LENR phenomena in Constantan; a steady progress toward practical applications:

Observation of *Zener-like* behavior, in air atmosphere, of Constantan sub-micrometric wires after D_2-Xe loading-deloading and related AHE.

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Outline

- **Introduction and background: Motivations of current work.**

- **Review of progresses in terms of AHE and stabilization of the effects.**
  - ✓ **Introduction of glass fiber sheaths in the experimental setup.**
  - ✓ **use of new "ingredients".**
  - ✓ **special geometrical arrangement and new start-up procedures.**
  - ✓ **Latest measurements and observations on the role of oxides as qualitative indicator of the AHE occurrence.**

- **Next Steps and Conclusion.**

- ***The experimental work object of this presentation was carried out at INFN-LNF; some trials were done at the premises of a Metallurgical Company of North Eastern-Italy. Selected experiments have also been attempted within Martin Fleischmann Memorial Project (i.e. M. Valat and B. Greeyner) and in the framework of a Live Open Science approach.***

Introduction

- **A research program has been initiated in 2011 aiming to increase the magnitude and reproducibility of Anomalous Heat Effects (AHE).**

- **This program focused on the study of Constantan, an alloy of Nickel and Copper ($Cu_{55}Ni_{44}Mn_{1}$, abbreviated as *CNM or Cst*) instead of metals such as Pd *, Ti**, and Ni*** that have been deeply studied before.**

- **This alloy, unusual in the field of LENR research, was selected at the beginning of 2011 after the hypothesis or guess of a *"hidden factor"* (see notes) behind AHE successful generation in early experiments of A. Rossi (most likely this factor was not immediately recognized).**
- **To the best of our knowledge these successful experiments occurred around 2007 while A. Rossi was collaborating with B. Ahern in the United States.**

- ***We would like to highlight that the real reasons for the selection of Constantan in our experiments was not presented nor publicly disclosed before.***

***F. Paneth, 1926; M Fleischman-S. Pons, 1989.**

****S. Jones, F. Scaramuzzi, 1989.**

***** F. Piantelli, rods bulk shaped, 1991; A. Rossi-B. Ahern as powders, about 2008.**

Choice of Constantan: Motivation

- This has started in 2011 when we made the hypothesis that the "real and main catalyst or initiator" of the reaction with gaseous Hydrogen was the ***thermocouple*** inserted within the Ni nano-powders, and not the Ni itself.

- **We refer to *J-type* (*Fe-Constantan*), particularly suitable for the temperature range of most experiments (<750 °C). This thermocouple is particularly convenient also because of its low cost and high sensitivity (about 50 μV/°C).**

- ***Furthermore, we had reason to believe that these thermocouples* could be partially damaged after several tests, leading to activation of its surface; we believe also that the insulating and protective material covering the thermocouple (a kind of glass) may contribute to the observed phenomena.**
- **Later that year (June 2011) we found an article showing that Cu-Ni alloys, such as Constantan, may provide an extremely large energy for the catalytic dissociation of Hydrogen molecule (2-3 eV for a wide range of compositions; i.e. Cu/Ni ratio) to the atomic state ($H_2 \rightarrow 2H$);**
- **This behavior was predicted by computer simulations since 1999 by S. Romanowski and Collaborators (see notes).**

Reprint from S. Romanowski (Tab. 1) shows predicted values for the energy of dissociation of Hydrogen molecule to atomic Hydrogen. Some of these data have also been confirmed experimentally/qualitatively, by the same Authors.

Material composition	**ΔE (eV) for Hydrogen dissociation ($H_2 \rightarrow 2H$)**
$Ni_{0.375}Cu_{0.625}$	3.164
$Ni_{0.625}Cu_{0.375}$	2.861
$Ni_{0.8125}Cu_{0.1875}$	2.096
Ni	1.736
$Ni_{0.1825}Cu_{0.8175}$	1.568
$Ag_{0.8125}Pd_{0.1875}$	0.572
$Ag_{0.625}Pd_{0.375}$	0.560
$Ag_{0.325}Pd_{0.675}$	0.509
$Ag_{0.1875}Pd_{0.8125}$	0.509
Pd	0.424
Cu	-1.110
Ag	-1.416

Tab. 1. Adapted from S. Romanowski et al. (*Langmuir 15 (18), 5773-5780*)

Best catalyzer is $Ni_{0.375}Cu_{0.625}$ at +3.164 eV; worst is Ag at -1.416 eV.

- **A similar behavior, can also be expected for Deuterium gas, and it was retroactively noticed in electrolytic and gaseous experiments carried out by our group since 1989 (see Notes).**

- **It is also worth to mention that on Summer of 2012, our coworker G. Vassallo, brought to our attention a patent filed in 1993 (published as US5770036, US5411654, US5674632) where B. Ahern is the first inventor. This patent reported that the *Cu-Ni* could be a good candidate to obtain AHE, especially when at *nanometric dimensions* or prepared alternating layers of copper and nickel.**

- **This information made us more confident on the "Cu-Ni hypothesis" as a trigger of AHE phenomena. Furthermore, it encouraged the use and additional development of our technique to prepare a multilayer and nanostructured texture using electrical pulses (see next slides).**

The INFN-LNF main steps and related improvements.

Wires Pulsed/Flash Oxidation

- **To increase the surface area of *CNM wires*, we applied to them several hundred electric pulses (typically 50 ms duration) with a rather large peak power (15-20 kVA/g). This allows to reach a surface temperature of 800-1000 °C, where *Constantan* starts to oxidize showing the formation of a spongy sub-micrometric texture.**

- **We believe that is due to the fast rising in temperature followed by a rapid cooling (quenching). This also leads to some phase separation, with the formation of separated islands of nickel rich or copper rich phases.**

- **It is likely that a skin effect (pulse rise-time 1 μs) concentrates most of the current (power) at the surface of the wire, with predictable effects on temperatures increase and gradient.**

- **Interestingly the wire surface shows, after pulsed oxidation, the *formation of mixed oxides of copper and nickel* (Cu_xO_y, Ni_wO_z) arranged in a multilayer and sub-micrometric structure .**

- **This came as a surprise when we first looked at the materials with SEM-EDX.**

- **Highlight: pristine *CNM* is the substrate where sub-micrometric materials, of various composition, are supported. The material prepared per this procedure shows a reduced tendency to self-sintering. In other words, the inert material which is often added to reduce sintering problems (e.g. ZrO_2 chosen by Yoshiaki Arata since 2002 for nano-Pd) is replaced with structures, that can possibly absorb some amounts of Hydrogen and eventually take part in the exothermic reactions.**

- **For the sake of clarity, we do not have a precise control of dimensionality of nanoparticles as in the Arata's procedure. In facts, He obtains, 2-15 nm nano-particles when using Pd_35%-over ZrO_2_65%, using melt-spinning and quenching processes.**

- **Weak points. We have occasionally observed that the oxidized and partially reduced structures on constantan wires may detach and fall off. When this phenomenon occurs, the experiment outcome may be negatively affected. Such adverse effects increase after H or D absorption and several thermal cycles (e.g. 20→400--700→20 °C).**

Introduction of fiber glass sheaths and their impregnation

- **(2) To prevent or minimize the separation of active surface layers from the wires core, we put them, immediately after their preparation, within a *fiber glass sheath* (this procedure was systematically adopted since 2013).**

- **We have also reason to believe that this glass sheath may, under certain circumstances, contribute to the generation of AHE. This phenomenon was also observed in a previous set of experiments with Palladium wires in 2008, just because electrical insulation purposes.**

- **At that time, several types of fiber glass sheaths were tested. We realized that Alumina (Al_2O_3) based materials, although able to withstand quite large temperatures (>1200 °C), never gave useful effects. Only more common glass types (E Glass, i.e. boro-silico-alumino-calcic glass; e.g. made by SIGI-Favier, IT-F; a derivative of borosilicate glass with further addition of TiO_2, Fe_2O_3, Fe_2), although limits on maximum continuous temperatures of 550 °C, was showing synergistic effects with respect to AHE phenomena. We first thought that the glass itself could be an important factor but we didn't have yet any justification for our experimental observations.**

- **Having in mind the idea of a "vessel" or containment made of micrometric fibers (diameter 4-6 μm, almost porous) we started modifying the sheaths by impregnation. This was done dipping the sheaths into a solution of $Sr(NO_3)_2$ in H_2O or D_2O, this was later decomposed to SrO at high temperature.**

- **Wires were later inserted in the sheaths impregnated per this procedure.**

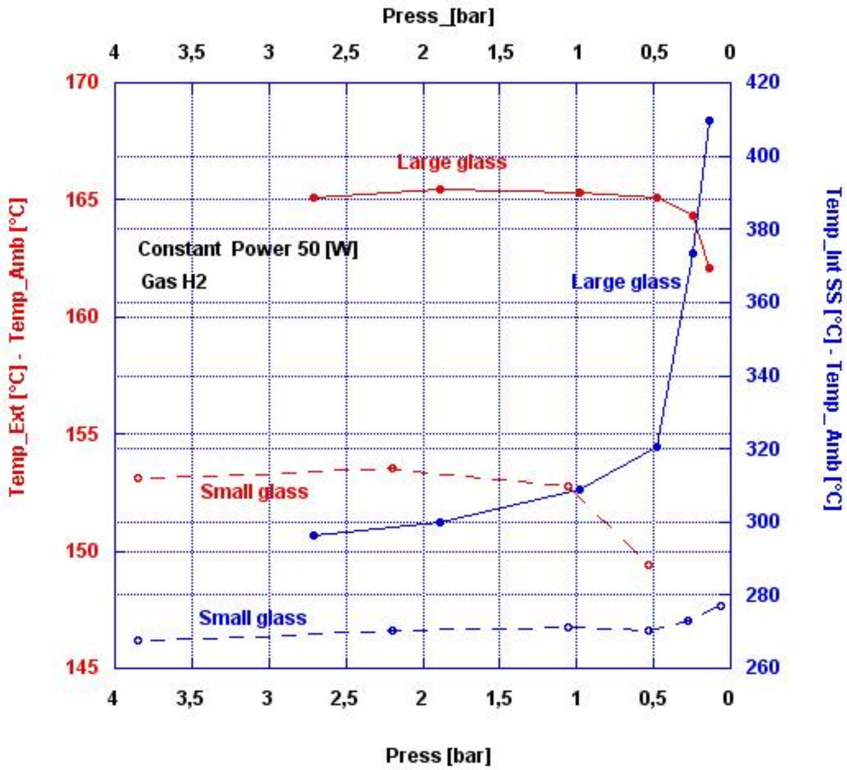
- **Please note that SrO is one of the materials (e.g. CaO, Y_2O_3) that have a low working function for electron emission. The use of these materials is in accordance with procedures of Y. Iwamura (1999) in the field of transmutations (Sr→Mo, Cs→Pr) induced by Deuterium flux on multilayered (CaO, Pd) structures.**

Rediscovery of the work of Irving Langmuir

- ***We believe that the impregnation step further enhances the intrinsic tendency of glass fibers to absorb or interact with atomic hydrogen.***

- **We consider important to mention also that the properties of some specific glasses with respect to their interaction with atomic hydrogen were discovered by *Nobel Laureate Irving Langmuir* around or before 1927 (see notes).**

- **Fig.1. Main results presented at “*2014 MIT Colloquium on Cold Fusion effect*” (21-23 March 2014; MIT-Cambridge-USA), of experiment using 2 Constantan and 1 Pt wires, inserted inside glass sheaths, at low and large amounts of additional glass. H_2 atmosphere, different pressures. Reported internal and external temperatures, minus ambient. Effects larger at *low pressures*, in agreement to observations on Langmuir about 2H to H_2 recombination.**



Introduction of Iron and Potassium and their effects

- **(3) Aiming to increase AHE, in a further development of such material, we added Fe (as mixed oxides) on the surfaces of wires and sheaths together with K (as a dissociation promoter of $H_2 \rightarrow 2H$ reaction, following Fischer-Tropsch like procedures, along 1920-1945, for gasoline synthesis starting from CO and H_2). The addition of iron was made before the pulsed, high power, procedure. Later-on (May 2016) we added also Mn in order to stabilize the observed effects: possibly because Mn may decrease the K evaporation at high temperatures (see notes). As a similarity, the effect of Mn can remember that of Iodine to make longer, and overall more efficient, the useful life span of the, well-known, incandescent lamps (halogen W lamp).**

- **Concerning Fe addition, we later realized that the first batch of *CNM* that we had used was prepared before 1970. We measured that the Fe content, either as impurity or intentionally added, was as large as 0.5-1% on average, while in certain spots we have measured up to 3-5% concentration, especially on the surface.**

- **In addition to the lower purity of starting materials (i.e. Cu, Ni, Mn), we have been suspicious of some surface contamination during swaging process and/or inappropriate storage in a rusted iron cupboard in Italy.**

- **In facts, we observed that the first "vintage" batch of constantan gave relatively large values of AHE (up to 5-20% of the input power - at 50 W input).**
  While AHE became much lower with "recent" batches featuring a higher purity.

- **If we also consider that the J-type thermocouples, mentioned before, also contains iron, the case for its synergistic effect on AHE is strongly reinforced.**

Importance of “non-equilibrium” and “knots”

- **In almost all our experiments we realized that having Non-Equilibrium conditions is a key factor to induce, and possibly increase, AHE effects. On the base of this conclusion, in 2015 we introduced a new type of wire geometry, aiming to increase local thermal (and possibly concentration) gradients.**

- **In other words, We developed a simple procedure to get thermal gradients along the wire taking advantage of fiber glass sheaths that, for several aspects, are step-discontinuity to heat transfer from the wire to local gaseous environment. This effect is increased further if the wire has a current flowing in it, as usual in our experiments. After various attempts we realized that the simplest approach was to introduce several knots in the *CNM* thin wire.**

- **The procedure worked very well and first results were presented at ICCF20 (October 2016). Moreover, we realized that the AHE value is positively correlated with the number of knots.**

- **In the experiments shown at ICCF20, two 200 μm Constantan wires having 41 and 71 knots have been compared in terms of their capability for AHE.**

Reactor assembly, including knots preparation (presented at ICCF20, publishing by JCMNS).

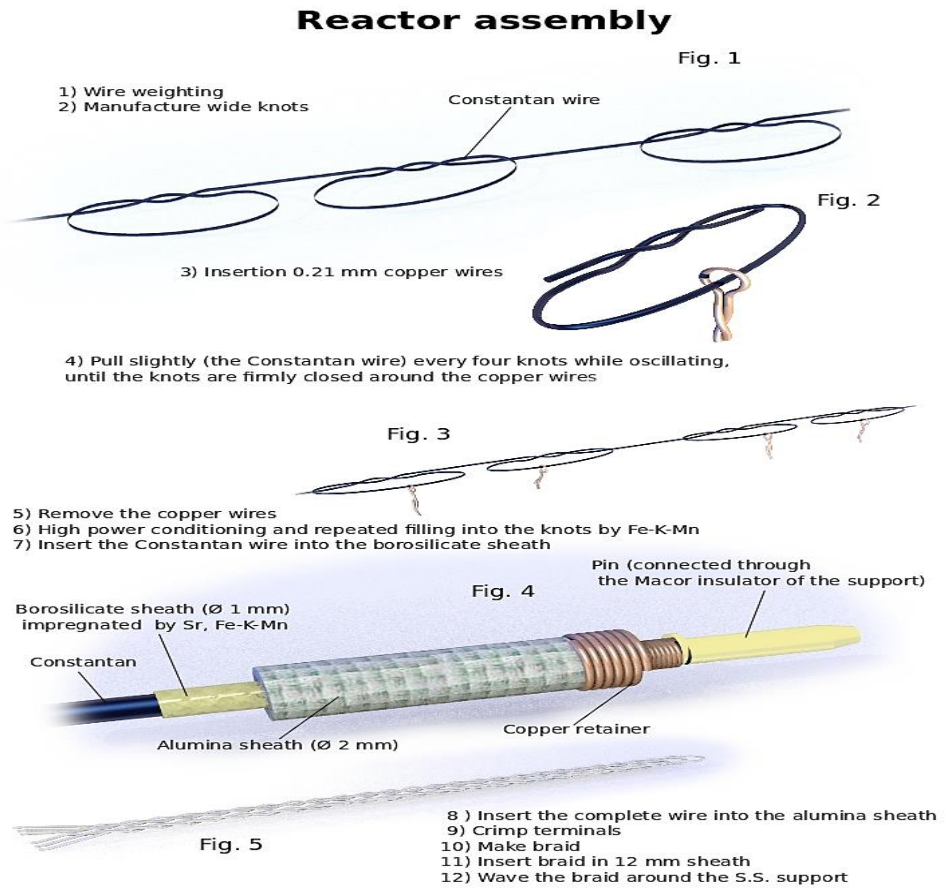


***Figure R1**: Preparation of the knots in the Constantan wire. **Figure R2**: Insertion of the copper wires in order not to completely tighten the knot. **Figure R3**: Critical point of tightening the node due to possible stress of the Constantan wire. **Figure R4**: After conditioning, insertion of the wires inside the several glass sheaths. **Figure R5**: Braid of the three wires to be waved around the SS support.*

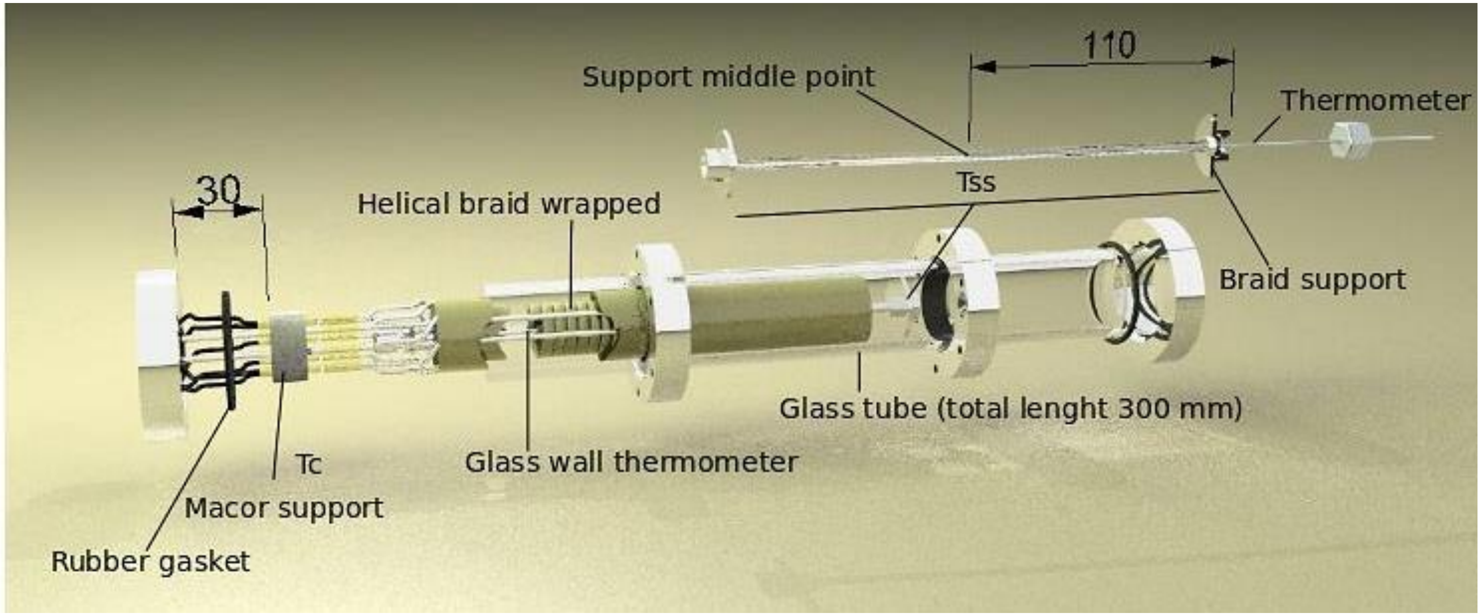


Fig.2 Overview of the reactor once assembled. Regarding temperatures, Tc is external, Tss is internal to the reactor core.

Effects of number of knots on wires (reprinted from ICCF20 Conference, publishing by JCMNS).

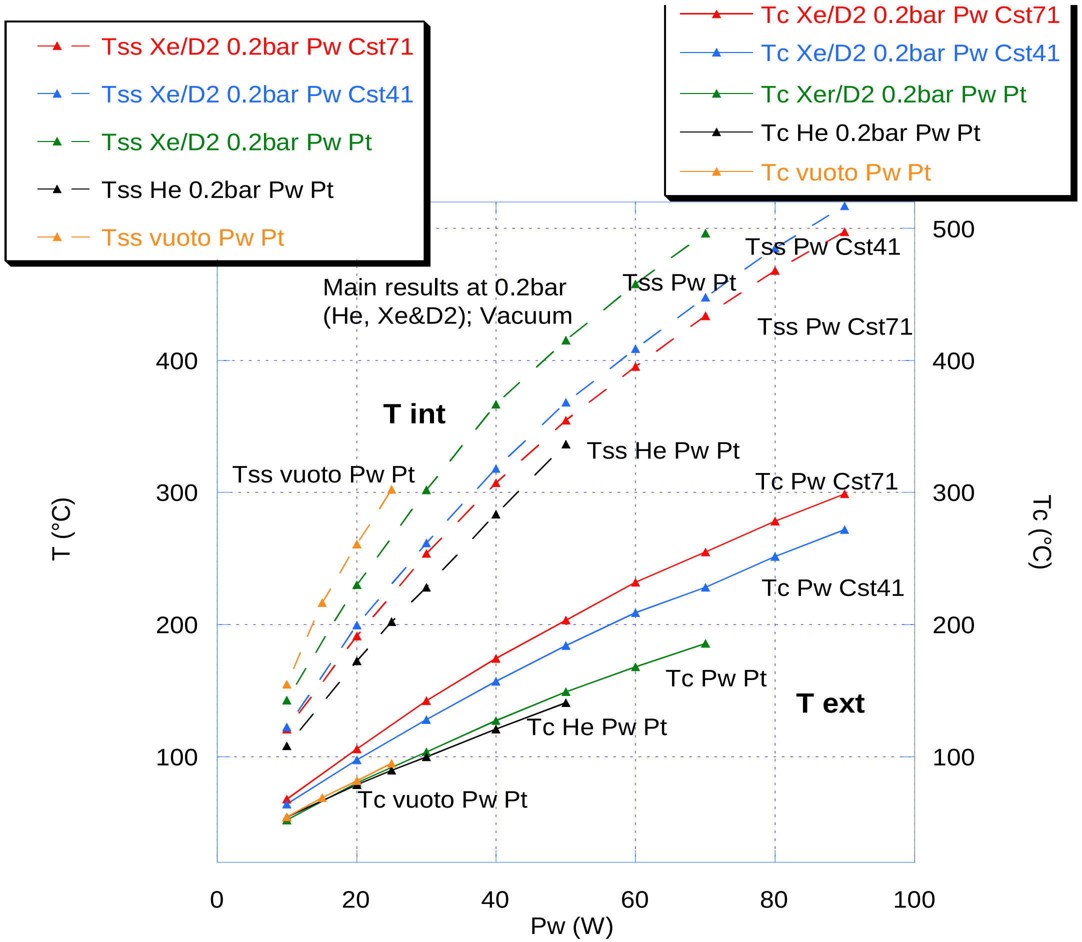


Fig.3 Overview of the main experiments **performed using Vacuum (Pw at Pt), He (Pw at Pt), Xe+D$_2$ mixture** *(Pw at Pt, Cst41, Cst71). It is discernible a large increase of external temperature Tc with respect to Pt case, when Pw is applied at Cst41 and Cst71 (best result). See Notes.*

Introduction of noble gases with low thermal conductivity (Xenon and Argon)

- **Since 2008 we observed that adding Argon and other low conductivity noble gases to H_2 or D_2, could increase the likelihood of AHE occurrence. This was noticed even in experiments conducted at low pressure (e.g. 0.1 bar).**

- **In case of Xenon, in particular we could measure an effect on AHE occurrence and magnitude much bigger than expected.**

- **At the end of November 2016, while still puzzled trying to interpret the effect of Xenon on AHE, it was with great surprise that we found a 1993 German patent (DE4300016) claiming the addition of Xenon to Deuterium to enhance the reaction $2D^{+}+2D^{+} \rightarrow He^{4}$. We also found similarities in the experimental apparatus where this reaction is supposed to occur, a thin glass tube containing ionized Xe and D.**

Comparison of some temperature values, internal and external, at 50 W input power, changing the gas mixtures. Values using the 71 knots, Φ=200 μm, *CNM* wire. Data presented at ICCF20, pending publication by JCMNS.

Gas Type	D_2	Xe/D_2	Xe/D_2	Ar/D_2	He	H_2	D_2O(2cc) Air(10cc)	D_2O(2cc) Air(10cc) Xe(45cc)
Press.(bar) React. off	1	1/0.8	1/0.8	1/1	1	1	0.05	0.2
Press.(bar) React. on	1.41	2.63	2.64	2.71	1.346	1.32	0.20	0.51
Pw(W)	50.18	50.13	50.38	49.91	49.75	50.25	50.11	50.30
Tc (°C)	197.2	208.3	208.6	205.5	191.0	192.8	203.7	212.4
T_ss (°C)	258	342	342.9	308.9	253.5	243.7	367.8	400.1
T_Pt (°C)	257	318	319.4	292.3	252.1	244.6	344.7	376.1
T_amb(°C)	20.7	20.4	20.0	18.4	17.0	17.8	20.5	20.6

Tab.2. Effect of Xenon and heavy water (D_2O) addition on temperatures measured in the reactor.

- **On January 2017, aiming to further increase the amount of AHE, we changed the previous configuration of one Constantan wire of Φ=200 μm (apparent length 105 cm, real about 120 cm) 70 knots, with 4 independent wires of Φ=100 μm; put in parallel, each electrically insulated by fiber glass sheaths the total numbers of knot. Tanks to lower wire diameter, the knots were 300 in total and having an internal diameter of only 0.15-0.20mm.**

- **Resuming, with 4 wires of Φ=100 μm in parallel, we had: a) same resistance; b) double active wire surface; c) number of knots over 4 times larger. Main drawback was the surface temperature (at constant input power), lower in respect to single 200 μm wire used before.**

- **We are reasonably certain, that the value of absolute temperature is a control parameter for AHE generation, i.e. it should be as high as possible.**

- **Unfortunately, increasing the temperature, the risk of sub-micrometric material sintering and deactivation increases. When this occurs, values of AHE strongly decrease.**

2017 set-up: experimental results and learnings

- **Because of reactor assembling constraints, in more recent preparations we have not been able to put the fiber glass sheaths inside a high-temperature furnace to dry-up water and to decompose nitrates to oxides after impregnation.**

- **In other words, some residual D_2O was still present at the surface of the fiber glass sheaths (made by micrometric fibers).**

- **Surprisingly, we have observed that in this case the AHE could be measured at the beginning of operations, already during the cycle for conditioning the reactor trough vacuum treatments at high temperatures (giving power to the Pt wire used usually as a calibrator).**

- **This came with a marked reduction of the value of *CNM* resistance, that we interpret as Deuterium absorption on Constantan according to both all our previous experiments on H or D absorption and several papers on H effects on *CNM*. We just note that some of the Authors (W. Bruckner et al., *Thin Solid Films 258, 1995, 252-259*) didn't take in consideration the full potentialities of H ab/adsorption. Deeper studies were performed 10 years later (A. W. Szafransky, *Journal of Alloys and Compounds, 404-406, 2005, 195-199*).**

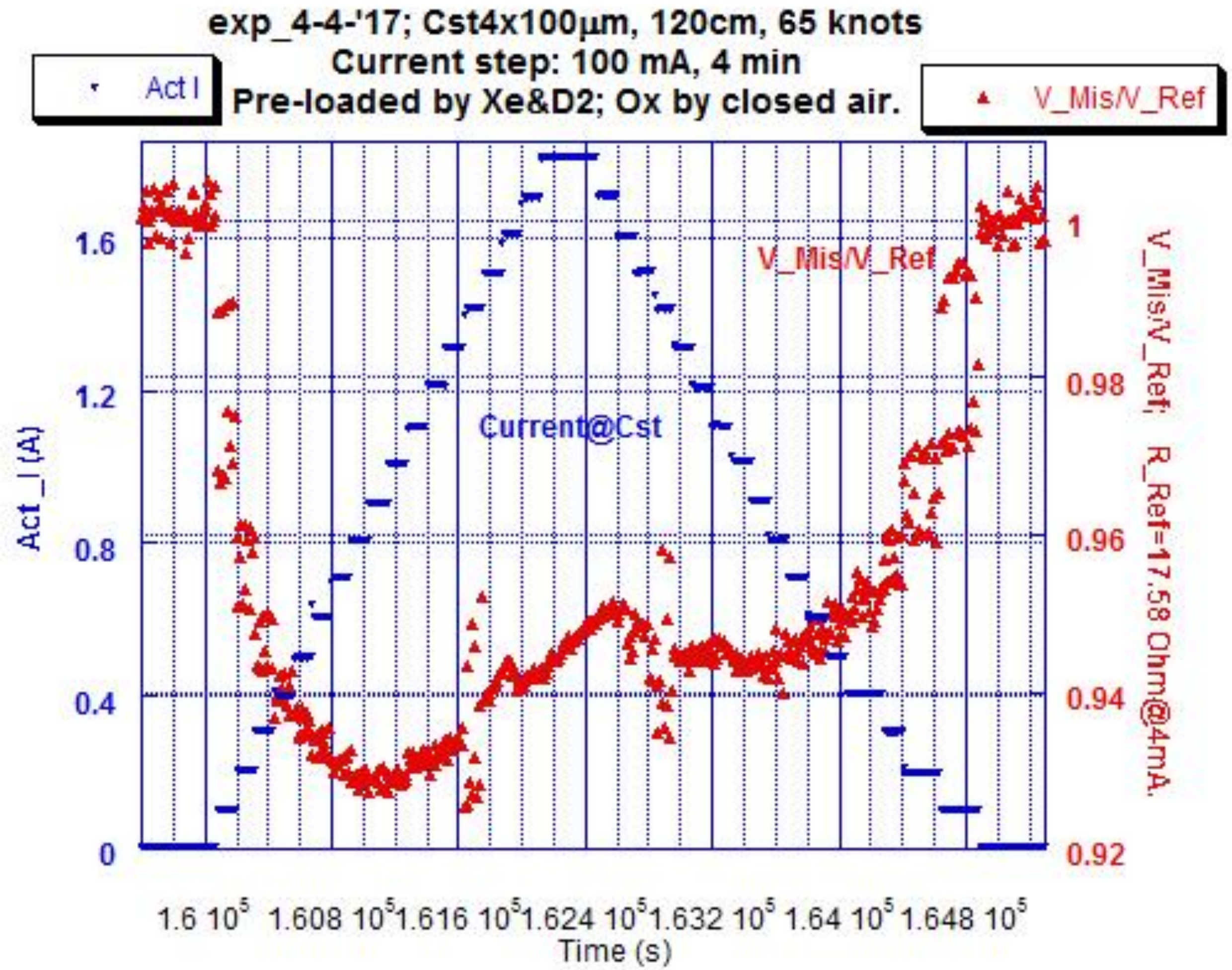
- **Moreover, when the power was applied to the *CNM*, at the end of power cycles (90 W down to 10 W, step 10 W, He atmosphere) the value of resistance at minimum current (4mA) was *HIGHER* than that at usual 750mA (giving about 10 W of input power). Such intriguing effect was present *only* when the power was applied to the *CNM* (i.e. direct heating), not to the Pt (indirect heating of *CNM*).**

- **Further studies have shown that such effect is magnified when *CNM* undergoes only a partial oxidation of the surface, i.e. when some residual Deuterium is still present into the wire.**

- **In short, increasing the current applied to *CNM* (up to 700 mA), we observe a *reduction* of the resistance.**

- **In figure 4 the behavior of wire voltage for increasing applied current (step 100 mA, duration 4 minutes) is shown, normalized to its value at minimum current used (i.e. 4 mA).**

- **The phenomenon of *resistance decreasing* when current is increased (and vice-versa) recalls the well-known *Zener diode* effect in the region of voltage self-stabilization. This effect is reduced when the temperature is increased (Figure 5), for currents larger than 700 mA.**



- *Figure 4: In blue, the applied current as a function of time. Each step has a width of 100 mA and a duration of 4 min. In red, the voltage (calculated as the measured resistance times the applied current) is normalized to its reference value at 4 mA. The total number of knots is 300.*

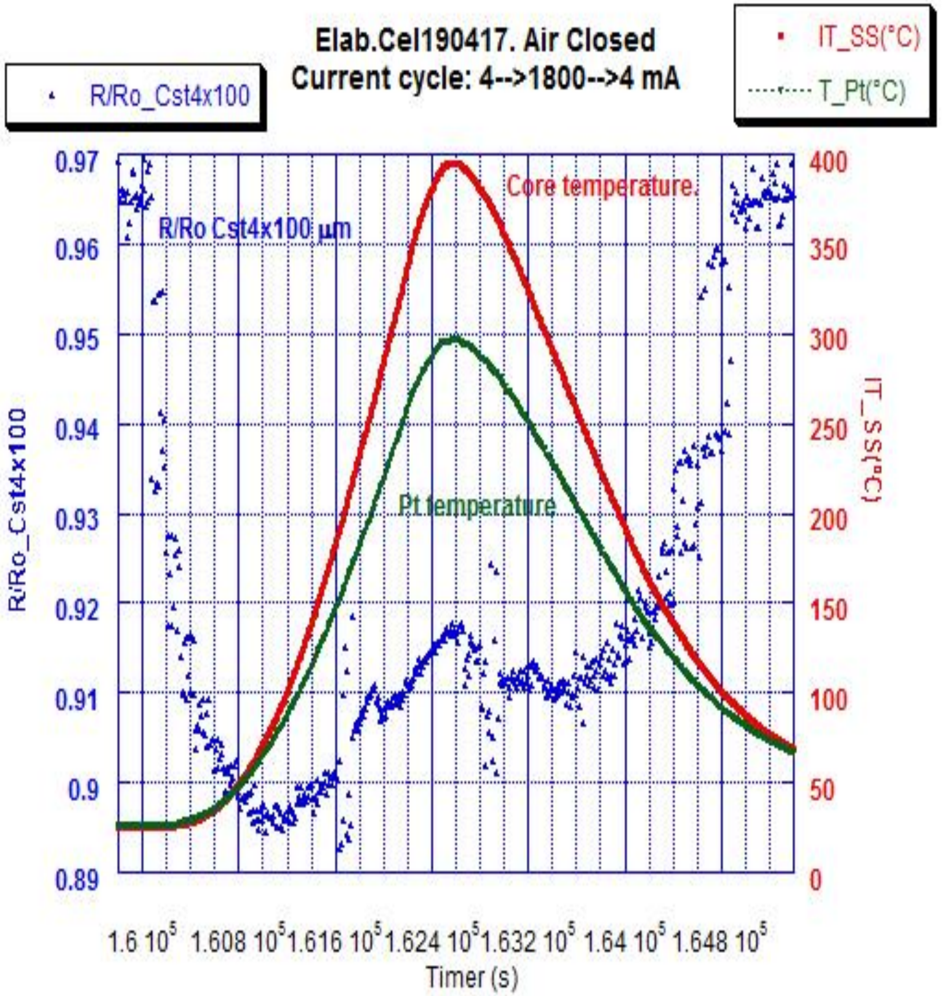


Figure 5: Behavior of resistance of CNM wires with time (blue) compared with that of temperature for the reactor core (red) and Pt wire (green).

- **It was not expected that a local effect (few micron of dimension), possibly Zener like, can be evident even on a scale of meters, i.e. 1 billion times larger than usual. Perhaps, some long-range coherence, or "confinement" induced by voltage (or current), can arise when loading values are extremely large. Similar phenomena were predicted and in part observed by Prof. G. Preparata and E. Del Giudice in Pd-D system since 1996.**

- **Strong experimental evidence points toward a correlation between the observed Zener-like effect and AHE. (see notes)**

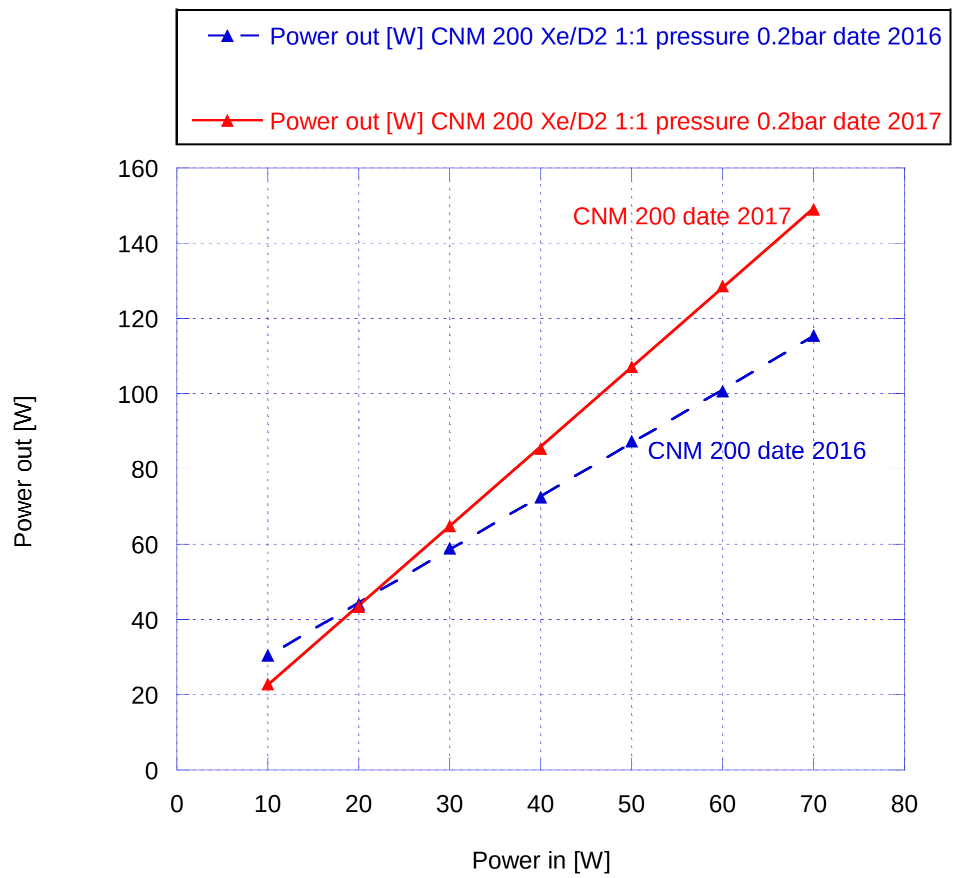


Figure 6: calculated output power versus electrical power on 200 micron thick Constantan wire using similar gases and pressures. This figure compares 2016 and 2017 data i.e. the last one after increasing the number of Constantan wires (1→4) and knots (65→300) in the reactor. The effect is related to indirect heating of 4x100 *CNM* wires. It provides clear evidence of AHE scalability.

Conclusion

An experimental program started in 2011 has allowed to significantly increase probability of occurrence and magnitude of AHE phenomena.

It is important to mention:

- **The use of Constantan.**
- **The use of direct heating (NEMCA effect*).**
- **The pulse oxidation of wires to increase surface area toward nano-structures on wires surface.**
- **The addition of Iron and Potassium.**
- **The use of Impregnated Fiber Glass Sheaths.**
- **The use of Manganese to stabilize the system over time.**
- **The introduction of knots on the wires.**
- **The addition of Xenon and Argon to Deuterium.**
- **The use of thin wires (4x100 µm Vs 1x200 µm).**

***Non Faradaic Electrochemical Modification of Catalytic Activity (largely studied/developed by Costas Vayenas around 199. First similar observations, un-explained, since around1905).**

- **We have elements to think that the several procedures adopted, just trial and error approach, have increased AHE from 5-20% (in 2012) to current values of over 100% (i.e. a factor 2) with satisfactory reliability and reproducibility.**

- **Most notably, the internal and external temperatures of the reactor were markedly increased.**

- **In that respect, during selected experiments (e.g. using Xe-D_2 mixtures) the internal reactor temperature exceeded 700 °C while external reactor temperature was as high as 300°C without any damage to the wires, sheaths and other components.**
  In our opinion this represents a key achievement toward the application of LENR for practical energy exploitation.

- **As highlighted before, we believe that further and possibly large improvements can be expected optimizing the reactor design – e.g. combining a high catalytic surface with controlled thermal exchange with the environment. Further improvements are also expected with an increase of the mass of the active material, now not exceeding 0.6 g.**

Notes

Slide 2:

- We must pay a tribute to Yasuhiro Iwamura for his experiments. In facts, as per his procedure we introduce low working function materials in our experiment. For instance, fiber glass sheaths covering our wires have always been modified with Strontium Oxide.

Slide 3:

- Since about 2007 Rossi was investigating LENR phenomena in Ni Powders together with B. Ahern in USA.

- The "demonstration" of A. Rossi held in Bologna in January 2011 was not considered conclusive by the LENR community.

- Constantan was discovered by E. Weston (1897).
- We arrived to hypothesize the effect of constantan thermocouple on AHE occurrence after the controversial "demonstration" held by A. Rossi (jointly with Prof. S. Focardi) in Bologna-IT, on January 14, 2011.

Slide 4:

- **Romanowski published the article: *Density functional calculations of the hydrogen adsorption on transition metals…*; Langmuir 15 (18), 5773-5780) but *our group was not aware of it before February 2011*.**

Slide 6:

- **At that time, some of the results did not have a clear explanation (especially comparative tests of Pd and Ni in electrolytic environment conditions). In facts, after repeated cycles of cathodic/anodic regimes, and High/Low current densities, we observed that Cu (and Ag) could occasionally show-up in our electrolytic cell because of a contamination coming from the electrical connections (wires of Cu-Ag covered by PTFE). This was due to the corrosion mediated by LiOD-D_2O vapors.**

  In other words, we had observed that Cu and Ag could be deposited on Pd surfaces and even more on Ni (a metal less "noble" with respect to Pd).

Slide 7:

- **Constantan has been used in form of long (l=1 m) and thin wires (Φ=200 μm; weight=0.28 g/m). The wire surface is very smooth before our electrical pulses and oxidation.**

Slide 11:

- **In the case of Langmuir, the type of glass was that selected for the construction of incandescent lamps, i.e. able to withstand repeated (>1000) fast cycling of temperatures (20→200→20 °C) without self-damaging.**
- **First specific results on glass addition, at large amounts, were presented at *2014 MIT Colloquium on Cold-Fusion effects*, MIT-Cambridge-USA, March 21-23, 2014.**

Slide 12:

- **We went to know about the glass propriety on atomic Hydrogen adsorption only on November 2013, thanks to *re*-discovery *of the Langmuir papers by L. Del Sorbo and L. Notargiacomo* (both students at Rome University "La Sapienza") held in the (undergrounds, old documents) library of CNR (Consiglio Nazionale delle Ricerche).**

Slide 13:

- **The use of Manganese in reducing K loss was described by A. Kotarba in Journal of Catalysis 221 (2004) 650-652 and was based on the pioneering work of A. Miyakoshi on Applied Catalysis A 216 (2001) 137**

Slide 14:

- **Over many years of experiments, we noticed that all kind of local non-equilibrium (thermal, electric, H and/or D concentration, radiation….), may trigger AHE release. In our case we have a mild excitation, as intensity, using gamma ray coming out from commercial Toriated Tungsten rods (used for TIG welding) put *outside* the glass reactor, located inside an airtight small SS tube.**
- **Knots had at beginning an internal diameter (see picture on slide 15) in the range of 0.2-0.6 mm; later the diameter was decrease toward 0.15-0.20 mm.**

Slide 17-18:

- **Cst41 and Cst71 means a Constantan wire with 41 and 71 knots respectively.**

Slide 19:

- **The motivation of inert gas addition is to reduce the input electric power thanks to lower thermal conductivity losses. This allows for instance to enhance the detection of very small AHE. Such effect was further magnified when the Ar was substituted with Xe (the gas with lowest value of thermal conductivity, 5.5 mW/m*K at 300 K among the non-radioactive).**

Slide 22:

- **We recall that each fiber glass sheath covering the wires (T_{max}=550 °C continuously) is covered by another Al_2O_3 able to withstand 1200°C. In other words, each thin wire is covered with 2 sheaths making the overall (wire-sheath) assembly rather bulky.**

- **Sheaths have been impregnated using separate solutions of Strontium Nitrate and Iron Nitrate/Potassium permanganate in D2O. After impregnation sheaths are normally dried and heated in a furnace to decompose nitrates. This last step could not be done in a recent series of experiments.**

Slide 27:

- **We observed that the new set-up (2016 Vs 2017), featuring 4 times more knots and twice the surface of constantan wires, is about 30% more efficient on AHE emission. For instance, supposing valid the power emitted combining the Stefan-Boltzmann law (proportional to T^4) and Newton dissipation (at 10 W*K*m^2), at 70 W of electric input power, the thermal power emitted are respectively 115 W and 150 W, using as gas a mixture of Xe and D_2 at 0.1 bar of pressure: shown in Fig.6.**