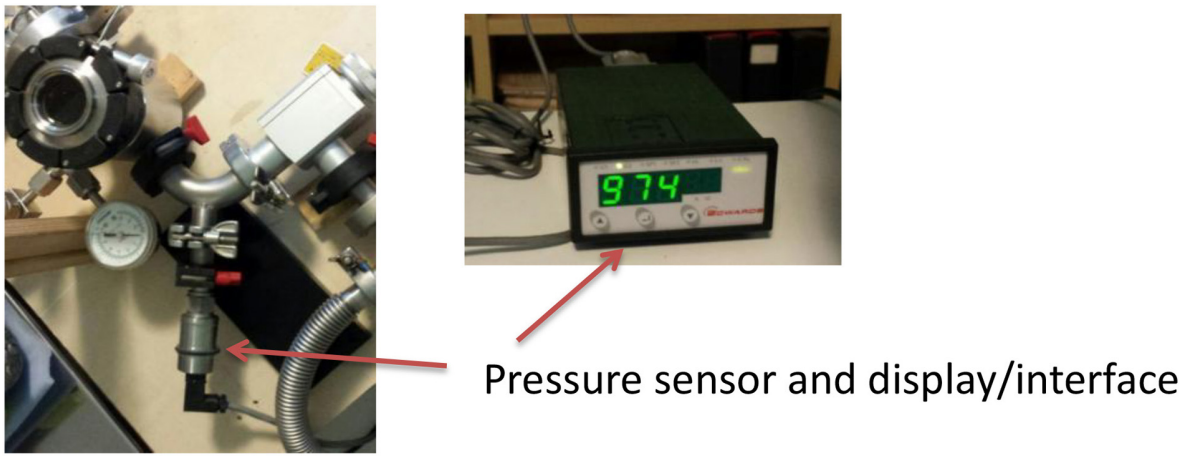

Figure 3. Setup for the pressure measurements.

2. The Material

The sample under test was a nickel strip with a deposit of about 200 nm of Palladium on both sides by electroplating. The deposit was made in the ARGAL laboratory with a solution of Palladium chloride and lithium chloride by placing the nickel strip on the cathode of a small elctroplating cell. To prepare the sample for deposit I used a mechanical action with a diamond file followed by cleaning with pure ethyl alcohol.

The deposit was calibrated for a thickness of about 200 nm and the aspect was similar to those reported in codeposition experiments

Weight of Ni sample 0.63 gr. The sample was folded several times to be able to introduce it into the glass tube on which a heating resistor is wound. Heating was used in the degassing phase of the material under vacuum before introducing hydrogen. Then the absorption experiment continued at room temperature, which remained fairly stable around 22 degrees centigrade.

3. Absorption Test Results

The graph in the figure 6 shows a clear absorption of the H_2 introduced into the reactor at a pressure of 315 mbar. In about 2 hours and 30 minutes the pressure dropped to 147 mbar.

The black curve illustrates this trend.

Taking into account that the absorption of H_2 by the small amount of palladium deposited on the nickel would have been able to make the pressure drop by about 3 mbar, it is evident that the reduction in pressure is mainly due to H_2 absorption by the nickel. The red curve indicates the increase of a thin film palladium resistance always into the reactor as presence of H_2 or D_2 monitor.

The graph in the figure 7 shows a clear absorption of the H_2 by a different sample in the same reactor R1.

Here the black curve illustrates this trend, and the red curve indicates the increase of the thin film palladium resistance that is in the reactor as a monitor of the presence of H_2 or D_2 in it.

The volume in liters of the absorbed gas is obtained multiplying the ratio between the delta pressure and the standard pressure at ambient temperature by the volume of the reactor.

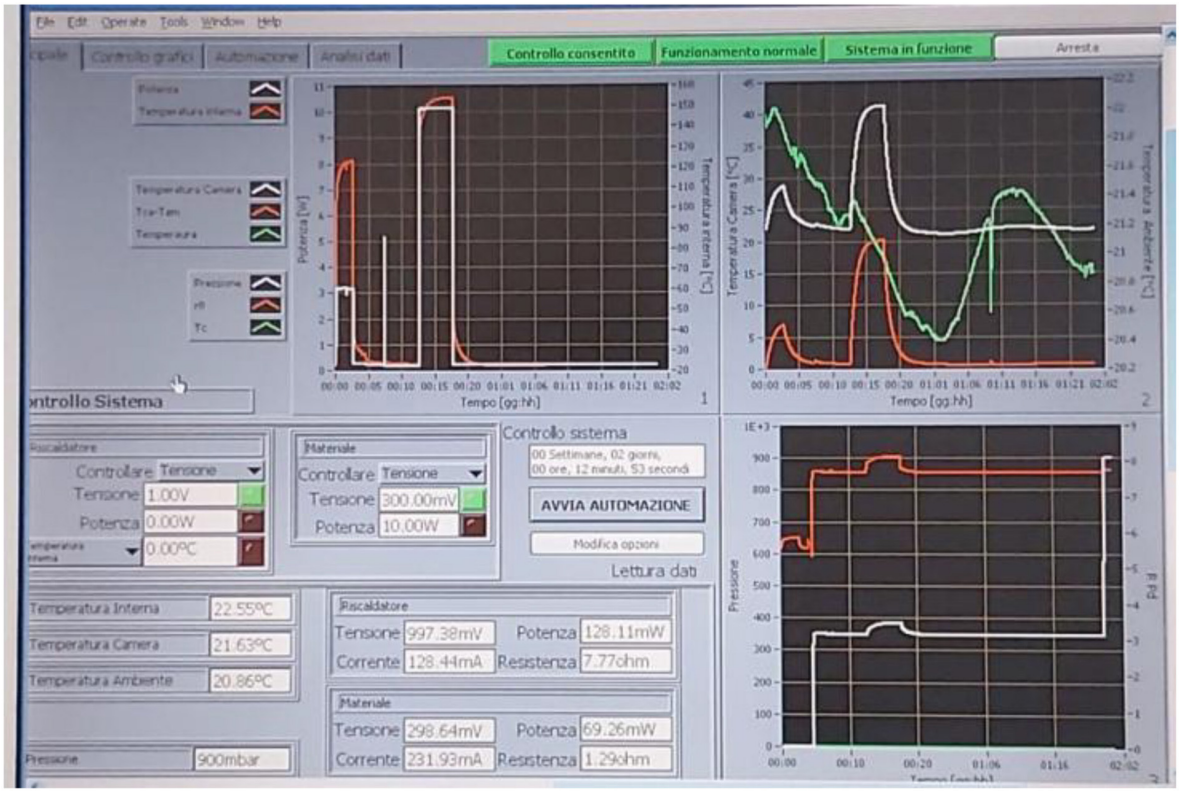

Figure 4. Screen shot of the LabView program controlling the reactor parameters.

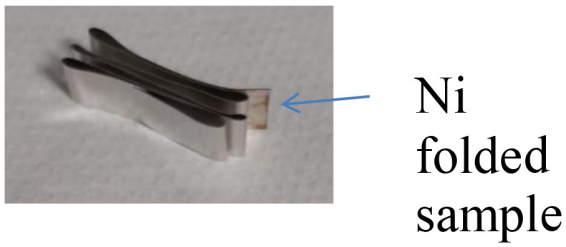

Figure 5. The sample folded to be adapted to the heater support.

Then the ratio between this volume and the standard volume of one mole of gas gives the H_2 absorbed moles. Dividing the H moles by the nickel moles gives the <H/Ni> ratio.

After the first absorption a hydrogen refill brought the pressure to 0.91 bar and after the second absorption to 0.981 bar. Here below the description of the adopted procedure.

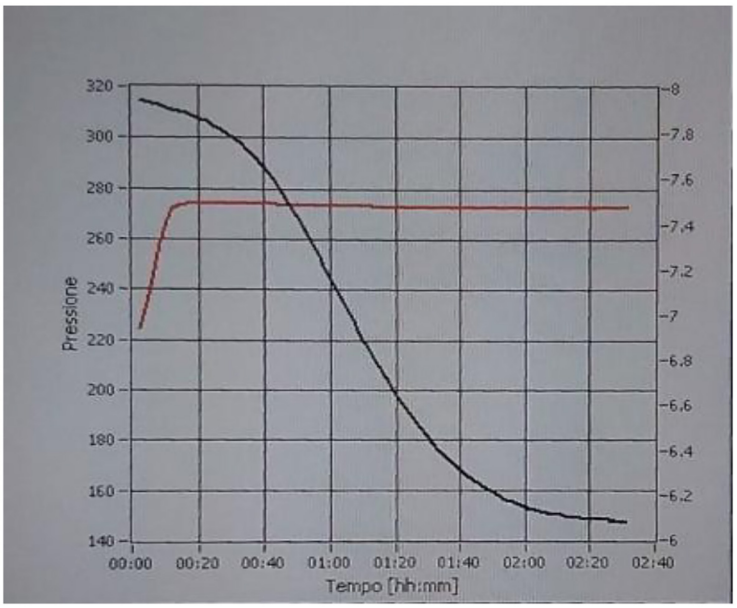

Figure 6. Pressure behavior when the reactor is filled with Hydrogen.

Table 1. Numerical data for absorbed Hydrogen moles calculation

Delta press. 1 (0,315 bar to 0,147 bar); Delta press. 2 (0,91 bar to 0,836 bar); Delta press. 3 (0,981 to 0,968 bar);
$(((0,315-0,147)/1,013)*0,29)/24,22+(((0,91-0,836)/1,013)*0,29)/24,22+$ $(((0,981-0,969)/1,013)*0,29)/24,22$
First absorption Second absorption Third absorption

Table 2. From absorbed moles to Hydrogen to Nickel atoms ratio

H2 absorbed moles	H moles	Ni moles	H/Ni ratio
0.0030	0.0060	0.0107	0.56

For the calculation of the absorbed moles we used the following procedure for each absorption phase: the difference between the initial and final pressure (ΔP) is divided by the pressure value (here we indicate with Ps) at which one mole of gas occupies 24.22 liters at 22 degrees centigrade (we denote this volume by Vs), then we multiply the result by the reactor volume (we denote this volume by Vr) and divide the obtained value, which represents the part of the reactor volume absorbed, by the volume of one mole of gas and we will have as a result the moles of H2 absorbed. By repeating the procedure for each absorption phase and adding together we will obtain the total amount of moles absorbed. The summary formula is:

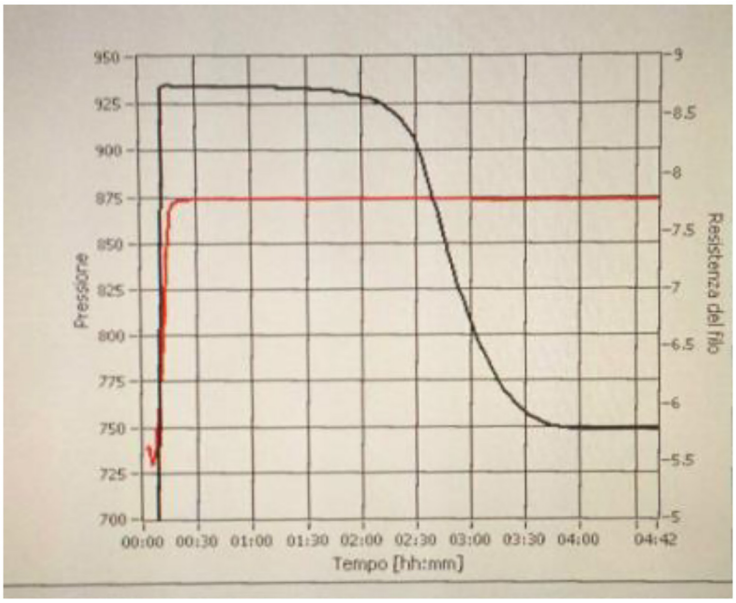

Figure 7. For another sample in a previous test the absorption started 2 hours after filling Hydrogen into the reactor.

4. Neutrons Measurements

The ARGAL laboratory in Bareggio is continuously monitored nearby the reactors by a Helium3 neutron detector (Ludlum) and with a Multichannel detector (Ludlum) with a 3" sodium iodide scintillator for gamma radiation [3].

In particular, for neutrons monitoring, is used the Ludlum 12-4 neutron meter detector. This detector is interfaced to a PC that uses a LabView program to record the events reported by the detector. The acquisition program records the data in two different modes, one in the form of events (counts) as a function of time (Figure 8), indicating the number of counts every minute (left axis) and every hour (right axis); then in a different screen (Figure 9) the normalized histogram for counts every hour. The program performs an acquisition for 8000 minutes, followed by a reset and the beginning of a new acquisition. The data of each complete acquisition are stored in a remote hard disk for any subsequent analysis.

The graph of figure 8 shows how it is changed the pattern of neutrons counts after the reactor was filled with Hydrogen.

The duration of the monitoring was 65 hours and up to the 33rd hour indicated by the yellow line the reactor had been kept under vacuum.

In the figure 8 the neutrons per minute are plotted as isolated dots while the neutrons per hour are plotted with dots united by the white line and it is clearly seen that at a certain point when hydrogen was introduced into the reactor the number of neutrons every hour is significantly increased as will be better shown in the histogram of figure 9.

During the absorption test, the neutron/hour counts showed an increase of about 80%.This situation has also been verified several times with samples having similar structure. So, in the neutron/hour histogram in figure 9 above on the left there are two distinct data populations, while for a reactor without hydrogen the neutron/hour histogram, in figure 9 on the right, get from a blank experiment, basically overlaps the background.

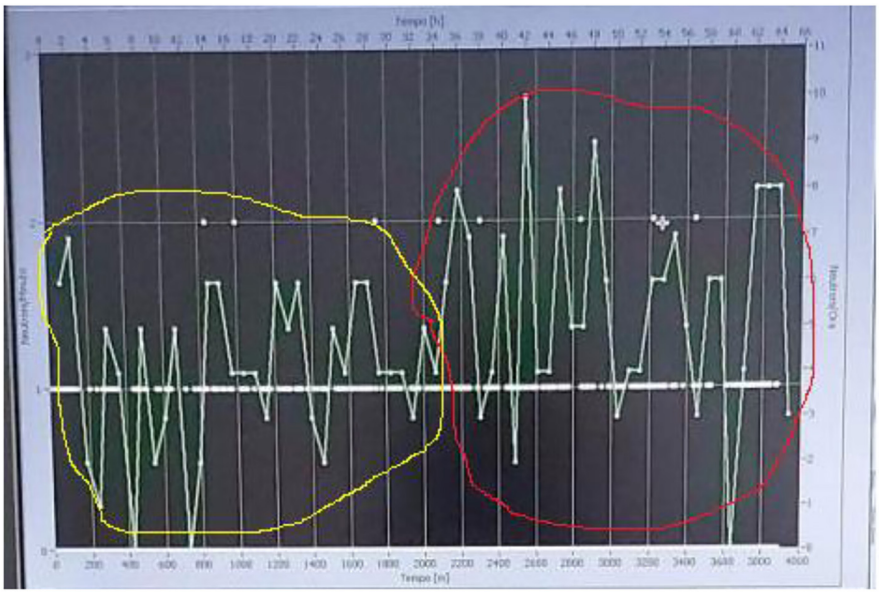

Figure 8. neutrons per minute and neutrons per hour trend. Into the yellow line the counts when the reactor was maintained in vacuum; into the red line when the reactor was filled with Hydrogen.

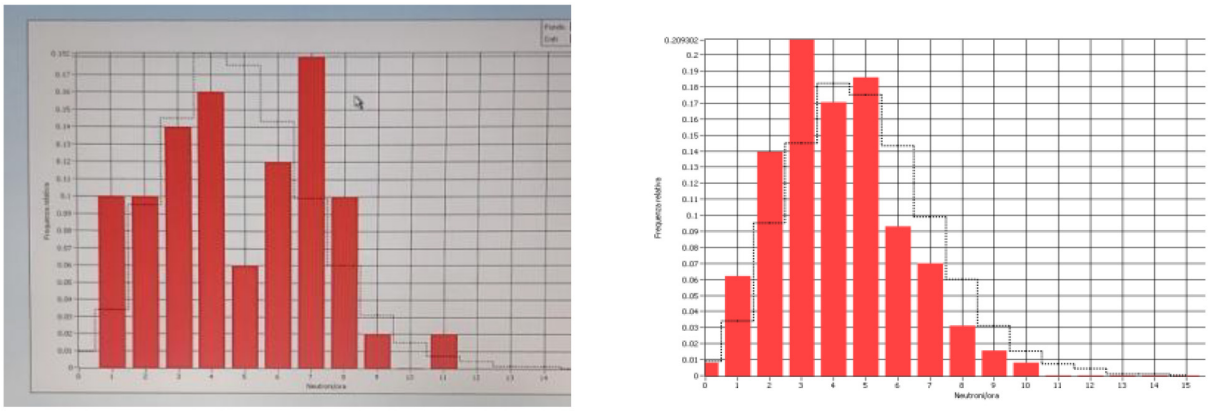

Figure 9. Neutron histogram during the experiment (left) and a typical background neutron histogram (right).

The production of neutrons showed peaks during the absorption phase, but a neutron emission in similar tests was seen to continue as long as hydrogen or deuterium remain in the reactor, as shown in the paper related to the iccf22 proceedings [4].

5. Final Remarks

In previous experiments the ability of nickel samples on which a thin layer of palladium was electrodeposited to absorb hydrogen even at room temperature in considerable quantities was verified several times, using nickel foam and nickel thin wires samples.

Once more the unexpected ability to absorb hydrogen at room temperature of such kind of structure, was verified on a different nickel sample: in particular a strip of 12 cm^2 of surface and 0.15 mm thickness.

In the specific, the pressure decrease at the end of three successive phases of absorption has been about 254 mbar (72 cc in volume of H_2 for a reactor volume of 290 cc), such as to bring the ratio between hydrogen and nickel atoms to a value around 0.6, despite the fact that the deposition of the palladium was not particularly uniform.

Neutron emission was associated to hydrogen absorption and was clearly detectable not only during the absorption phase, which lasted several hours, but also the entire time the sample remained in hydrogen atmosphere after the absorption phase.

References

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