Heat Generation in a PdD_x/Li System

An Analysis of the Fine Experimental Data of Excess Heat Generation in a PdD_x/Li System

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Abstract

The experimental data on the excess heat generation. in PdD./Li cathodes by an ICARUS 9 calorimeter were analyzed using the TNCF model. A quantitative measurements of the amount of the excess heat generated in the cathodes was used to determine the single adjustable parameter n_n density of the trapped thermal neutrons, the value of which was determined as $10^{11} \sim 10^{12}$ cm^{-3} showing a variety of trapping condition from sample to sample and also from time to time in the experiment.

1.Introduction

A novel high power dissipating heat flow calorimetric system ICARUS 9[1] developed at

IMRA Europe has been used to investigate the generation of excess enthalpy in the electrolysis of D_2O electrolytes at Pd and Pd alloy cathodes.

The unique feature of this calorimeter are, by the authors, (a) the ability to make long term measurements for (b) extended time periods (up to several months) at (c) high input powers and at high electrolyte temperatures (up to the atmospheric pressure boiling point of the electrolyte, and (d) there is negligible loss of the electrolyte due to evaporation and (e) there is no recombination of the evolved deuterium and oxygen in the cell.

They obtained the data shown in Table 1 (copied from a view graph shown in the presentation O-014 at ICCF6, by courtesy of Dr. S. Pons). Experimental data shown in this table exhibits characteristics of the cold fusion phenomenon: (1) Qualitative reproducibility of the events (excess heat generation in this case) in an experimental set-up, (2) a long time (few months in this case) necessary to realize the condition to generate cold fusion products (the excess heat) and (3) contrast of the high maximum output-to-input power ratio (up to 250%) and the moderate average ratio (6.6 ~ 20.6%).

Excess heat generation:	No	No	Yes	Yes	No	Yes
Experiment category:	Large electrode	Large electrode	Large electrode	Large electrode	Large electrode	Small electrode
Input power regime:	low power	low power	low power	higher power	higher power	higher power
Experiment number:	ALU153689-927-A	ALU90365JH U947	ALU4667925-C	ALU74093-288-D	ALU94883-J2883-C	ALU6533-209G-917Z
Cathode material:	Palladium	Palladium	Palladium	Palladium	Palladium	Palladium
Cathode size	100x2mm rod	100x2mm rod	100x2mm rod	100x2mm rod	100x2mm rod	25x 2mm rod
Anode material:	Pt, 99.9%	Pt, 99.9%	Pt. 99.9%	Pt. 99.9%	Pt, 99.9%	Pt. 99.9%
Anode size:	1mm wire coil	1mm wire coil	1mm wire coil	1mm wire coil	1mm wire coil	0.1mm mesh
Electrolyte :	0.1M LiOD	0.1M LiOD	0.1M LiOD	0.1M LiOD	0.1M LiOD	0.1M LiOD
Electrolyte, mL:	90.7	90.0	90.6	97.0	97.0	90.4
Controlled current ?:	Yes	Yes	Yes	Yes	Yes	Yes
Controlled voltage ?:	No	No	No	No	No	No
Controlled power ?:	No	No	No	No	No	No
Power suppy, Wmax:	200	200	200	400	400	400
Experiment time, days:	94	134	158	123	123	47
Max power, W/4.2 hrs:	-0.1	-0.6	101	17.3	13.8	74.5
Total energy, MJ:	-0.0	-5.5	294	102	0.3	30.5
% excess power:			150 (30 days)	250 (70 days)		
Average power, W:	-1.0	-1.5	20.6	8.7	-1.0	6.6
Total data points:	27072	38592	45504	35283	35283	13402

Table 1: ICARUS 9 Experimental Details and Summary of Results (courtesy Dr. Pons).

Those features of the cold fusion phenomenon have been explained consistently using the TNCF model as results of the stochastic nature governing atomic processes in the material to realize the condition for effective trapping of the thermal neutrons in the crystal.

We will show a consistent explanation of these data given in Table 1 using the TNCF model.

2.Analysis of the Experimental Results

According to the scenario of the TNCF model[2~4], the trigger reaction in the electrolytic system with the LiOD electrolyte is assumed as a neutron-^{6}Li fusion reaction in the PdLi alloy layer (with a thickness l_o taken as 1 μm) on the Pd cathode surface:

$$n + {}^6\mathrm{Li} = {}^4\mathrm{He} + t + Q_1, \qquad (1)$$

where $Q_1 = 4.8$ MeV.

Then, the excess heat Q in time τ is expressed as follows:

$$Q = 0.35 n_n v_n n_{Li6} i l_o S \sigma_{n\text{-}Li6} Q_1 \tau. \qquad (2)$$

In this relation, $0.35 n_n v_n$ is the thermal neutron flux in the sample per unit area and unit time, S is the surface area of the cathode and σ is the fusion cross section; $s_{n\text{-}Li6} = 9.4 \times 10^2$ barns.

From the geometry of the cathode 1 (ALU4667925-C), 2 (ALU74093-288-D) and 3 (ALU6533-209G-917Z) with the excess heat generation "yes" in the Table 1, we obtain S as 6.28, 6.28 and 1.57 cm^2, respectively. With the velocity of the thermal neutron $v_n = 2.2 \times 10^5$ cm/s (300°K), $n_{Li6} = 3.4 \times 10^{22} \times 0.074$ cm^{-3} and $Q = 5$ W, we obtain the density of the trapped thermal neutrons (in average);

$$n_n = 2.4 \times 10^{11}, 9.9 \times 10^{10}, \text{ and } 7.5 \times 10^{10} \text{ cm}^{-3}. \qquad (3)$$

The results are shown in Table 2 with other data for maximum values.

These values are reasonable ones compared with values[4] obtained for other samples in different conditions.

Taking only the reaction (1), the number of events N_Q is equal to N_{He} and also to N_t. However, there will be other

Exp. No.	ALU4667925-C	ALU74093-288-D	ALU6533-209G-9172
$N_Q)_{exp\ max}$ s^{-1}	1.3×10^{14}	2.3×10^{13}	9.7×10^{13}
$N_Q)_{exp.aver}$ s^{-1}	2.7×10^{13}	1.1×10^{13}	8.6×10^{12}
$n_n)_{max}$ cm^{-3}	1.2×10^{12}	2.0×10^{11}	8.5×10^{11}
$n_n)_{aver}$ cm^{-3}	2.4×10^{11}	9.9×10^{10}	7.5×10^{10}

Table 2: Results of Analysis of Experimental Data obtained by ICARUS 9. (NQ)exp Q(MeV)/5 (MeV))

reactions such as written down below induced by the high energy particles 'He and i generated in the trigger reaction (1) contributing to the excess heat with and without 'He, we can expect the ratios NQINH@ and NQINHE larger than 1:

$$t\ (2.7\ \text{MeV}) + d = {}^4\text{He}\ (3.5\ \text{MeV}) + n\ (14.1\ \text{MeV}) + 2.7\ \text{MeV}, \quad (4)$$
$$n\ (14.1\ \text{MeV}) + d = n'\ (\varepsilon) + d'\ (\varepsilon'), \quad (5)$$
$$n\ (14.1\ \text{MeV}) + d = n'(\varepsilon) + p\ (\varepsilon') + d\ (\varepsilon''), \quad (6)$$
$$n + d = t + \gamma + 6.25\ \text{MeV}, \quad (7)$$
$$n + p = d + \gamma + 2.2\ \text{MeV}, \quad (8)$$
$$n + {}^7\text{Li} = {}^8\text{Be} = 2\ {}^4\text{He} + e^- + \nu_e + 16.2\ \text{MeV}, \quad (9)$$
$$n + {}^A\text{M} = {}^{A+1}\text{M}' + e^- + \nu_e. \quad (10)$$

Therefore, we can expect at least one ^{4}He and one tritium atom for one event generating the excess heat though the authors did not measure them as recent work has shown[5].

3.Conclusion

The TNCF model[2-4] has consistently explained a series of data obtained in the cold fusion experiments. Especially, the riddles of the cold fusion phenomenon such as the huge excess heat, the large N/N_n ratio[6,7], the generation of ^{4}He[5,8], nuclear transmutation[9], the cold fusion in a metal-hydrogen system[10] and the poor experimental reproducibility. These have been impossible to explain just by following simple fusion reactions between light nuclei, even when they occurred with a high probability:

$$d + d = t + p, \quad (11)$$
$$= {}^3\text{He} + n, \quad (12)$$
$$= {}^4\text{He} + \gamma. \quad (13)$$

The experimental data[1] obtained in the sophisticated apparatus ICARUS 9 clearly shows the complexity of the cold fusion phenomenon. For instance, the data in Table 1 show the characteristics of the phenomenon: long time (~ few months) for the generation of the excess heat, sporadic nature of the high excess heat generation compared with the average, and qualitative reproducibility of the excess heat.

Those characteristics can be explained by the TNCF model which assumes the stable existence of the trapped thermal neutrons in the sample. The condition for the neutron trapping is governed by atomic processes occurring in the sample which are stochastic from their nature. This is the reason that the cold fusion phenomenon has the qualitative reproducibility but not the quantitative.

Other events in the cold fusion phenomenon such as nuclear products (tritium, helium 4 and neutrons) and nuclear transmutation (NT) is attracting much attention from researchers in this field. The TNCF model could explain NT in several cases[9], though there remain many data still waiting an explanation. Also explained were data from metal-hydrogen systems generating large excess heat[10].

The analyses of those experimental data by the TNCF model depict the physics of the cold fusion phenomenon, predicting some new effects for further development of the solid state-nuclear physics.

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(More Monomania —from page 43)

AIDS, and a bunch of other illnesses. What possible harm can root canals do to you? Wait'll you read the book exposing this dark secret of the dentists. You have any fillings? Then read the Huggins book and find out what mercury poisoning is doing to you. Dowsing is baloney? Ignorance isn't bliss, so read the Lehto book. Maybe you'd better find out what a scam immunization shots are and what damage they're doing to your and your kids.

There are several books on education I've reviewed — like the one of the Sudbury Valley School, which is a model of freedom and results. You'll never send your kids to public schools once you do your homework. Never!

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