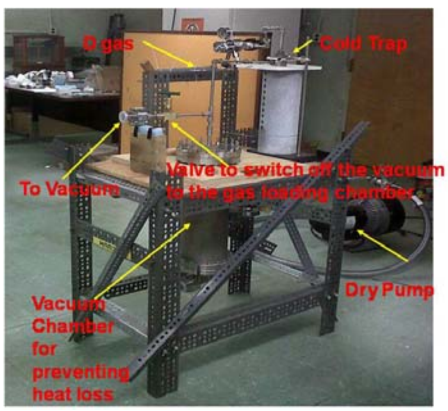
A Game-Changing Power Source Based on Low Energy Nuclear Reactions (LENRs) Xiaoling Yang and George H. Miley, University of Illinois, Urbana, IL 61801 (104 S Wright Street, 216 Talbot Laboratory, Urbana, IL 61801, xlyang@illinois.edu, ghmiley@illinois.edu)

Excess heat generation from our gas-loading LENR power cell (Figure 1) has been verified, confirming nuclear reactions provide output energy. While there are similarities between ours and the Rossi E-Cat gas-loaded kW-MW LENR cells that have attracted international attention, there are important differences in nanoparticle composition and cell construction. Our experiment has established a remarkable proof-of-principle power unit at ca. 350W/kg under room temperature when using deuterium (D_2) gas (H_2 can also be employed) with Pd rich nanoparticles, producing 1479J heat, well above the maximum exothermal energy (690J) possible from all conceivable chemical reactions (Figure 2). Neglecting unlikely chemical reaction contributions, the energy gain is virtually unlimited due to negligible power input with gas loading!



A

B

Figure 1 Gas loading power system. A) Experimental apparatus for pressurizing a stainless tube containing nanoparticles and performing calorimetry on the heat production. B) NPRE undergraduates operating the experiment. The nanoparticles are manufactured by students in the U of Illinois materials research lab. The experimental results have attracted wide attention.

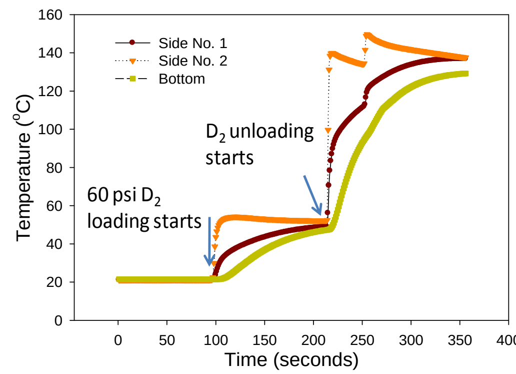


Figure 2 Using sharp changes in the applied pressure. Raw data (Temperature Profile) from an experiment using a gas-loading calorimetry system, the temperature can be increased and operated at a desired level.The slower increase of temperature in two of the three thermocouples was due to poor thermal contact resulting from their location. The 60 psi D_2 gas loading caused the temperature increase from ca. 20 ^{o}C to ca. 50 ^{o}C. The further temperature increase from ca. 50 ^{o}C to ca. 140 ^{o}C occurred during unloading.

Currently, the state of practice power system is heavy, bulky, not efficient enough, and cannot function properly in some extreme environments. As for Radioisotope Thermoelectric Generators (RTG)s, the availability of Pu^{238} is very limited, increasing the cost of Pu^{238}-based RTG. The radioactive product from Pu^{238} also brings up maintenance difficulties. An optimized gas-loaded LENR system of this type can be used in a RTG unit, as shown in Figure 3.

With LENR based heating source, the used fuel, such as H_2 or D_2, is virtually inexhaustible. The reaction products are mildly radioactive such as He^4 from D-D reaction and the beta decay from possible transmutation, but with their short range, both products can easily be contained, thus lowering down the maintenance cost. The huge energy released in the nuclear reactions makes this an extremely compact, long-lived energy source. This new type of RTG would be durable, and have a very high energy density (ultra-long lifetime). The use of gas loading of the metallic nanoparticles allows high temperature operation (analogous to a high temperature gas cooled fission reactor), insuring efficient energy conversion by a traditional thermoelectric pile or advanced Stirling turbines to electricity. This type of RTG will help enable advanced science missions and new capabilities, such as long-life subsurface probes and radioisotope electric propulsion. Such a nuclear power source would completely change NASA's power systems for space, exploration and colony development as well as in-atmosphere travel. Indeed, such applications have already been explored in conceptual design studies by scientists at NASA Langley assuming Rossi-type cell performance. Their extremely encouraging results support the game-changing advantages of developing this technology. While our present test units are at lab bench power levels (multi 100s watts), scaling up to RTG power levels seems quite feasible using larger amounts of nano-particles and an improved heat management design.

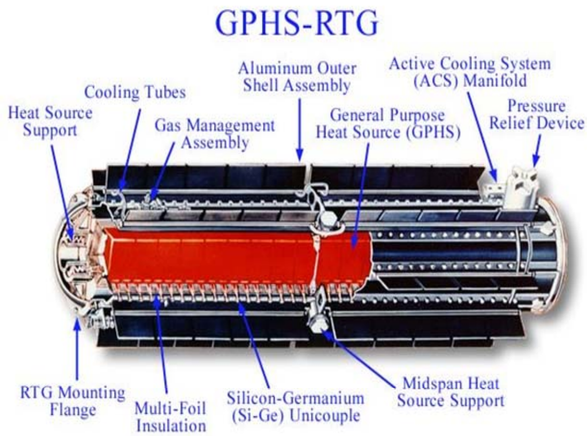


Figure 3 Drawing of a GPHS-RTG that is used for the Galileo, Ulysses, Cassini-Huygens and New Horizons space probes. The goal of the proposed project is development of an optimized LENR gas-loading system to replace the Pu^{238} heat source.