Tian, J., et al. *Excess Heat Triggering by 532nm Laser in a D/Pd Gas-Loading System*. in *ICCF-14 International Conference on Condensed Matter Nuclear Science*. 2008. Washington, DC.

Excess Heat Triggering by 532 nm Laser in a D/Pd Gas-Loading System

J. Tian, L. H. Jin, B. J. Shen, Z. K. Weng, X. Lu
New Hydrogen Laboratory, Changchun University of Science and Technology
7989 Weixing Road, Changchun, Jilin 130022, PR China

Abstract

A laser (λ=532 nm) operated in three modes (continuous, static pulsed and dynamic pulsed) was used to irradiate a series of palladium deuterides with different deuteron loading ratios in a D/Pd gas-loading system. (The loading ratios were D/Pd=0, 0.08, 0.10, 0.17 and 0.27.) The results showed that static pulsed triggering produces a maximum excess heat effect of about 2.6 kJ within a half hour when the loading ratio of Pd was about 0.1 and input power was 25 mW. This corresponds to 4.9×10^{-15} J/atom D or 1.8×10^{4} W/cm^3 Pd. The reason the static pulsed triggering produced more excess heat than other two modes needs to be further studied. The proper ratio in the Pd lattice matching a suitable triggering power may be a key point for heat production.

Key words: D/Pd gas-loading system, heat triggering, static pulsed laser, loading ratio, excess heat.

1. Introduction

Laser stimulation is one of the most potentially useful methods of triggering excess heat in cold fusion (or Condensed Matter Nuclear Science). Letts and Cravens [1] presented this method for the first time in 2003, reporting that it generates highly reproducible significant excess heat from deuterated palladium electrodes in a heavy water cell. V. Violante [2] and K. Sinha[3] repeated and modified the Letts experiment in 2005 and 2006. In 2007, we [4] found transmutation effects on the surface of Pd after exposure to a H_2 gas-loading system and was irradiated with a YAG frequency doubling laser. A gas-loading system can reach a relatively higher temperature with the same amount of input energy or excess heat than an electrolysis system can, due to the lower heat capacity of gas. But we did not find clear evidence for an anomalous exothermic effect. To improve the situation, a D/Pd gas-loading system was chosen and a new kind of triggering laser was applied. The laser has the same wavelength as before (λ=532 nm) but three different working modes were used: continuous, static pulsed and dynamic pulsed.

2. Experimental

2.1 Materials and equipments

A schematic of the experimental system was shown in reference [4]. Both the reaction chamber and Pd material were the same as the previous study, but the Pd wire length (***l*** =50 cm) was shorter. The spot length irritated by laser was about 1 cm, with a volume of about 7.8×10^{-5} cm^3 and contained 5.3×10^{18} Pd atoms. The deuterium gas was produced by an Ultra-Pure Gas Generator (Model DCH-IV, Beijing Tianwuyuan Company, China), which can produce D_2 gas with more than 99.999% purity. Pt-100 resistance thermometers monitored four temperatures: inside and outside the chamber; the whole Pd body; and the laser spot on the Pd wire. The loading radio (x) of Pd wire was calculated by current and voltage with the four-wire resistance measurement method. A data acquisition system (Keithley 2700) was used for record the voltage and current in the Pd circuit and all temperatures. The laser (Changchun Zhongji Optical Electronic Company) wavelength was 532 nm after doubling frequency; pulse frequency was 1 s^{-1}; pulse width was 50 μs for the static mode and 20 ns for the dynamic mode. The working voltage was 850 V, and maximum output power was 2.0 W. Another new feature of this gas-loading apparatus was the precision of its water circulation system. By adding isothermal material outside the flask the temperature fluctuating due to ambient temperature change decreased to ±0.1°C.

2.2 Experiment process and results

2.2.1 Heat triggering of Pd wire with continuous laser

At the beginning of the experimental run, the pure palladium ware was irradiated with the laser as control. Then the wire was charged with deuterium in different ratios: 0.08, 0.10, 0.17 and 0.27. A spot on the wire was continuously irradiated with the laser for 1800 s. The temperature responses for different loading ratio were recorded by the data acquisition system. The results are shown in Figure 1.

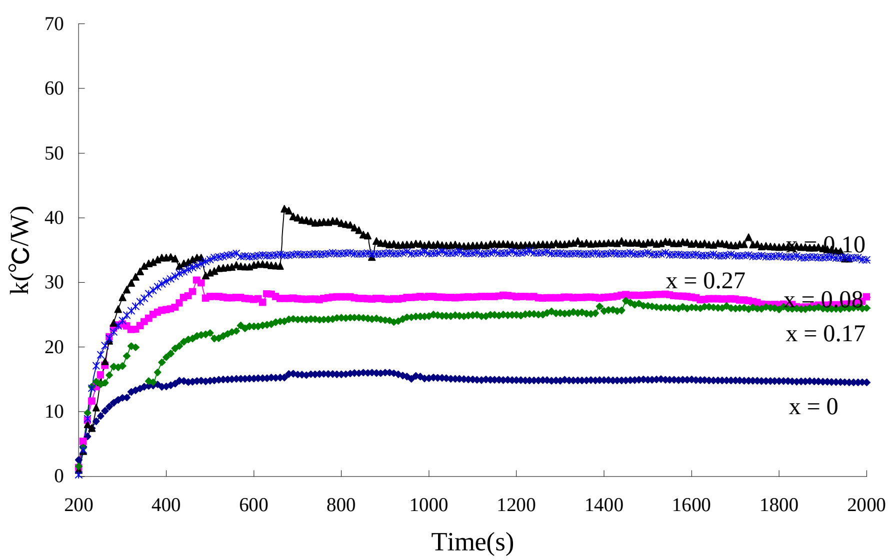

Figure 1. Heat responses of Pd wire with different D_2 loading ratios, triggered by a continuous laser. "x" represents the loading ratio.

2.2.2. Heat triggering of Pd wire with dynamic and static pulsed laser

The same Pd wire with the same deuterium loadings was triggered with dynamic pulsed laser (pulse width 20 ns) and static pulsed laser (pulse width 50 μs) for 1800 s. The temperature responses for each triggering mode are shown in Figures 2 and 3.

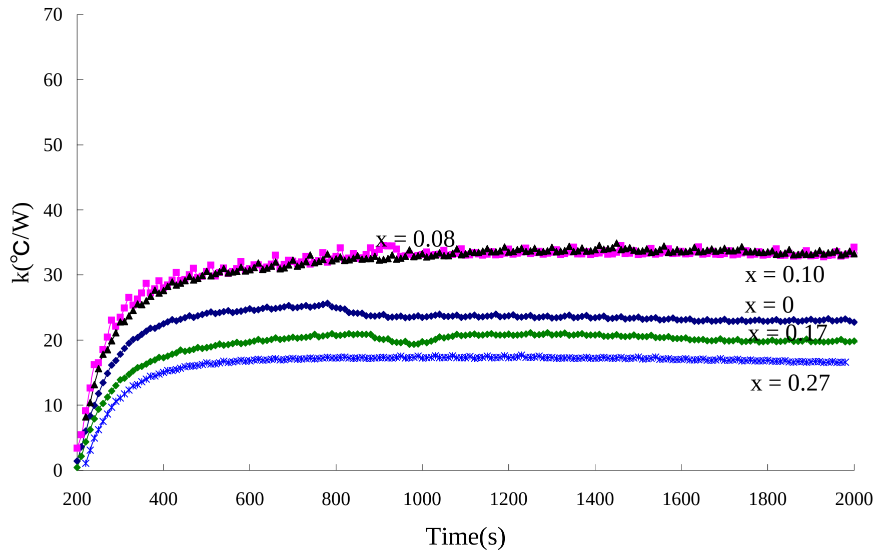

Figure 2. Heat responses of Pd wire with different D_2 loading ratios triggered by dynamic pulsed laser

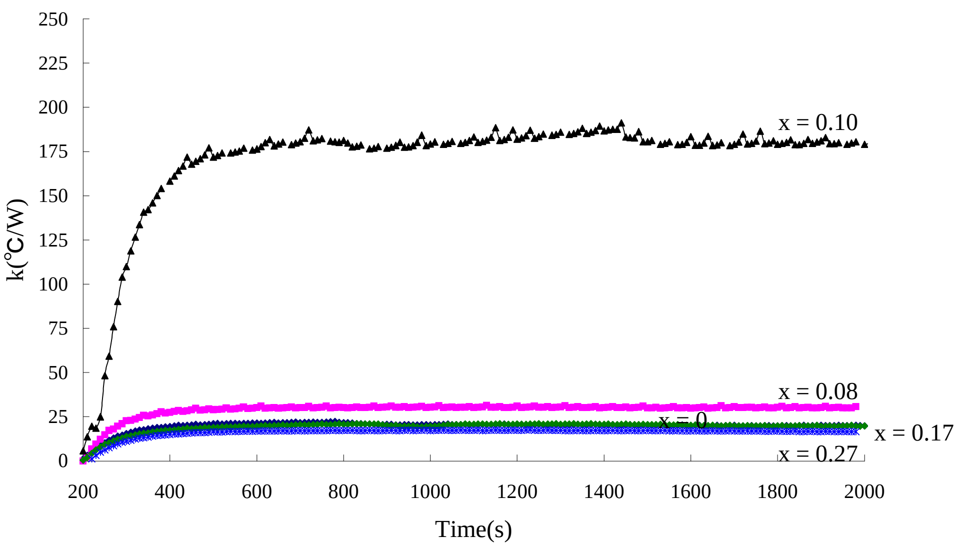

Figure 3. Heat responses of Pd wire with different D_2 loading ratios triggered by static pulsed laser

3. Analysis and discussion

3.1 The excess heat and excess power estimation

The excess heat and excess power were roughly estimated based on the following equations:

$$Excess\ heat = [(k - k_0)/k_0] \times E_{in} \text{ (Joule)}$$

$$Excess\ heat\ power = [(k - k_0)/k_0] \times P_{in} \text{ (Watt)}$$

where ***k*** is the System Constant. ***k*** **=**△T/△P (°C /W), in which △P was the difference of input power (W), △T was the difference of output temperature (°C).

3.2. Excess heat and excess power calculation

For each triggering mode, a set of data was collected and calculations were made. Results are listed in Tables 1 to 3.

Table 1. Data and calculations for continuous laser triggering

x (D/Pd)	***k*** (°C /W)	P_{input} (mW)	Q_{input} (J)	Q_{eh} (J)	Q_{eh} / Q_{input}	Q_{eh} /atom Pd (J)	Q_{eh} /atom D (J)
0	14.8	117	200	–	–	–	–
0.08	26.8	57.2	103.0	162	1.6	3.0×10^{-17}	3.8×10^{-16}
0.10	35.3	42.8	77.2	277	3.6	5.2×10^{-17}	5.2×10^{-16}
0.17	24.4	48.4	96.8	130	1.3	2.4×10^{-17}	1.4×10^{-16}
0.27	33.3	35	62.4	250	4.0	4.7×10^{-17}	1.7×10^{-16}

Table 2. Data and calculations for dynamic pulsed laser triggering

x (D/Pd)	***k*** (°C /W)	P_{input} (mW)	Q_{input} (J)	Q_{eh} (J)	Q_{eh} / Q_{input}	Q_{eh} /atom Pd (J)	Q_{eh} /atom D (J)
0	23.7	166.3	299.3	–	–	–	–
0.08	32.9	45.5	82.0	116.8	1.4	2.2×10^{-17}	2.7×10^{-16}
0.10	32.8	93.9	168.1	114.9	0.7	2.1×10^{-17}	2.1×10^{-16}
0.17	20.1	89	161.1	–	–	–	–
0.27	17.1	83.9	151.1	–	–	–	–

Table 3. Data and calculations for static pulsed laser triggering

x (D/Pd)	***k*** (°C /W)	P_{input} (mW)	Q_{input} (J)	Q_{eh} (J)	Q_{eh} / Q_{input}	Q_{eh} /atom Pd(J)	Q_{eh} /atom D(J)
0	20.6	191.2	344.2	–	–	–	–
0.08	32.1	71.8	128.5	192.9	1.5	3.6×10^{-17}	4.5×10^{-16}
0.10	177.5	25	45.7	2623.3	57.4	4.9×10^{-16}	4.9×10^{-15}
0.17	20.2	176.7	319.3	–	–	–	–
0.27	16.9	159	278.0	–	–	–	–

3.3 Description and discussion

From Figure 1 and Table 1 it can be seen that when the laser was continuously output, the largest heat responses and exothermic behavior was observed, no matter what the loading ratio was. The amount of heat was relatively small. For pulsed triggering, the dynamic mode produced better results when the loading ratio was less than 0.1, which can be seen in Figure 2 and Table 2. The most anomalous phenomena appeared with pulsed triggering with a static mode. When loading 0.1 and input power was 25 mW, the heat response from the Pd wire increased up to ***k*** = 177°C /W (see Figure 3 and Table 3), an astounding result. That meant each deuteron released 4.9×10^{-15} J, and the excess heat power density reached 1.8×10^{4} W/cm^{3} Pd. The reason for this anomalous phenomenon needs to be further discussed. There might have been some resonant tunneling mechanism between deuterons with the help of palladium lattice, which was described by Dr. Li [5] in 2000.

4. Conclusions

Three conclusions could be drawn from the experiment:

1. D/Pd gas loading system has higher sensitivity to detect anomalous heat than the electrolysis method.
2. For excess heat by laser triggering, not only the wavelength but also a working model is important. Pulsed laser light might be more effective than continuous light.
3. It seems that palladium deuteride with high loading ratios need stronger triggering power to release more excess heat.

References

1. D. Letts and D. Cravens. Laser Stimulation of Deuterated Palladium: Past and Present. Infinite Energy, Vol. 50, 2003, p10
2. V. Violante, , M. Bertolotti, E. Castagna, I. Dardik, M. McKubre, S. Moretti, S. Lesin, C. Sarto, F. Tanzella, T. Zilov. Progress in Excess Power Production by Laser Triggering, Proceedings of 12th International Conference on Condensed Matter Nuclear Science. Yokohama, Japan, Nov. 27- Dec. 2, 2005, p. 55
3. K. P. Sinha and A. Meulenberg. Laser stimulation of low-energy nuclear reactions in deuterated palladium. Current Science, Vol. 91, No. 7, Oct. 10, 2006, p. 907
4. J. Tian and L. H. Jin *et al*., Heat Measurements and Surface Studies of Pd Wires after Being Exposed to a H_2 Gas-Loading System Irradiated with a YAG Frequency Doubling Laser. The 13th International Conference on Condensed Matter Nuclear Science. Sochi, Russia, 2007. http://lenr-canr.org/acrobat/TianJheatmeasur.pdf
5. X.Z. Li, J.Tian, M.Y. Mei, and C.X. Li. Sub-Barrier Fusion and Selective Resonant Tunneling. Physical Review C, Vol. 61, 2000, p. 4610