Effects of "super-Capuchin knot" geometry, and additional electric fields, on Hydrogen/Deuterium absorption: related AHE on long and thin Constantan wires with sub-micrometric surfaces at high temperatures.

Francesco Celani[1,2], C. Lorenzetti[1], G. Vassallo[1, 3], E. Purchi[1], S. Fiorilla[1], S. Cupellini[1], M. Nakamura[1], P. Boccanera[1], R. Burri[4], P. Cerreoni[1], A. Spallone[1,2].

1) ISCMNS_L1, Via Cavour 26, 03013 Ferentino-IT; 2) INFN-LNF; Via E. Fermi 40, 00044 Frascati-IT; 3) DIID, University of Palermo, 90128 Palermo-IT; 4) IETCLaboratories, 6827 Brusino Arsizio-CH.

Email: francesco.celani@lnf.infn.it**;** franzcelani@libero.it **-**ret. INFN (Guest Researcher); (Vice-President) ISCMNS.

In the framework of Low Energy Nuclear Reactions (LENR) studies focused on Anomalous Heat Effect (AHE) generation by Hydrogen /Deuterium interaction with proper lattices, using Constantan (since 2012; CNM, alloy of Cu_{55}-Ni_{44}-Mn_1) wires, with long (up to 130 cm) and thin shapes (surfaces made sub-micrometric by proper thermal treatments), since 2015 we developed a procedure to increase the local temperature of the wire (like hot spot) flowing specific amounts of current, by proper knots with low diameter holes. We observed that the amount of AHE increases: A) increasing the number of knots (up to 50/m); B) reducing the hole diameter (down to 200 μm); C) reducing the wire diameter (200, 100 μm); D) increasing the total length of the wire; E) increasing the local wire temperature and gradients along it. Moreover, the addition of oxides of specific elements (Fe, Sr, K, Mn; multilayer structure) at the surfaces of both wires and the specific glass sheaths (where CNM is inserted) had some effects both for the "lighting-on" and overall stability of the system, about AHE production (up to some days in the best experiments). Anyway, the reproducibility of the effects and the amount of AHE were, in the whole, not enough satisfactory, special toward a practical application (in prospective) of the effect. In addition, the amount of AHE, although not stable over time, was significantly reduced when we moved from isoperibolic thermal measurements (intrinsically with large thermal gradients along the wire length) to flow-calorimetry one (thermal gradients largely reduced).

In order to overcome such limitations we introduced, just after ICCF21 (Colorado State University-USA, 3-8 June 2018), a quite innovative geometry of the wire, based on the so called "*Capuchin knot*". The first results were presented at IWAHLM13 (Greccio-Italy, 5-9 October 2018). By such geometry were reconfirmed both the beneficial effects of high temperatures and local (large) thermal gradients. Anyway, because excessive mechanical stresses during the preparation, the maximum number of turns was limited to 8 and minimal distance among the knots was about 12 cm. So, the total numbers of "coils" was limited to 4-5/m. Moreover, the construction of Capuchin knot and the overall installation inside the reactor (made by a tube of tick borosilicate glass) were quite difficult/time consuming.

Because such considerations we further developed the knot construction introducing an *hybrid geometry* that keeps the best of Capuchin geometry reducing, at the same time, the drawbacks of excessive mechanical stresses/difficulties. In addition, we had the opportunity to add both a "field" wire (insulated) and a thermometer inside the loop of the long coil. In conclusion, the number of turns is not anymore limited and the assembly is extremely compact: the apparent length, starting from a wire with 180 cm of length, is just 12 cm with an outer diameter of 1 cm. Such coil, with 50 turns, is inserted inside a 10-12 mm diameter SS316 tube that is used both for mechanical support and IR reflection emitted by the wire. In such a way the local temperature of most of the wire is largely increased (in respect to a nuke wire configuration, even covered by our usual hybrid glassy sheaths, i.e. borosilicate glass and SiO_2-Al_2O_3 fibers) reducing (factor of 4-8) the external electric power needed to reach the operating temperatures (600-800 °C).

Although the new assembly is operative from only 1 month and the data are few, we observed: a) the AHE increases reducing the wire diameter (from 350 to 200 μm); B) the effects of AHE increases increasing the absolute temperatures of the wire (tested up to 850°C); C) the field wire, inserted inside a porous Quartz-Alumina sheath, quite close (1-2 mm) to the CNM coil, although absorbing a very limited amount of power (<1 mA at 300V) is able to both control the amount of Deuterium absorbed (by usual Resistance Ratio measurements) and the amount of AHE produced. Such (extremely interesting) result is obtained just by changing the values of *Voltage* applied and its *Polarity*. We started to study also the time response of the system: 5-10 ms of duration of, cyclic, excitation.