Are specific glass surfaces co-factors for generation of anomalous effects, by catalytic materials, under H₂ gas at high temperatures?

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Warning

Preliminary results, work in progress!!!

The idea/correlations shown in this specific report, although arising from observations of some experiments made by us since 2007, and more deeply on 2008 with specifically selected materials, are quite innovative (and/or crazy...).

Moreover, also because my poor ability about English Language, are not easy to be understood.

Please, be patient about.

Motivation

- Since 2007 we made, at Frascati National Laboratories of National Institute of Nuclear Physics-Italy, several experiments with long (80-100cm) and thin (diameter, Φ, only 50µm) wires of Pd, Pd-Y (Φ=100µm), Ni with surface "activated", i.e. covered (by physical-chemical, home-made, procedures) of several (up to 50-200) very thin layers (<<µm) of different elements (soluble salts), like Sr, B, Th, P, C, Si. Such salts, usually nitrate (except C; Si was added as, nanometric sized, colloidal silica), were decomposed by Joule heating at high temperatures (>500°C) to, mainly, oxide states during the very long preparation phase (up to 6-8 hours).
- The "activated" wires (i.e. Pd, Pd-Y, Ni), usually 2, were individually inserted inside specific high temperatures (up to 550°C) glass flexible sheaths (Φ =1-2mm) and very closely **BRAIDED** with a Pt wire (Φ =50µm), also inserted in a glass sheath: in total 3 wires. Original motivations were electrical insulations to allow, among others, R/Ro measurements of Pd: from such value was possible to evaluate the mean D/Pd ratio (supposed mainly as a bulk effect).

- The Pt wire was used both as extended length thermometer (thanks to the well know, and almost stable, characteristics of RTC of such noble metal) and for calibration purposes.
- Each glass sheath, since 2006 based on a general purpose material (Φ =2mm), on 2008 was changed to a more sophisticate one produced by SIGI (Italy \rightarrow France): made by >>100 glass fibers with diameter of only 3-10 μ m each, closely waived.
 - We notify that other experiments using sheaths made by almost pure alumina (Al₂O₃, T_max up to 1000°C) with similar geometrical dimensions, give results, about thermal anomalies, completely different, i.e. at lower intensity.
 - At that time the different behavior was ascribed to the possibility that the alumina sheaths, mechanical more hard that glassy one, could damage/detach the multiple (and weak) nano-coating at the surfaces of Pd and/or Ni wires.

- The braided wires were put inside another 1 or 2 glass sheaths of larger dimensions (Φ=10-20mm; i.e. several thousand of individual 3-10µm fiber). Some-times they were further thermally insulated, from the reactor metallic external wall, by "glass wool" (brand name Superwool607[™], UK).
- Cross-check of the temperatures, apart mean values by Pt wire, were made by several thin (2mm), Stanley Steel (SS) covered, type K thermocouples (up to 1200°C) put inside the braid, at its center.
- All the system was put, usually, inside a SS tube (some-times internally covered by Cu to reduce the problem of Sulfur emission from the SS AISI 304) to can make specific test even at high pressures (up to 20 Bar) and high temperatures (external wall temperatures even larger than 200°C).

- Later-on, frequently, the tube, to reduce the adverse problem of sulfur scavenged by the Hydrogen at high temperatures, was made by thick-wall borosilicate *Schott Duran glass* (good performances on mechanical strength at high pressure and temperatures, like our situation). We recall that the sulfur is a quite powerful poisoner to several catalytic reactions, specially those based on Pd or Ni as active materials.
- Such experimental set-up showed, but only few times and at too-low reproducibility levels, amount of excess power density at high temperatures (>350°C) really remarkable: up to 1800 W/g of Ni at 900°C and Hydrogen atmosphere, 400 W/g of Pd by Deuterium gas at about 400°C. The maximum absolute power emitted was as large as 26 W. The total time of most intense anomalous effects was as long as 5 days with several ON-OFF (during the night, safety reasons) periods. Calibrations were made by comparison with previous experiments, same geometry and wires, and were performed at the *beginning*, i.e. before of any H₂ (or D₂) interaction: used mainly pure He (and/or He-Ar mixtures) gas at similar pressures (some bar).

We observed, occasionally, that after long time of interaction with H₂ (or D₂) at high temperatures, the subsequent calibration experiments with He were more "noisy" and unstable, especially at low pressures, i.e. different from that at the beginning. Such phenomena were not understood at that time. We just guess that some H₂ was "stored" in some hidden places inside the reactor (Cu, glass, SS,...).

- Another motivation to the unusual experiment/re-analysis, was quite private and "local": complete cut of the budget with the end, for-ever, of the experimental activities at a date not over year 2013.
- Because such impelling/dramatic situation, I decided to change the order of previously planned experiments and to study again, more deeply, some of the most intriguing effects previously found, even by chance, but not elucidated at all. Some of those were observed several years before and could be crucial to increase the amount of anomalous heat detected. In such a way, if the experiments will get success, will be the possibility to reverse the bad situation.
- Moreover our systematic work, using the "surface modified Constantan wires" by us developed, was performed by the MFMP group, adopting the Live Open Science approach/procedures, at excellent scientific level. So, no real damage to the systematic studies, with me at "part time", because the quality of experiments performed by the MFMP group.

- Anyway recently, after some discussion/agreement with the top management, I got permission to continue the activity because some private Company is currently involved to overcome the budget problem.
- Resuming: because "forced" situation by external events, we studied, in a systematic way and deeper details, a side-effect that, in proper conditions, could increase the amount of anomalous heat produced, especially at the highest temperatures.

Experimental set-up

- The experiment was planned to have an overall geometry and experimental set-up (HW, SW) as similar as possible to that developed by us since June 2012 and presented both at ICCF17 and ICCF18. In such a way most of the previous experiences, very precious, will be not lost.
- The main difference was about the geometrical set-up of the wires inside the glass tube and cover. In short, the wires were not helicoidally rounded, naked, over the mica (BTW also material ad and ab -sorbing Hydrogen) support but inserted inside glass sheaths and closely braided. The control wire wasn't anymore Ni-Cr but Pt wire. The active wires were not only one (surface modified constantan) but 2, both of constantan: "standard" 500 layers and another new with only 2 layers. The overall length was kept constant (100cm) and the "free" exposed length (12 cm) of wire, inside the reactor, kept constant.

• The goal was to get reliable data about thermal anomalies using the external glass wall temperature, main "marker" (L=30cm, external Φ =40mm, internal Φ =34mm), as in previous experiments. Power emitted (normalized to the free surface) were computed both using the Stefan Boltzmann law (power emitted proportional to T^4, in K) and linear term because free convection (temperature difference between the glass surface and ambient; "convection factor": 12W*K*m⁻²). Differently from previous experiments, the large "dead" section of the glass tube (top and bottom), far from the wire main section, were covered by one layer of thermal insulating (5mm thick) tape. Moreover, will be largely used the values of temperature most inner to the tube, by a thermocouple inserted inside the central support (Φ =12mm), made by Stainless Steel (identified as T_SS). The external of the SS tube is further protected, by glass sheaths, against possible short circuits because large temperatures involved.

- In order to evaluate the effect due to of amount of braided glass, if any, were planned 2 different experiments, never changing the 3 wires inside the reactor. The first experiment was performed with minimal amount of sheaths (mainly for electrical insulating purposes among the 3 wires), the second with added quite large amount of sheaths.
- The first experiment started on October 17, 2013. We realized, few days after the beginning, that had happened several unexpected and uncontrolled phenomena. According to our previous experience, most of the active wire surface of the 500 layers Constantan was damaged because, fully unexpected, spontaneous over-heating (>700°C in H₂-Ar mixture): run-away?
- Anyway, apart time limit reasons, we decided to continue the experiments because some of the results look really interesting and give indications of *new kind of phenomena*.

- Some of them were consistent with the effect due to very close geometrical interaction between Constantan (supposed able to promote the endo-thermic reaction of H₂ splitting reaction, i.e. H₂→2H, even at enough low temperatures, e.g. our report at ICCF18) and Pt wire acting as promoter of reverse, eso-thermic reaction H+H→H2.
- Other phenomena suggested that the specific geometry and/or the glass itself, even at low amounts, could play useful roles.
- The complex, and often unclear, results make us over-busy and doubtfully, up to February 13. On February 14 we decided that the ONLY way to clarify the situation was to add larger amount of glass sheaths and observed the results, with a mind as open as possible to accept the results obtained, of any kind.

- Moreover we worried that the new thermal insulation, even limited to the dead-area of the tube, could fake our results. So, we imposed, in the calculation about thermal anomalies, that the results with low amount of glass inside the reactor (experiments performed between 17 October 2013 and 13 February 2014) will be the "blank"; the "black" will be that with large amounts of glass sheaths, i.e. starting from 14 February.
- Even with such conservative constrains the comparative results among the 2 experiments showed that the effect of Hydrogen, adsorbed at the surface of glass as monolayer, has intrinsic co-effect on the generation of anomalous heat. Obviously some specific material able to increase the dissociation rate of Molecular Hydrogen to Atomic one, even at low temperatures (*like "our" surface-modified Constantan*), is necessary. Finally, in order to get a better understanding/control of the absolutes temperatures, key parameter to get Hydrogen dissociation, we made several experiments giving power to the Pt wire: the Constant is heated "indirectly" and with more tight control.

Hydrogen adsorption at glass surfaces.

- According to measurements made by Prof. Irving Langmuir (1927; Nobel Laureate in Chemistry on 1932) in the Laboratory of GE at Schenectady, N.Y.-USA, the amount of Atomic Hydrogen adsorbed at the surface of a glass bulb (used in his experiments about incandescent lamps) was as large as 1.5x10¹⁵ atoms/cm². The glass was kept at about 90K and Atomic Hydrogen, after recombination to molecular, collected back at Room Temperature and Pressures. Such Atomic Hydrogen was produced by high temperature (>2000K) low pressure (about 0.1 Bar) Tungsten filament ("Flames of Atomic Hydrogen", Industrial and Engineering Chemistry Vol. 19, No. 6, June 1927, pg. 667-674, 1927).
- Considering the effective surface of even the smallest glass sheaths (where the single wire is inserted) used in our experiments, we have surface of 1 square meter: up to over 10¹⁹ atoms of atomic H.

- Because the peculiarity of monolayer, bi-dimensional highly reactive Atomic Hydrogen, can be not strange if such geometrical situation could allow/increase the "Energy Localization" phenomena.
- The Energy Localization was discovered, by chance, by *Enrico Fermi*-Italy (Nobel Laureate in Physics on 1938), and co-workers, in 1954, at LANL-USA. Because the results, completely unexpected, by digital computer (Maniac1) simulations were not fully understandable at that time, were named as the *"Fermi-Pasta-Ulam paradox"*.
- Recently such important phenomenon was revisited by Prof. Brian Ahern-USA (previously at DARPA and EPRI) and considered as candidate to the explanation of some of the complex phenomena found in LENR experiments.

Details about fiber glass used

The mean diameter of each glass fiber, by us measured, was about 5μ m.

The mean glass density was 2.23g/cm³.

- In the old experiment (Oct. 17, 2013) were used only 3 sheaths of glass fiber, each long 100cm, external diameter 1mm. The weight was 2.677g each. The mean effective area of each slave was about 0.96m².
- Moreover, it was used a 30cm long, internal diameter 12mm sheath, to cover the SS tube. The weight was about 8g. The effective area was about 2.8m².
- There were also 2 other sheaths, diameter 3mm and long 30cm to protect the SS thermometers. The total weight was about 4 g, equivalent to 1.4m².
- In the new experiment (after Feb. 13, 2014), were added:
- Sheath, Φ =8mm, L=100cm. Weight=16.5g, equivalent to 5.92m². Specific sheath filled also with Tungsten wire, L=10m, Φ =0.2mm.
- Most external sheath, Φ =20mm, L=114cm. Weight=46.3g, equivalent to 16.6m².

Supersedes : v3 16	-09-2008	Version : 4 ; Date : 12/11/2012	Page: 1/3
1- MANUFACTURER : CO	OMPAGNY - PRODUCT IDE	NTIFICATION	
HEAD QUARTERS :	FAVIER TPL Le Bourg 63480 Bertignat (France)	돌 +33 (0) 4 73 82 12 93	
PRODUCT IDENTIFICATION :			
	BRAIDED GLASS	FIBRE	
2- COMPOSITION - INFO	ORMATION ON CONSTITUE	NT PARTS	
COMPOSITION :			
PART 1:	PART 1 : E Glass (99% - 100 %)		
	E Glass is a boro-silico-alumino-calcic glass with a low alkaline content.		
	Its composition (expressed in oxides) is within the following limits :		
	SiO_2 $52 - 62\%$		
	Alkine terrous oxides (CaO, Mgo,) $16 - 30\%$		
	B ₂ O ₃		
	Al ₂ O ₃	11 – 16 %	
	TiO ₂		
	Fe ₂ O ₃	0 - 1 %	
PART 2:	Organic solvents < 1 % : CA	S n° 64742-46-7 and CAS n° 64742-46-9	
HAZARDOUS INGREDIENTS	see nart 2		
AZARDOUS MOREDIENTO	See part 2		
3- HAZARDS IDENTIFIC	ATION		
Not hazardous according to Coun	cil Directive 88/379 EEC and its	subsequent amendments.	
t's important to remember that the	fibres are not breathable fibres	(i.e. they do not penetrate the lower lung	c) This is
the finest dust is significantly long values used to define breathable f	m (the diameter of most strands end of the diameter of most strands er than 5 μm and the length/dian fibres.	exceeds 10µm). Even after manipulation t heter ratio is greater than 3. These are the	he length of normal
4- FIRST AID			
INHALATION :	Remove from the scene of	exposure. Make breath of the fresh air.	
SKIN CONTACT :	Wash copiously with lukewarm soapy water. Do not rub excessively.		
EYE CONTACT :	Flush in running water (for at least 10 minutes).		
ALLERGY :	Remove from scene of exposure.		

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STABILITY :

IY: Stable in normal use and storage conditions, and in normally foreseeable usage

conditions

HAZARDOUS REACTIONS : Oxidizing agent

HAZARDOUS DECOMPOSITION PRODUCTS :

In continuous combustion conditions, in addition to water vapour and CO₂ small quantities of CO and NOx may be released by the combustion of the size and/or the binder.



Assembling of the reactor with glass fibers: old and new set-up



Internal of the reactor, old set-up (17 10,'13--13 02,'14. In total (3x0.96)m² glass sheath (covering each wire), 3m² covering the internal SS tube (diameter 12mm).



New set up (after Feb. 13, 2014). Internal view of the reactor with over 30m² of glass fiber in total.



Old assembly of the reactor (17 Oct. 2013-13 Feb. 2014), external view.



New (after Feb.13, 2014) assembly of the reactor. External view.



Schematic of the new assembly, section.

Main result and comment

- There are reported some of the results aimed to show the large differences in the temperatures, both internal (as expected because large thermal insulation provided by the larger amount of glass) and external.
- The study was performed applying the power to the Pt wire, i.e. the Constantan is only indirectly heated.
- It is quite interesting to observe that the phenomena is magnified reducing the pressure of Hydrogen.

- According to Irving Langmuir measurements, the probability of Hydrogen dissociation increases both increasing the temperature and reducing the pressure, down to 0.1 bar.
- The phenomena observed can be in agreement with an increase of anomalous energy production just because large number of sites (the glass surface) were the energy localization phenomena can be located.



Main result of experiment using 2 Constantan and Pt wires, inserted inside glass sheaths, at low and large amounts. H₂ atmosphere, different pressures. Reported int. and ext. temp., minus ambient.

Conclusions

- There is some probability that we found, just by chance, a geometrical set up and simple/low-cost, apparently inert material (i.e. fiber glass), that could increase the amount of anomalous effect during experiments at high temperature with Hydrogen and proper catalytic materials.
- An intuitive way to consider the Hydrogen adsorbed on the surface of thin glassy sheaths is that it is SIMILAR to a geometry were it is like an: Hydrogen-Single Wall Nano Tube (H-SWNT).
- Obviously, as thin are the diameters of the fibers, as better are expected the performances.

 Further work is necessary to rule-out some hidden error, always possible, and/or increase the amount of the effects.

- I will be happy, as usual, to share all the details of the experiments in the genuine spirit of Live Open Science for the advantage of the mankind.
- I am happy to inform that the LOS procedure, i.e. the MFMP group, was candidate, informally since October 2013 and later-on formally, for the Nobel Prize for Peace in 2014.