22. A New Energy caused by "Spillover-Deuterium"

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Abstract: It was verified that a new kind of energy is caused by "Spillover-Deuterium" generated in a double structure (DS)-cathode with "Pd-black". Using this cathode, the authors confirmed the sustained production of a significantly abnormal amount of energy over a period of several months that could not be ascribed to chemical reaction energy. The chemical reaction energy of 0.1 [mol] Pd-black used is only 4[kJ], but more than 200[MJ] of excess energy was continuously produced for over 3000 [hr] at an average rate of 50–100 [kJ/hr] using a DS-cathode with a same quantity of Pd-black. Intermittent operation over a period of two years using this structure proved the complete reproducibility of these results.

Key words: Spillover deuterium; Pd-black; DS-cathode; new energy.

Introduction. Since Fleischmann *et al.*[1] first reported on a hypothesis of "unknown fusion reaction" in 1989, various experiments[2] have been carried out but without sufficient reproducibility of the results as known well. Taking a different approach as below, the authors began to research the same subject in March 1989 and reported initial results at the end of the same year[3];

[A] Surface atomistic structure will plays a key role in the production of a new type of energy.

[B] Lattice imperfection such as lattice defects, amporphous structures, intense local stress and microcrack are very important.

[C] Bottle and/or cylinder shaped (50 mm × 20 mm dia.) "Pd-electrodes" with function as the cathode in electrolysis were designed to examine the possibility of "solid-state plasma fusion" under the condition of the high pulse/high frequency current when the author conducted the first "plasma fusion" experiments in Japan in 1958 (Feb).[8]

Based on points [A] and [B] above, the authors recognized the importance of using Pd "powder". Experiments were first carried out after applying the powder to the cathode's surface by thermal spraying, and our accumulated results utilizing this method were presented in our first and subsequent reports.[3–5] Based on [C], we produced large cathodes in the form of a Pd rod and bottle with the same size mentioned above.

In 1990 the authors developed a Double Structure Cathode (DS-cathode below) based on points [A], [B] and [C] above.[9] The DS-cathode consists of a Pd cathode with an internal vacuum zone filled with a deuterium storage type powder. A long trial and error period of over two years was required before success was achieved in the DS-cathode experiments.

The DS-cathode first used consisted of a Pd bottle-shaped outer cathode filled with "Pd-black" powder as an inner cathode. The outer-cathode was used principally to introduce D^+ ions into the inner-cathode where the primary reaction that realizes excess energy takes place. After repeated trial tests lasting over a year, the authors began the main experiment using this DS-cathode in September 1992 and the experiment is still in progress. It should be noted that DS-cathode is fundamentally different from the Single

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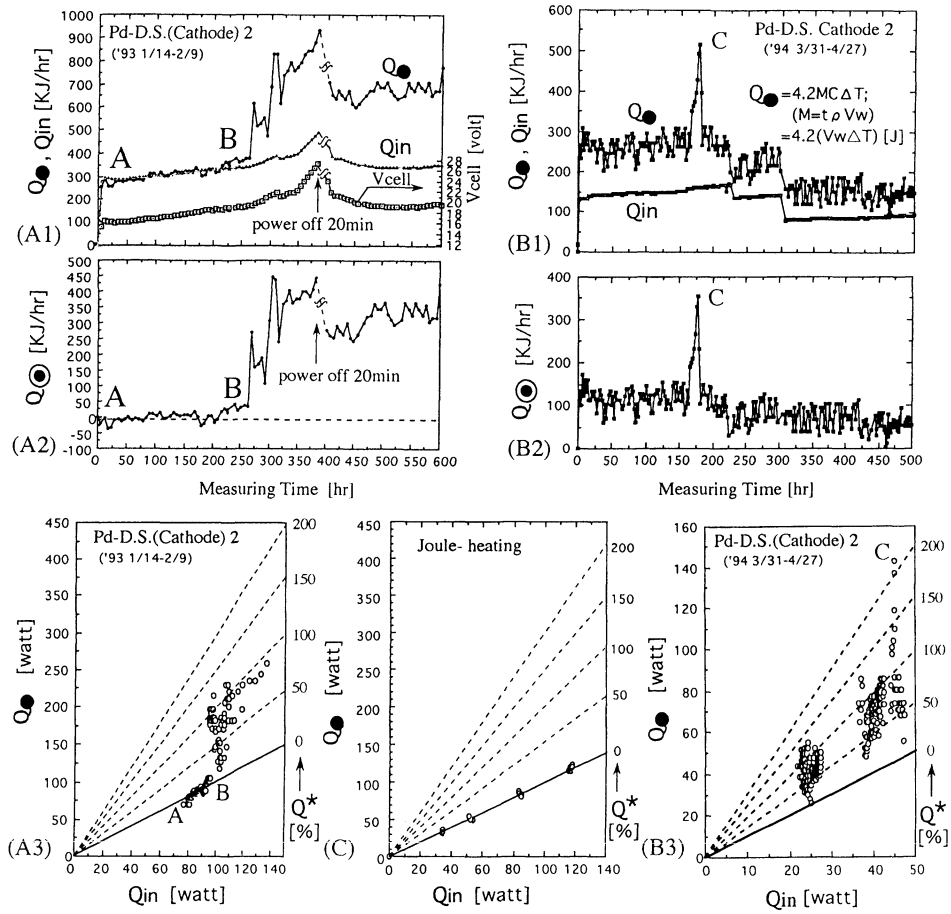

Fig. 1. Excess heat characteristics in DS-cathode for a long period over 2 years. Note: A-series (A_1, A_2, A_3); experiments in 1992–1993, B-series (B_1, B_2, B_3); re-experiments in 1994 after 1 year idling period of A-series' cathode, and (C); experiments of "standard joule heat sources".

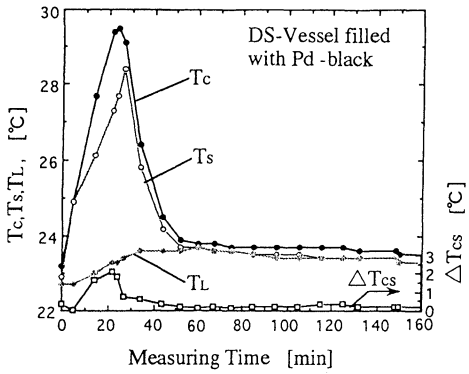

Fig. 2. Chemical reaction characteristics when the same quantity of "Pd-black" was used with that of Fig. 1 DS-cathode.

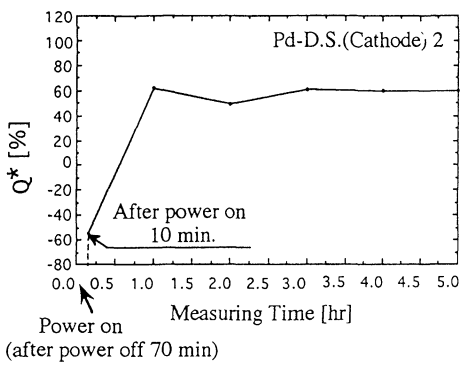

Fig. 3. Excess heat generation characteristics at the beginning of re-test using DS-cathode of Fig. 1.

Structure Cathodes (SS-cathodes below) used by all other researchers which consist of a plate, foil, wire, cylinder or rod.

Experiments and discussion. The experiments were conducted under the basic guidelines described in Appendix I, where the symbols used in this report are defined. The DS-cathode used in an earlier study[6] was retested after being left idle for a period of one year to test the reproducibility of the earlier reported results. An intermittent test was conducted over 1000 [hr], and a 3000 [hr] continuous test was also conducted. The functional principle and characteristics of the DS-cathode are described in Appendix II.

Fig. 1 shows the excess heat characteristics in DS-cathode for long period over 2 years. The A-series (A_1, A_2, A_3) show one example (600 [hr] continuous) of the 1992–1993 experiments. Since a new intermittent tests conducted over a period of 1000 [hr] yielded similar results each time, it was decided to leave the DS-cathode idle for one year to investigate any change due to "aging". The B-series (B_1, B_2, B_3) show the retesting results for experiments conducted one year later in 1994 using the same DS-cathode employed for the A-series. Here (C) is the result obtained using "standard joul heat sources" of joule heating by standard resistors in above same cell. It is surprising that A and B-serieses in Fig. 1 are virtually identical, demonstrating the complete reproducibility of this system. (A_1) in A-series shows the time characteristic of the relation between the Effective Output $Q_{\bullet}$, Electric Input Q_{in} and the Cell Voltage V_{cell} ($=Vo-1.5$[V], Vo: constant current supply voltage). Here, $Q_{in}=tIV_{cell}$[J]. (A2) shows the time dependency of the most important parameter, Cell Power $Q_{\odot}$ ($=Q_{\bullet}-Q_{in}$). (A3) clarifies the relationship between Q_{in}, $Q_{\bullet}$ and the Excess Rate Q^* of excess heat emission. Period A-B shown in A-series is the incubation period required whenever a cathode is used for the first time, however in a cathode once produced excess heat, it is significantly shorter. (B1), B2) and (B3) in B-series correspond to (A1) (A2) and (A3) in A-series after one year elapsed, respectively. While there is absolutely no change in Q_{in} and V_w, the appearance of a C-zone which indicates the suddenly increased temperature by about two times for 17 [hr] offers significant hope for future.

In a 3000[hr] continuous experiment using the DS-cathode with Pd-black (0.1[mol]), an excess energy higher than 200[MJ] was obtained with an average rate of 50–100[kJ/hr]. It is well known that the chemical reaction energy between Pd and deuterium is almost 40[kJ/mol], and in this case only 4[kJ], which was confirmed by experiment result of Fig. 2. In other words, when the "DS-vessel" (Stainless Steel Vacuum Vessel similar to the DS-cathode) with a same amount of Pd-black is placed at same position of DS-cathode in the cell and then deuterium is introduced in this vessel, the internal temperature Tc rises immediately and the surface temperature Ts follows. The electrolyte temperature T_L rises almost 1°C which corresponds to 4[kJ]. These test data shows that there is a significant difference between the characteristics of the chemical reaction energy and the excess energy of the DS-cathode, and it is obvious that these energy were produced by fundamentally different mechanisms respectively.

Fig. 3 shows the excess heat characteristic when the DS-cathode used in Fig. 1 was retested after "off-interval" of 70 min. The Excess Rate Q^* was -60%, ten minutes after startup of the system, but a stable generation of excess energy was achieved within one hour with Q^* stabilized at 60–70%. The same phenomena caused with complete responsibility in the repeated tests. Fig. 4 compares the internal temperature T_c of the DS-cathode during the experiment with the temperature T_s of the electrolyte near the cathode surface, which is heated to the highest by joule heat. T_c is constantly almost 1°C higher than T_s, demonstrating that the "heat source" is clearly internal. A surprising finding is that the temperature difference $\Delta T_{c,s}(=T_c-T_s > 0)$ was observed even after the power was turned off, and a difference of almost 0.3°C was maintained during test-off

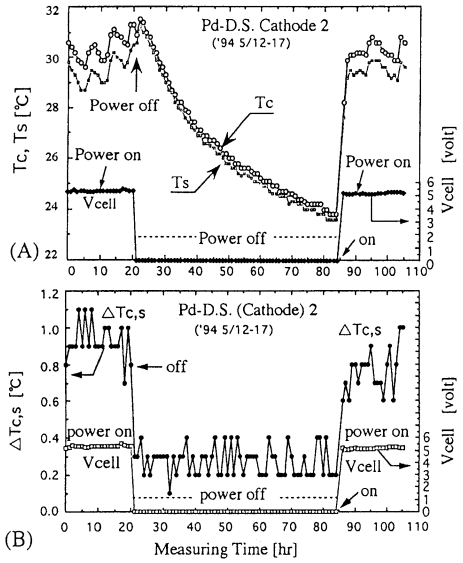

Fig. 4. Internal temperature characteristic of the DS-cathode.

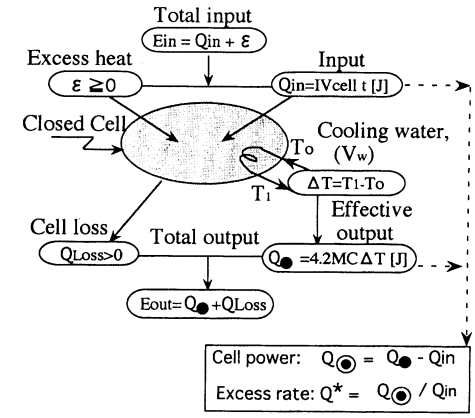

Fig. 5. Block diagram of the measurement system for the cell power.

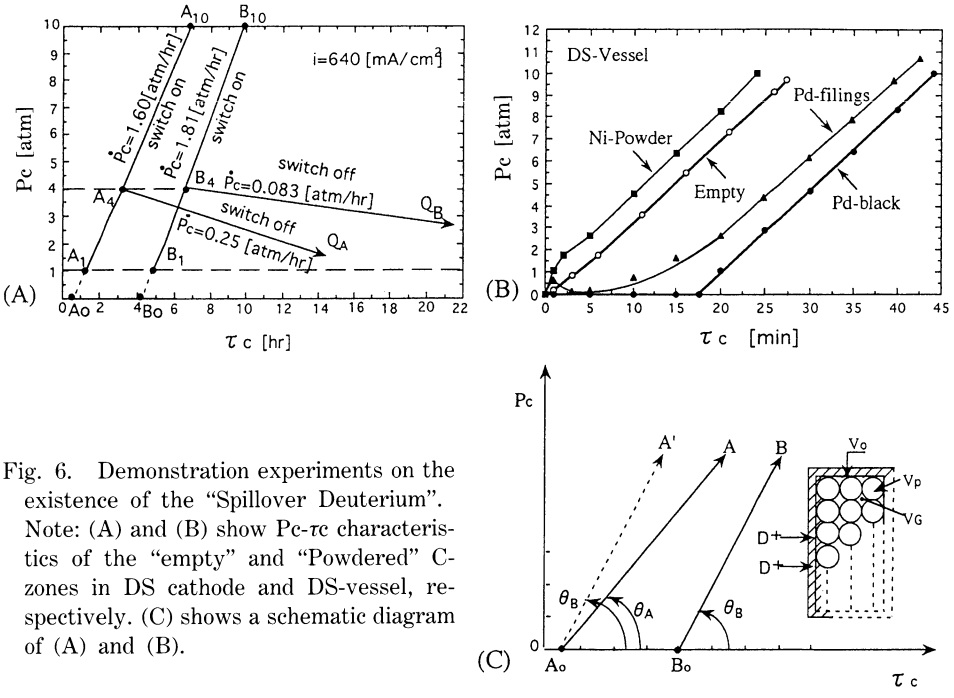

Fig. 6. Demonstration experiments on the existence of the "Spillover Deuterium". Note: (A) and (B) show Pc-τc characteristics of the "empty" and "Powdered" C-zones in DS cathode and DS-vessel, respectively. (C) shows a schematic diagram of (A) and (B).

($Q_{in}=0$), and the same results were obtained repeatedly with complete responsibility.

Appendix I system for measuring cell output characteristics. The experiments were conducted using a closed cell[6] in which excess heat was measured by the system shown in Fig. 5. The total input (E_{in}) and the total output (E_{out}) in closed cell are equal. E_{in} is the sum of the electrical input (Q_{in}) and the excess heat (ε). E_{out} is the sum of output energy ($Q_{\bullet}$) delivered outside of the system by the cooling water flowing through the cooling duct in the closed cell, and loss energy flowing from the cell to the outside (cell loss; Q_{Loss}). The relationships between these parameters are given by

$$E_{in}=E_{out} \quad \text{..... (a)}$$
$$Q_{\bullet}-Q_{in}=\varepsilon-Q_{Loss} \ (\equiv Q_{\odot}) \quad \text{..... (b)}$$
$$Q^{*}\equiv Q_{\odot}/Q_{in} \quad \text{.....(c)}$$
$$Q_{in}=tIV_{cell}[J];\ Q_{\bullet}=4.2MC\Delta T[J] \quad \text{..... (d)}$$

where

$Q_{\bullet}$: the actual energy delivered from the cell, and named as "effective output"
$Q_{\odot}$: the effective excess energy that can be extracted from the cell, and herein named as "cell power"
Q^{*} : the rate of effective excess energy to Q_{in}, and named as "excess rate"
Q_{Loss} : the loss energy flowing out of the cell, indicating the heat insulation characteristic of the cell, $Q_{Loss} \neq 0$.

Appendix II structure and characteristics of the DS-cathode. The conventional SS-cathode is contaminated by the electrolyte and impurities during prolonged electrolysis. Moreover the shape and size of the SS-cathode are extremely limited and deuterium is not absorbed enough to keep the homogeneous distribution in SS-cathode. In contrast, a DS-cathode that enabled the no limitation in size is separated into two parts, an outer-cathode and an inner-cathode, each of which performs a specific function. Specifically, the outer-cathode (B-zone) receives D^{+} ions from the electrolyte (A-zone), and transfers these D^{+} ions to the inner-cathode (C-zone). C-zone is filled with an inner-cathode material of the desired shape such as "Pd-black", and an electromagnetic energy can also be easily given for inner cathode as required.

If the "Pd-black" particles in the C-zone contact the inside wall of the outer-cathode, deuterium in the outer-cathode travel instantaneously and distribute homogeneously on the surfaces of all particles through the contact zone by "Spillover-Effect"[7] (surface migration), and penetrate quickly into all particles, respectively.

When the vacuum space of "Particle-gaps" (V_G: space between each particle) in the C-zone should be filled with D_2 gas as electrolysis progresses, the pressure P_C rises with time τ_C therein. Fig. 6(A, B) show the Pc-τ_C characteristics in the C-zone. For example, the average time required for the deuterium to pass the B-zone and/or reach the C-zone is $\tau_C=A_0$ in Fig. 6(A) when the electrolytic current density i=640[mA/cm^2]. This is the incubation period of the D_2 gas appearing in the C-zone. The subsequent time required for Pc to reach 1, 4, . . . , 10[atm] as operation continues is $\tau_C=A_1$, A_4, . . . , A_{10}[hr], respectively. The effect of the on/off state on P_C and on the pressure rise rate $\dot{P}_C$ at i=640[mA/cm^2] are shown in Fig. 6(A). Line $A_0A_4A_{10}$ is the pressure characteristic in the "on-state" (during switch on state) in a "empty" C-zone (not filled with powder); line A_4Q_A indicates the "off-state" characteristic. Line $B_0B_1B_4B_{10}$ is the pressure characteristic in the "on-state" in a C-zone filled with Pd-black ("Pd-black" C-zone); line B_4Q_B indicates the "off-state" characteristic. It is very important that the incubation period in "Pd-black" C-zone is significantly longer than in "empty" C-zone, and that drop in pressure P_C is very gradual in the "off-state". It is notable that these phenomena also appear in DS-vessel, as

shown in Fig. 6(B).

Appendix III the characteristic of "Spillover-Deuterium". Fig. 6(C) is a schematic diagram of Fig. 6(A, B). A look at what happens in these figures shows that there is no incubation period in the "empty" C-zone or in the "Ni-powder" C-zone (even 20 [nm] Ni black), which is defective to absorb D_2 gas. On the contrary, the incubation period is very large in "Pd-black" C-zone. In other words, in a DS-cathode with constant electrolysis current or in DS-vessel with a constant D_2 gas inlet speed, internal pressure P_c rises linearly with time τ_C as the gas penetrates into the "empty" and "Ni-powder" C-zones respectively as lines A_0A and A_0A' in Fig. 6(C). However, there is no pressure range "A_0B_0" appearing over a long period in "Pd-black" C-zone. This range expresses the time that deuterium is absorbed until the powder is saturated, providing clear proof that the deuterium is fulfilling its function as "Spillover-Deuterium".

In other words, if spillover-deuterium is not present, for example, the deuterium penetrating into the C-zone will first fill the "Particle-gaps" V_G ($=V_o-V_p<V_o$; V_0=C-zone volume, V_p=total particle volume), and the pressure should rise as shown by line A_oA' in Fig. 6(C) as in "Ni-powder" C-zone. The deuterium will then spread gradually into the particles as in "Pd-filings" C-zone in Fig. 6(B), which does not have as pronounced a "Spillover Effect"[7] as "Pd-black". These phenomena show clearly that "Spillover-Deuterium" instantaneously migrates to the surface of each particle of "Pd-black" and is evenly distributed. For such function of "Pa-black", we named "Pumping-up action" of ultra fine particles. The deuterium thereafter rapidly penetrates into the particles due to, for example, intercalation or lattice imperfection, reaching Bo near the saturation state, with the pressure suddenly rising and approaching the line BoB at an angle $\Theta_B(>\Theta_A)$. This conforms to the measured values. The spillover-deuterium phenomenon thus plays a key role in a "continuous new energy generation".

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