Further progress/developments, on surface/bulk treated Constantan wires, for anomalous heat generation by H_2/D_2 interaction

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Outline and motivations

1) **Proof, by calibration experiments with Pt wires (different diameters, gases, pressures, power applied), that main results obtained on 2012 with surface-treated Constant wires, were right. We focused on not-dependence of Anomalous Heat Effects (AHE) on pressure variations inside the transparent glass reactor: *reconfirmed and reinforced previous calibration data (June 2012) using He*.**

2) **Evidence of unexpected *water splitting phenomena*, under vacuum, by "*nanodiamandoids*-coated" Constantan.**

3) **Evidence of correlation between Resistive Thermal Coefficient (RTC) and resistance ratio (R/Ro), i.e. H loading of Constantan. Measurements at T=77-293K (by LN2) and 20-280°C.**

4) **Evidence of AHE under vacuum (no gas pressure effects) and different surface treatments on the same wire, varying also the mean local wire temperatures by different power applied. Comparison with Pt.**

5) **Big efforts to develop a procedure to get some AHE even with Constantan wires of poor-quality or damaged: FOUND. Key result: AHE depend on FLUX, any direction, of H. Same result found by NASA on Dec. 1989 with Pd-D system at T> 300°C. M.M. Kubre formula (1994), on Pd-D system, including flux for AHE, seems ok.**

6) **Conclusions and next scientific steps toward applications.**

Some key points presented at ICCF17 (2012)

The Constantan has extremely large values of measured catalytic power (ΔE, in eV) in respect to the dissociation of H_2 (Ref. 1), as following:

$Ni_{0.3750}$-$Cu_{0.6250}$ ==> +3.16eV

$Ni_{0.6250}$-$Cu_{0.3750}$ ==> +2.86eV

$Ni_{0.8125}$-$Cu_{0.1875}$ ==> +2.10eV

Ni ==> +1.74eV

$Ni_{0.1825}$-$Cu_{0.8175}$ ==> +1.57eV

$Ag_{0.8125}$-$Pd_{0.1875}$ ==> +0.57eV

$Ag_{0.625}$-$Pd_{0.375}$ ==> +0.51eV

$Ag_{0.1875}$-$Pd_{0.8125}$ ==> +0.51eV

Pd ==> +0.42eV

Cu ==> -1.11eV

Ag ==> -1.42eV

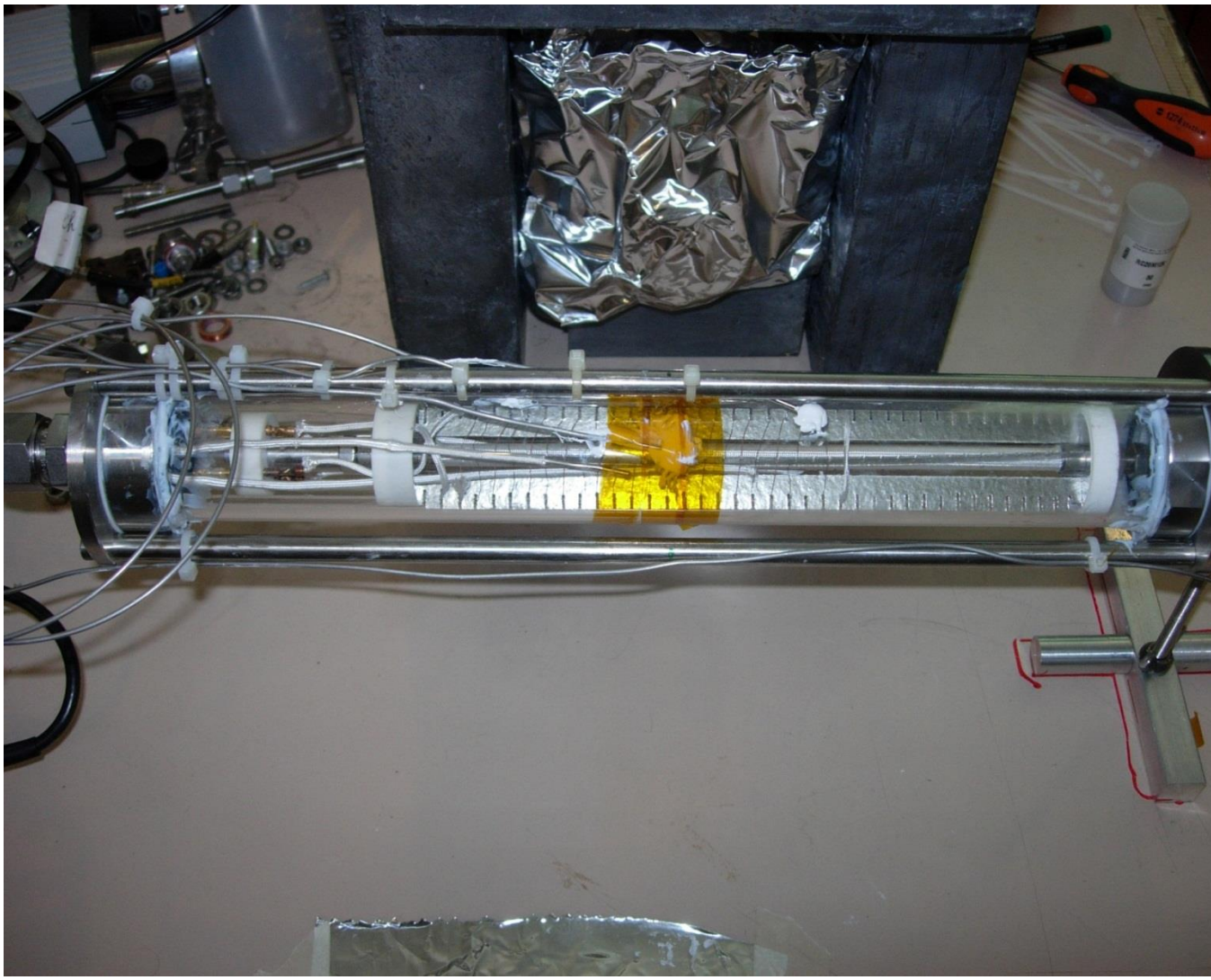
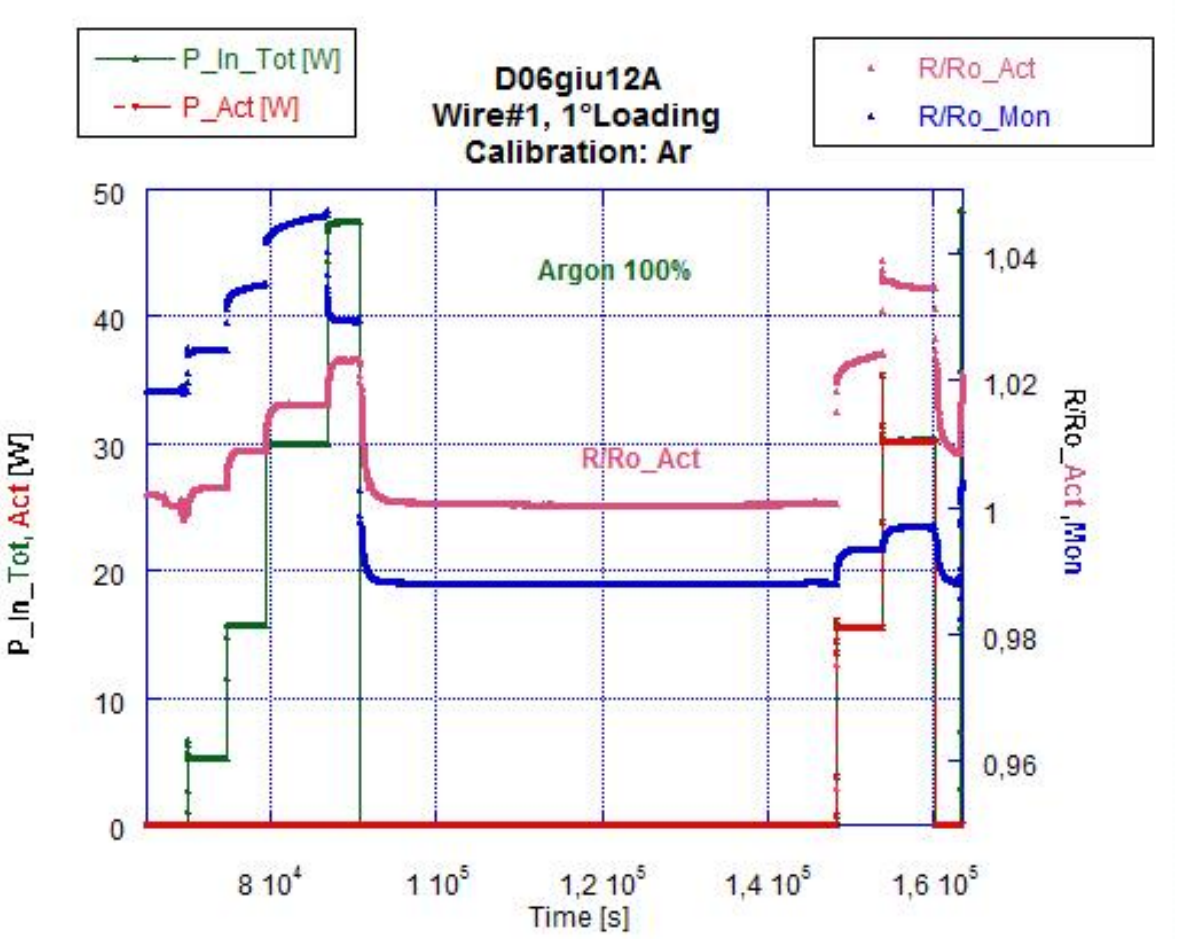
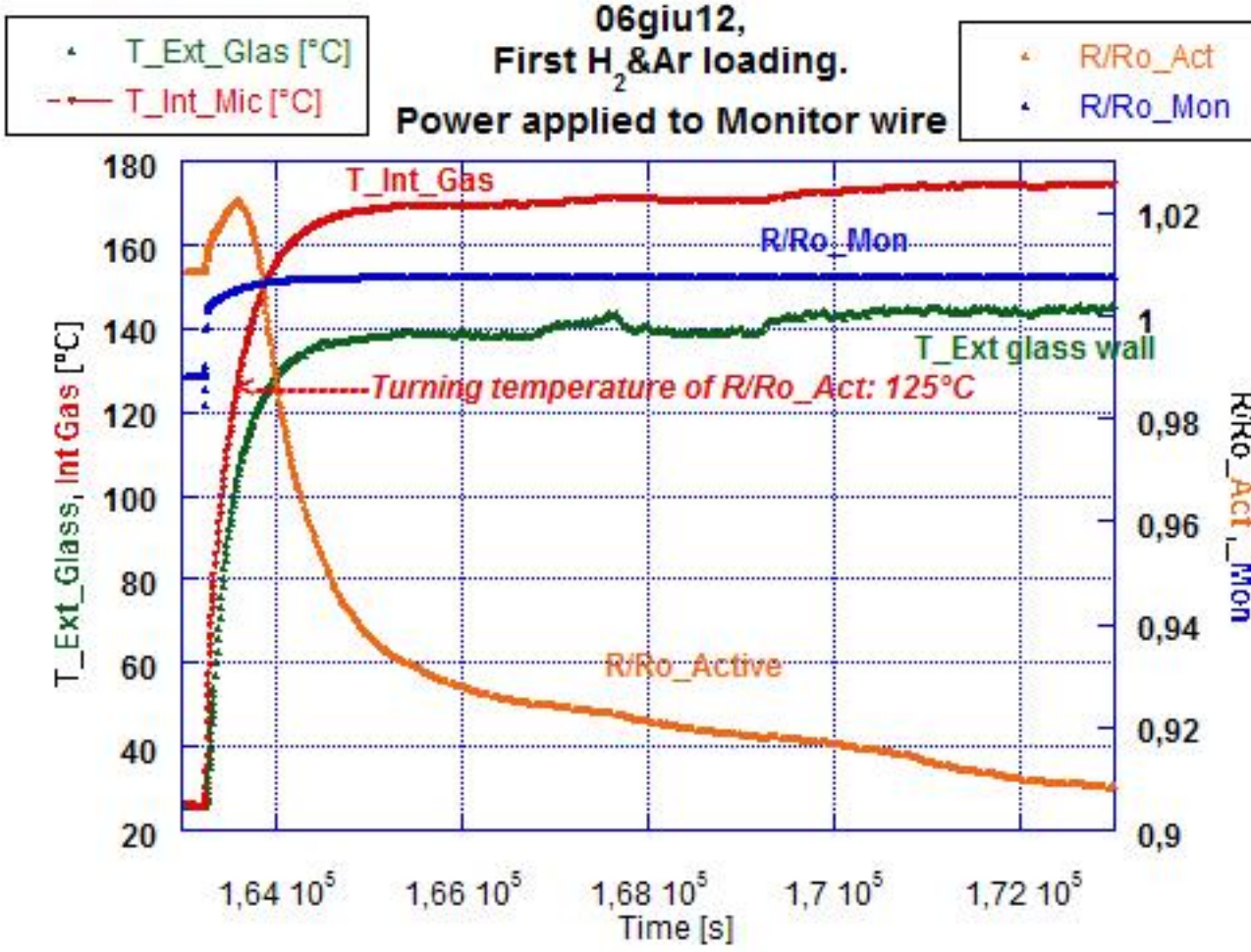


PHOTO OF THE SMALL, DISSIPATION TYPE, TRANSPARENT REACTOR OPERATING AT INFN-LNF. THE VOLUME IS ABOUT 250CC.

THE 2 WIRES, REFERENCE AND ACTIVE, ARE ROUNDED ON A MICA SUPPORT. THE THERMOCOUPLES ARE TYPE K, SS SCREENED (DIAMETER 1.5MILLIMETER).

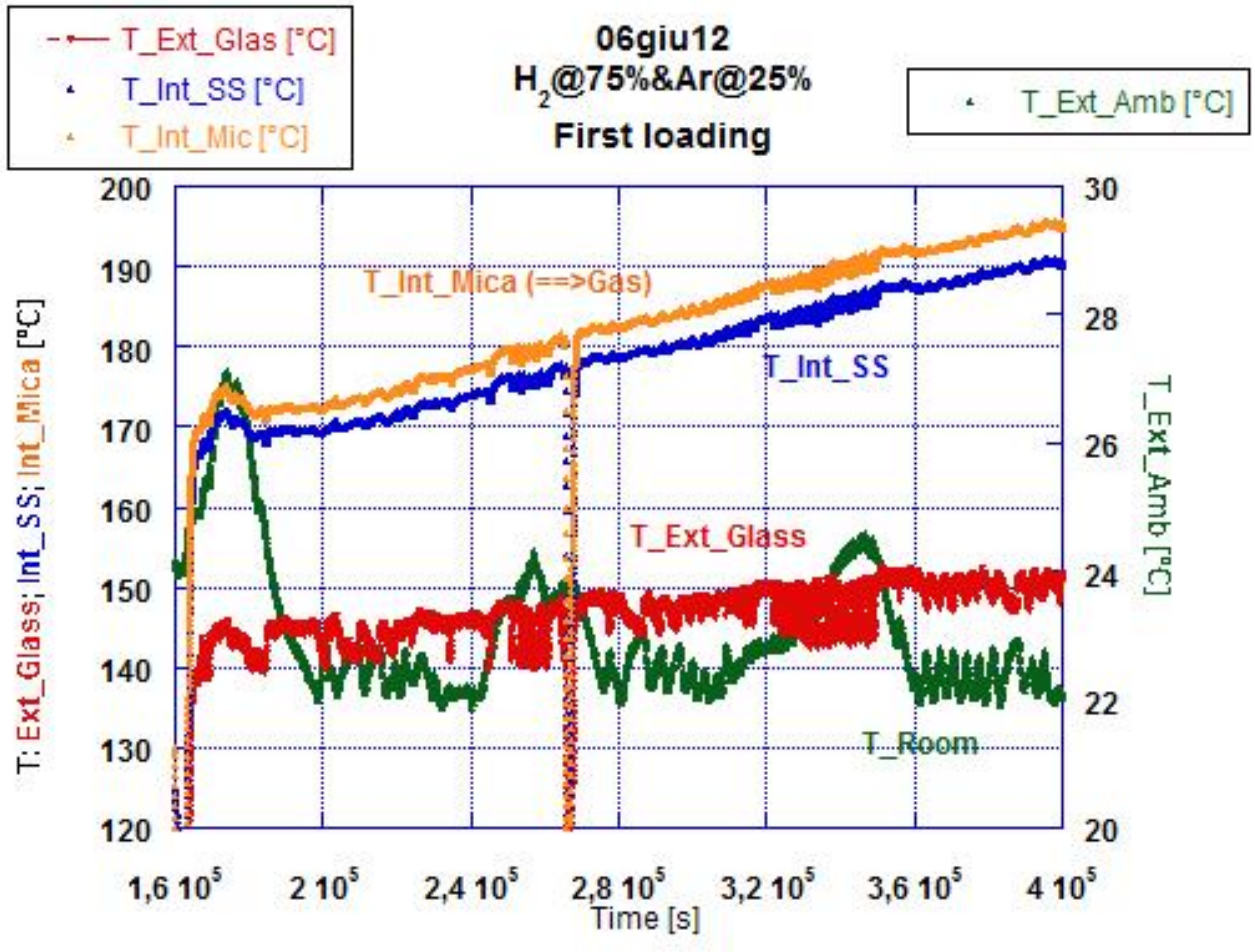


- **Calibrations by Argon. Power, up to 48W, at Reference wire (Ni-Cr).**
- **Maximum power at sub-micrometric Constantan wire was limited to 30W: precaution against very deleterious sintering problems of nano-sized particles under pure noble gas.**
- **The R/Ro, of both wires, just slightly increased (as expected), increasing the temperatures.**



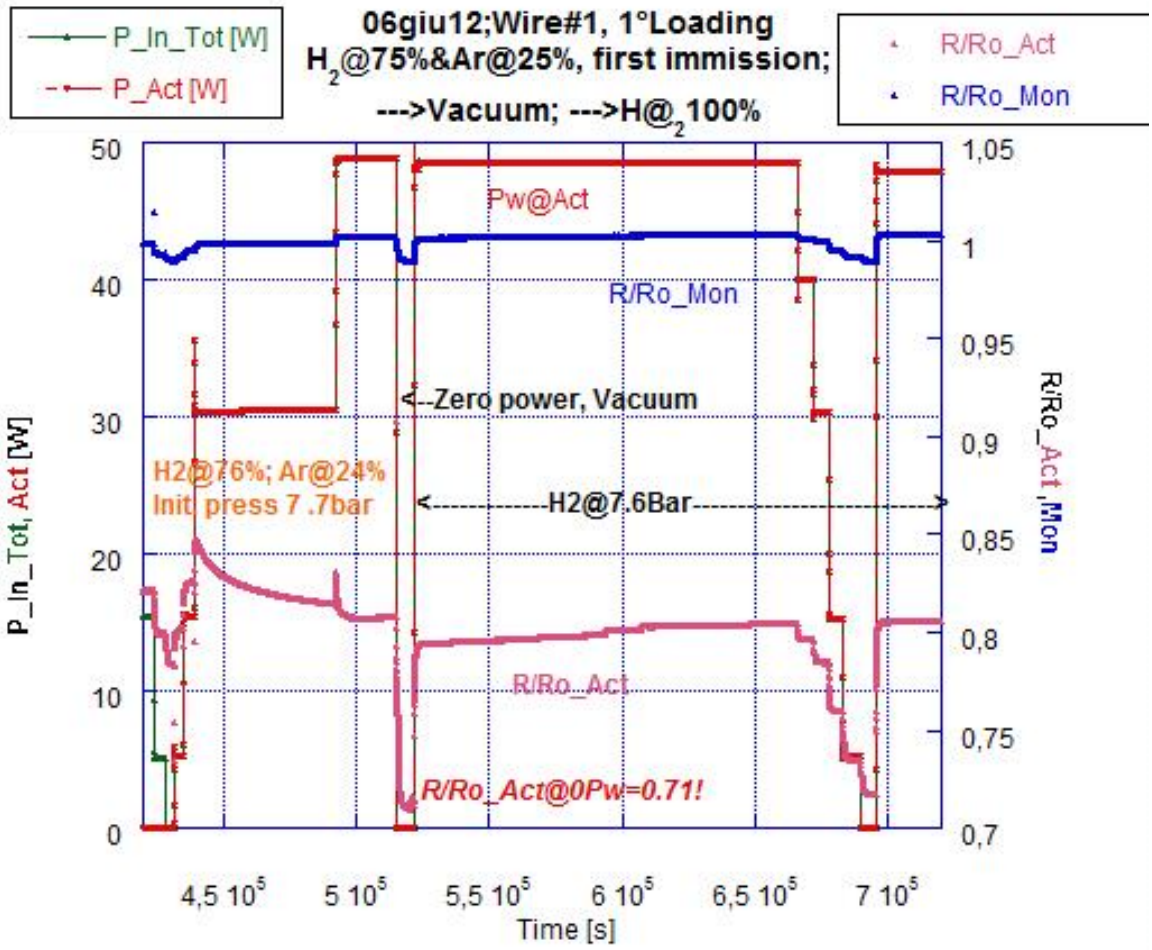
- **Details of first loading by H_2-Ar mixture.**

The "trigger" temperature, to get the large resistance decrease of sub-micrometric Constantan wire, was about 125°C. Temperature measured by a type K thermocouple (SS sealed) inside the gas cell.



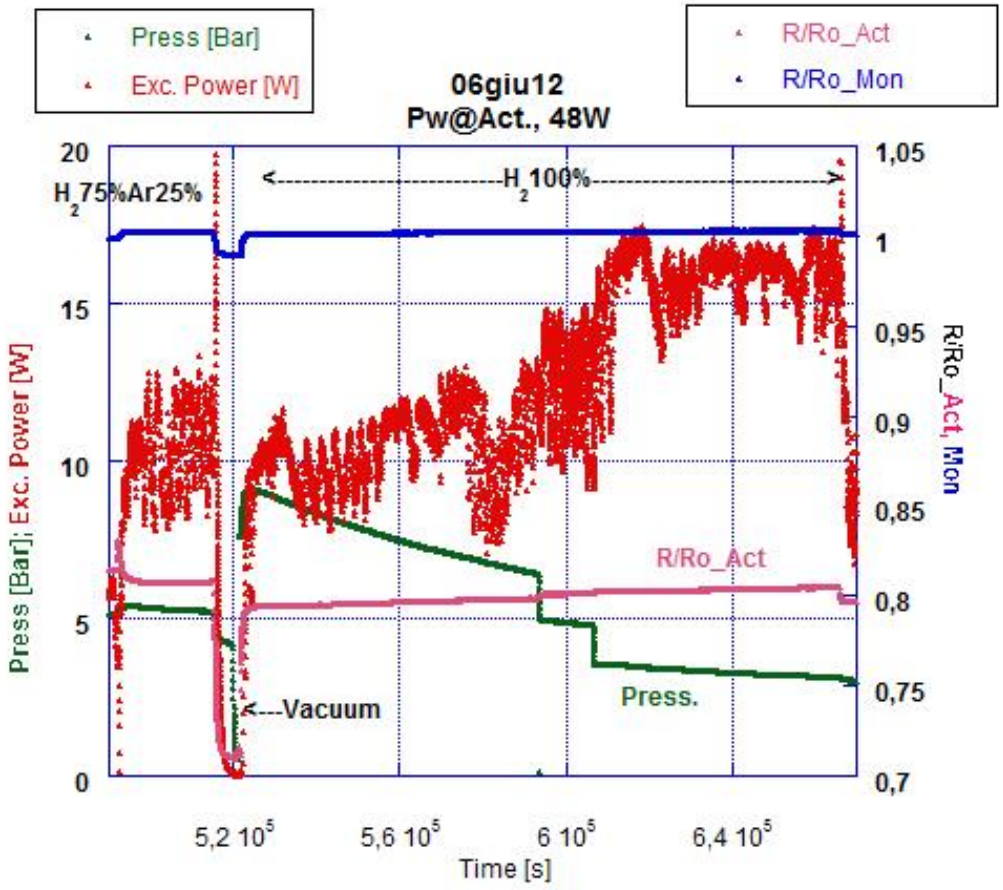
Behaviour of the temperatures of the reactor, at CONSTANT input power (48W at Mon. wire).

Flowing the time, BOTH the external glass temperature (140→150°C) and the 2 internal (Gas, 170→195 °C; "Stainless Steel", 168→190°C), increased. *The effect was not directly related to room temperature variations, altough such temperature variation helped to get not-stationary conditions.*



Behaviours of R/Ro changing: a) power applied from Mon. to Act. (time 420→520ks); b) Vacuum and no power (515→521ks); c) Gas changed from H_2&Ar to H_2 (at 100%) and power applied to Act.

After direct heating to Act., at the end of switch-off time (521ks),the R/Ro_Act dropped to only 0.71!



Experiment with power (48W) applied to Active wire. Up to time 518ks the gas mixture was H_2/Ar at 75/25 ratio. Later on, the power was reduced to zero and made vacuum: R/Ro was as low as 0.71. From time 522ks was added pure H_2: the excess power resumed the value before vacuum and, after controlled reduction of pressure, increased up to 16W.

NB. The excess power increases with lowering the gas pressure.

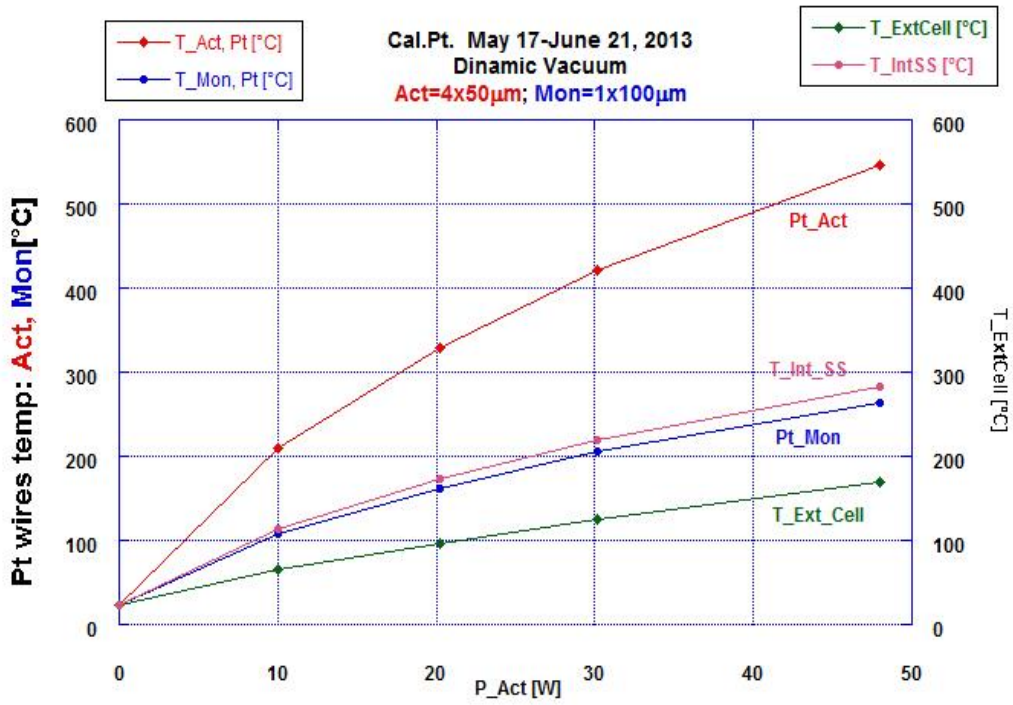
Main results/comments on Pt wires measurements

a) Were used 2 wires, l=100cm: a1) made by assembling, in parallel, 4 wires with Φ= 50μm (almost equivalent to 200μm, called Active); a2) with a single wire of Φ=100μm (called Monitor). i.e., similar resistances.

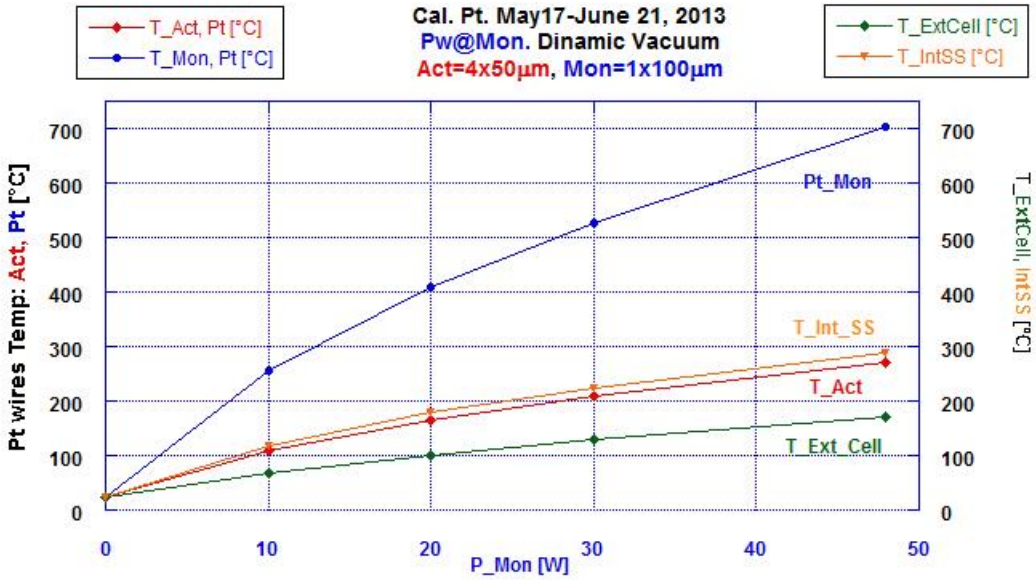
b) The behavior of mean local wire temperatures, changing the power applied, were as expected changing the wire diameters: higher temperatures on thinner wires.

c) The behavior of local wire temperatures, changing the gas used (H_2, He, Vacuum), were as expected: higher temp. into less conducting gas, i.e. vacuum (thermal conduction, apart local contacts with mica supports, mainly by irradiation).

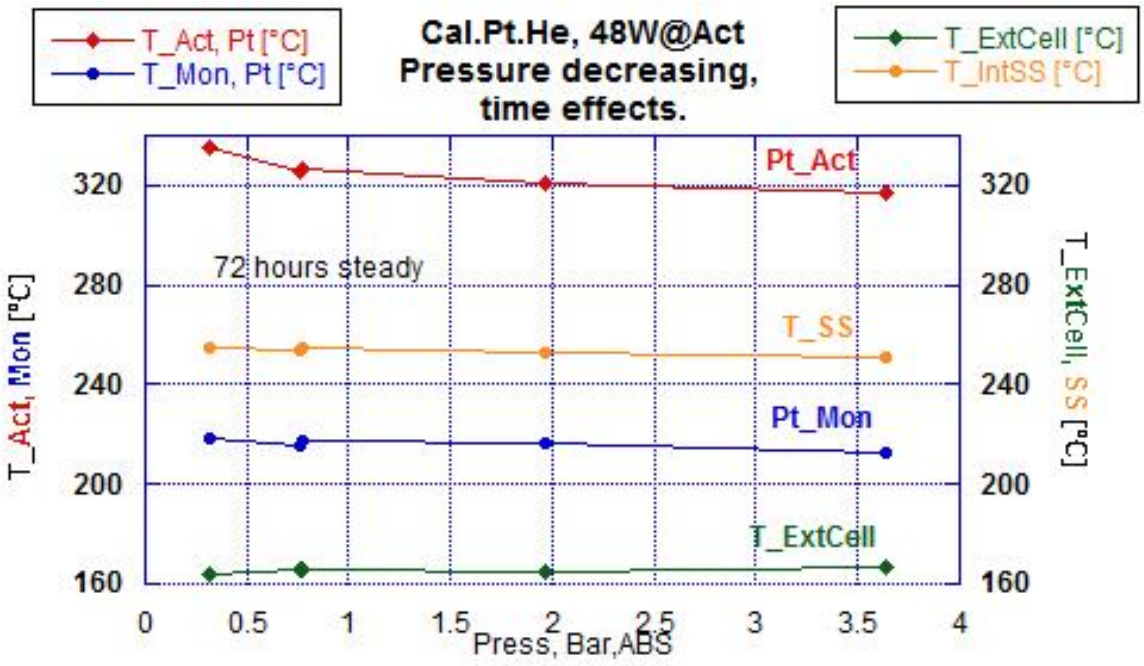
d) The effects on temperatures internal and external (used to calculate the anomalous excess power), if any, were as expected changing the pressures. I.E. reducing the pressure, under He, the internal chamber temperature increased and the external decreased. *Such result is the reply, fully experimental, to main critics on our previous experiments (June-December 2012) with Constantan and Hydrogen: in such specific conditions BOTH internal and external temperatures increased reducing H_2 pressures.* As a simple consequence, the experiments were right.



Pt wire, Pw applied to Act wire. Measurement of mean Pt wire temperature by resistive thermal coefficient values. Cross-ceck by visual observation, color, at higher powers: only limited wire sections start light-red colors.



Pt wire, Pw applied to Mon wire. Measurement of mean Pt wire temperature by resistive thermal coefficient values. Cross-ceck by visual observation, color, at higher powers: starts red color almost uniform.

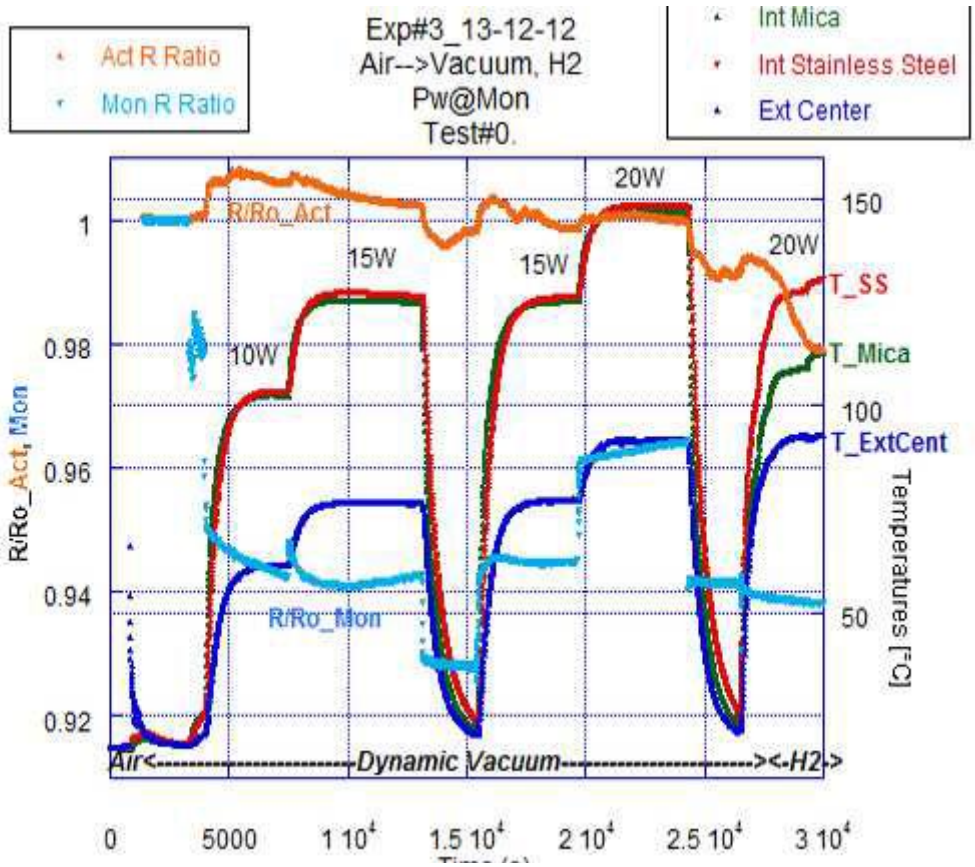


Pw at Pt_Act., 48W. He atmosphere. Effect of pressure variation on Pt_Act and Pt_Mon. temperatures: they increase as the pressure decreases. Also The internal cell temperature (T_SS) increases. Only the External Cell (ExtCell) temperature (green color) decreases.

Such value is used to evaluate the power produced inside the cell, both by the Stefan-Boltzmann low (proportional to T^4) and by simple linear calculation:

(T_extCell-T_Room)/P_in [°C/W].

Both the calculations method adopted gave similar results.



Time (seconds)

First experiment with 2 Constant wires, one with 2 layers (pale blue color) , the second with 360Layers (brown color).

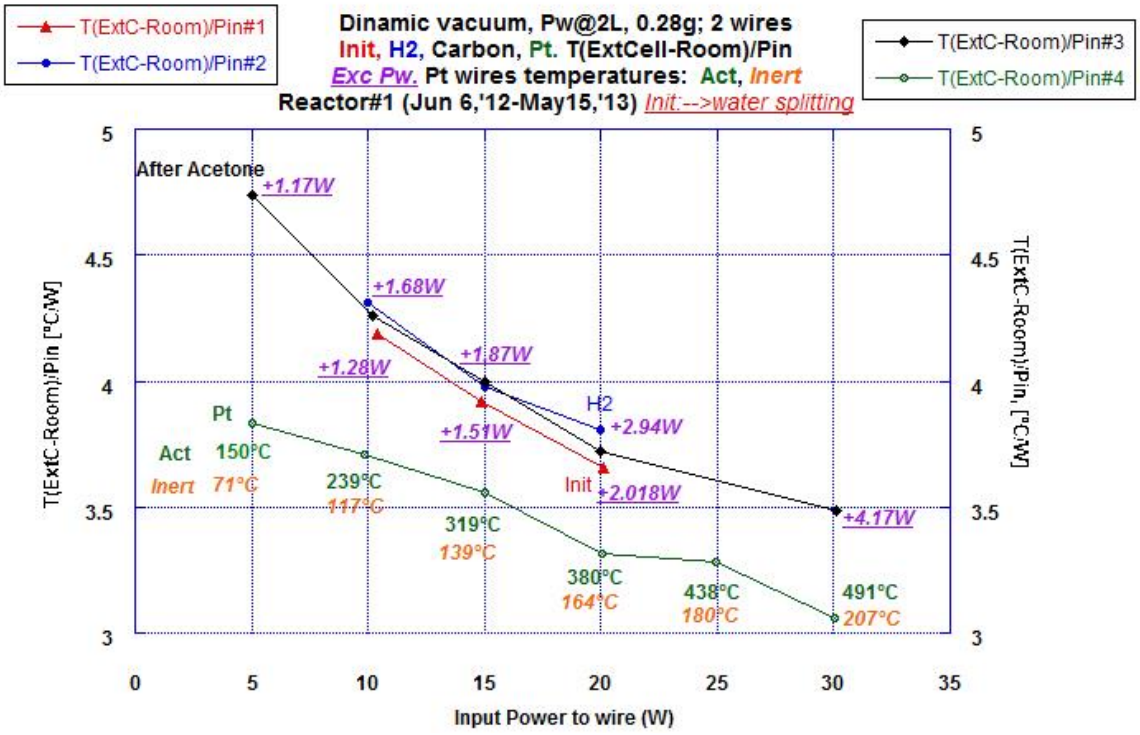
Observation of possible water splitting phenomena during vacuum degassing of the reactor and power applied at 2L wire.

The temperature where phenomena started was 240°C.

A possible processes step can be:

$$2H_2O \rightarrow 2H_2+O_2; \quad H_2 \rightarrow 2H$$

Absorption of H inside Constantan lattice. The H absorption is inferred by resistance decreasing of 2L constantan (-6%), stable even coming back to room temperature.



Dynamic vacuum measurements. Reactor #1 (June 2012; May 15, 2013).

Used linear relationship between temperatures differences (T_External Cell-T_Room) over the input powers [°C/W].

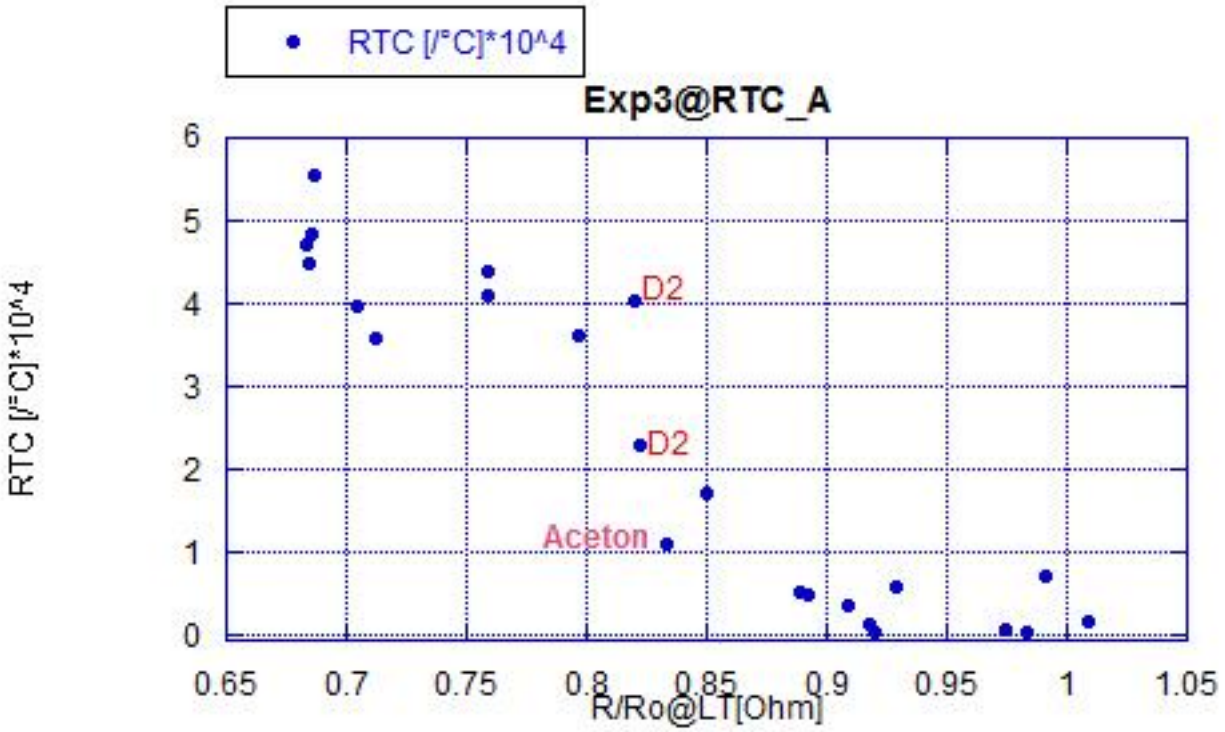
Cross-calibrations using Pt wire (4x50μm in parallel, called Act) of the same diameter of Constantan wire (200μm).

It is supposed that the values of °C/W of Platinum is the reference value, i.e. zero excess power. Excess power is shown in violet color.

Are reported behaviors of Constantan wire with power applied to wire type 2 layers (so-called nano-diamondoids type).

Init is after "water splitting" event; H_2 is after several loading cycles with H_2; Acetone is after injection of small amounts of acetone and air (1cc, 11cc) inside the cell (static vacuum) and subsequent high temperature decomposition (followed by vacuum→ H2→ vacuum cycles).

The anomalous power increases at higher local wire temperatures.



Experiment #3, Constantan wire (360L): RTC vs R/Ro.

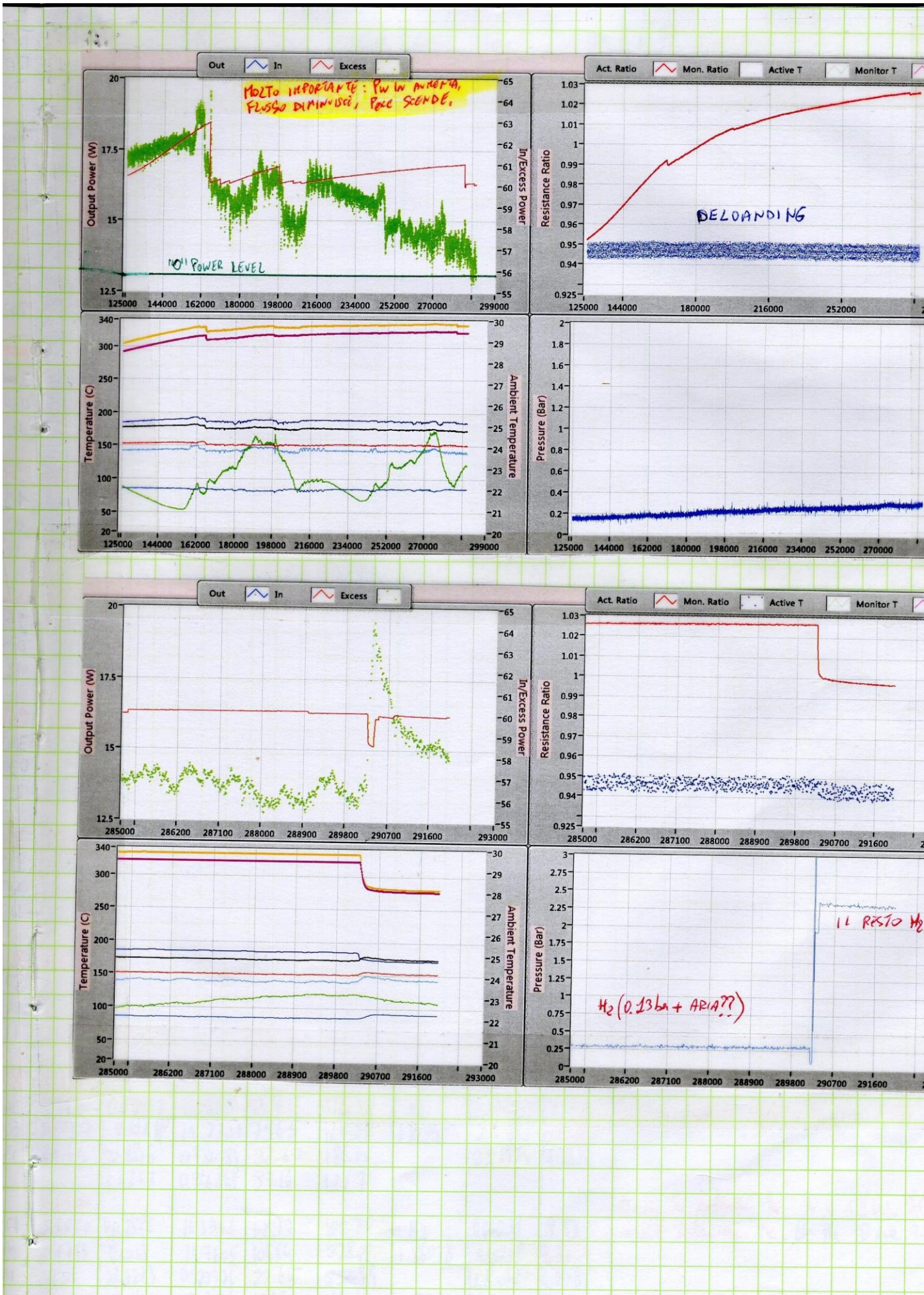
The results reported are made collecting the whole data from High to RT regime, indirect heating, "fast" cooling (about 15m to RT). The typical temperature were 180-280°C (High) and about 23°C for RT.

Other experiments were performed dropping the same cell, with some residual H_2 gas inside (pressure>1.2bar) to avoid fortuitous incoming of liquid nitrogen, from Room Temperature to 77K (liquid nitrogen) and then measured again at RT (usually 293K). The values of RTC were sometimes quite high (>$3*10^{-3}$) for situations at the lower values of R/Ro (0.68-0.72). Anyway such values, very intriguing, were of poor reproducibility.

It was detected a nice correlation between the amount of Hydrogen absorbed inside the Constantan lattice (because value of R/Ro) and the RTC.

The overall changing of RTC (temperature range 180-280→20°C) was as large as 60 and increased with the increasing of Hydrogen loading.

Further studies are needed, in particular at low temperatures (<100K).


Out
In
Excess
MOLTO IMPORTANTE: PW IN ANTICIPO, FLUSSO DIMINUISCE, POI SCENDE.
NO POWER LEVEL
Output Power (W)
In/Excess Power
Act. Ratio
Mon. Ratio
Active T
Monitor T
Resistance Ratio
DELOADING
Temperature (C)
Ambient Temperature
Pressure (Bar)
IL RESTO H2
H2 (0.13ba + ARIA??)

During degassing cycle the Pw, applied to Active wire, was kept almost constant.

The de-loading is due to the concomitant effects of high temperatures inside the wire and very low Hydrogen pressure (<0.2Bar ABS) inside the chamber. Moreover, the hydrogen pressure is probably further reduced by the slow inlet of external air ($N_{80\%}$, $O_{20\%}$) that increases the pressure of the chamber. The Oxygen can recombine with Hydrogen, at the high catalytic constantan surface, and forms water that can condensate as liquid at the colder area of the tube (at the ends).

The overall effect is a "fast" degassing of Hydrogen from the wire until the flux vanished (R/Ro close to 1). At this time also the AHE vanished.

Similar effects were observed, same times, in previous experiments. This time we decided to verify if the mechanism was correct with a dedicated experiment.

The forced de-loading procedure, by low pressure, although didn't give large values of AHE in respect to optimal conditions, anyway is simple proof of the flux-related heat, even at poor values of loading (R/Ro>0.95).

Conclusions

1) **The Anomalous Heat Effect (AHE), according to our results, seems strongly related to the "flux" of H_2 (and/or D_2, but only few experiments performed) through the "sponge" (at sub-micrometric size and quite different local composition) of the "*material*" ($Cu_{55}Ni_{44}Mn_1$). We have indications, mainly by experiments at STMicroelectronics, that even the bulk, after repeated low-high temperature and H_2-vacuum cycles, sometimes could be "activated".**

2) **The original observation by G. Fralick (and co-workers) at NASA on December 1989 (made public to "general people" on 2004) about the un-explicable Anomalous Heat Effect during BOTH the loading and de-loading of Pd tube with D_2 at high temperatures (about 320°C), using H_2 as reference, are still valid. Such KEY experiment was replicated by NASA itself on 2009 and went in public only on August 2011 (by chance).** *Recently, the NASA management decided to share almost immediately their results/projects on the LENR field*.

3) **The results obtained on Pd-D system both in electrolytic and gaseous experiments about flux effect (M.M. Kubre, X.Z. Li, J.P. Biberian, Y. Arata, F.C., ….) are all, among them, qualitatively consistent. Perhaps the original "formula", developed on about 1994 by M.M. Kubre in Pd-D system and electrolytic environments (relationship between the (loading value)x(flux^2) and excess heat amount, i.e.: AHE= k*(X-Xo)*flux^2), is still-now valid, at least qualitatively.**

4) **As a general observation (rule??) the AHE amount increases with increasing of temperature (up to 700°C in Cu-Ni-H??) until the concomitant self-sintering phenomena will damage the material, more or less permanently.**

5) **In other words, because of the key role of flux, the AHE is a dynamic effect (macroscopic and/or microscopic), not static. Even local "oscillations" (e.g. time about 10 minutes as detected in our experiments on July 2012) are important. Any kind of not-equilibrium conditions (external) could help to increase the effect, once the "proper" conditions of the material were fulfilled. Obviously the current pulsing at very large current density (up to 200kA/cm^2) and short duration (0.5-2μs), as we introduced since 1993, could help. Anyway, at this stage of research, we decided to have DC current in order to better identify the other, still un-known and/or uncontrolled, parameters**

6) **The extremely large efforts of *Martin Fleischmann Memorial Project* (worldwide collaboration), and their habit to show (in real time) the results of the experiments, without any kind of "filtering", was a source of scientific stimulations and deeper understanding of the quite complex phenomena and their cross-relationships. BTW, it is really peaty that their "transparency" was used, by some bad people, to dismiss the realty of any kind of LENR phenomena, not just thermal.**

7) ***We are now completely confident, thanks to long and tedious blanks with 2 Platinum wires (even 2 different glass reactors and mica supports), instead of Constantan, that our previous results, since June 2012, were real and not bona-fide mistakes, as we worried/commented several times in the past (even in public).***

8) **More and more work, of high quality, will be necessary to grow the *"child"* from baby-time (now) to *"adult age"* when, everybody in the world, will be able to switch–on the AHE "immediately" and reduce significantly the pollution due to green-house effects related to hydrocarbons combustion. The role of lattice geometry and local composition are, still now, the most problematic and scientifically appelling aspects. The preparation procedures, included the original composition of bulk material and its covering layer/mechanical stability (e.g. de-foiling problem), isn't, still now, under full control: giant, systematic and "creative" work, is needed (ASAP!!!).**

9) **Last but not least, the nice experimental results of Technova-Kobe University Collaboration (A. Takahashi, A. Kitamura and Co-workers), using an alloy of nanometric Ni_{80}-$Cu_{20,}$ dispersed in meso-porous silica, show, again and again, the general trend of "Constantan family" (cfr. Pg. 3) as good candidates to get AHE at low cost (in comparison with the precious metal Palladium, previously used from almost everybody in this field of Research).**

10) ***It is reconfirmed that the intuitions of Prof. Yoshiaki Arata (Osaka University, since 1993 with Pd-black and further key progress on 2002 with nano-Pd dispersed in Zirconia) about the specific role and characteristic of materials at nanometric sizes, were fully correct.***

11) The progress in these last years, about the key role of nano-dimensionality, were so large and wide-spread that, if the LENR community will get enough large resources, could be realistic to "made" some working devices, based on low-cost material, in few years since now.

12) We are indebted with Dr. James J. Truchard, CEO of National Instruments (Austin, TX, USA) and his Colleagues (Stefano Concezzi, Brian Glass, Wenzel Lothar, ...) because providing us (since July 2012) the PIXie system for data collection and on-line analysis. More important, their supports and moral encouragements were for us basilar to help to overcome the numerous and un-expected difficulties in such pioneering field of Science.

13) We would like to thank, from deep of our heart, all the brave Researcher worldwide (obviously included the MFMP group) that spent time and own money in the efforts to replicate our results. Now I understood more details, and weak points, of our fabrication procedures and experimental set-up, thanks to their long and wonderful work. In the next steps of experimentations I will provide them with materials having more controlled or specific characteristics, at the best of my ability. Moreover, even the "geometry" of assembling the wires and measurement procedures are quite important because the key requirements of Hydrogen "flux", i.e. *non-equilibrium*.