LETTERS TO THE EDITOR

COMMENTS ON COMPOSITE ELECTROLYTES AND COLD FUSION

Cold fusion phenomena have been observed by many experimenters. A detailed theoretical explanation of deuterium reactions in palladium and titanium was given by Hora et al.,[1,2] and it looks as if cold fusion is essentially a surface phenomena, with the probability of its occurring in the bulk material being much lower. In view of the foregoing results, I suggest the use of composite electrolytes, namely, a mixture of palladium powder, sand, heavy water, sodium hydroxide (NaOD), and pyrogallol (to prevent explosion hazards by absorbing oxygen). The main advantage of such composite electrolytes is not only a mere increase of the surface of contact of the palladium but also the behavior of each grain of palladium as an independent electrode, deuterium being released wherever a current enters a palladium grain. This allows a kind of pseudo-Coulomb multiplication, which has already been suggested for recovering the energy of lightning.[3] Electrolysis will actually happen if the potential difference between two adjacent metallic grains is larger than the theoretical decomposition voltage of water, 1.23 V. However, the palladium grains should not be in contact; otherwise, the conduction becomes electronic, thereby canceling the electrochemical effects.

We may assume that the grains of sand and palladium are located on the summits of a cubic lattice of parameter d but that the grains of palladium are located quite at random. Assuming a compact arrangement, the total density of the particles is $n_t = 1/d^3$ or $d = n^{-1/3}$. If the grains of palladium and sand have the same diameter, $d = 0.1$ mm, then $n_t = 10^6$ grain/cm^3, and the void volume between grains represents 47.6% of the total volume. The average distance between the palladium grains is assumed to be six times larger than the average distance between the grains of sand: $d_{Pd} = 6d_s$. The density of the palladium grains is $n = 1/d_{Pd}^3 = n_s/216$, where n_s is the density of the grains of sand. Because $n_t = n + n_s$, then $n_s = (216/217)n_t = 995381$ grain/cm^3 and $n = n_t/217 = 4608$ grain/cm^3. The average distances between the grains of palladium and sand are, respectively, $d_{Pd} = 217^{1/3}d = 0.6$ mm and $d_s = (217/216)^{1/3}d = 0.1$ mm.

For a random distribution, the probability of finding two adjacent grains of palladium between the distances r and $r + dr$ is given by Hertz's formula:

$$dP = 4\pi r^2 n \exp(-4\pi n r^3/3)\, dr \ .$$

Two grains of palladium will not be in contact if $r > d$, corresponding to the probability

$$P = \int_d^\infty dP = \exp(-4\pi n/3n_t)$$

because $n_t = 1/d^3$. Using the foregoing numerical values, we find $P = 0.9808$. This means that 98.08% of the grains of palladium is correctly isolated by the sand. The concentration of the grains of deuterium active for electrolysis is $n_a = Pn = 4519$ grain/cm^3, and their average distance is $d_{Pd_a} = 0.605$ mm.

The experiment could be performed with the electrolytical cell ABCD shown in Fig. 1. It is a container of section 100 cm^2 and length $l = 30$ cm, filled with the composite electrolyte. The current enters the mixture through the iron electrodes E_1 and E_2 connected to a pulsed-power generator. The use of pulsed power prevents excessive heating, and moreover, transient conditions are known to favor cold fusion.[4] The capacitor $C = 1\ \mu$F is charged through the resistance $R = 2$ MΩ by the direct-current (dc) potential source $U_i = 15$ kV, and the potential difference at the terminals of the condenser is

$$U = U_i[1 - \exp(-t/T)] \ ,$$

where $T = RC = 2$ s. If the spark gap S starts the discharge when $U = 10$ kV, then there is a discharge every 2 s. The resistance of the electrolyte, using a 0.5-m solution of NaOD is of the order of 100 Ω, so the time constant for the discharge is 10^{-4} s. In 1 h, the electrolytic cell has been crossed by 18 C. The average number of active palladium grains crossed by a line of current is $l/d_{Pd_a} = 495$. So in 1 h, the electrochemical effect would be equivalent to $18 \times 495 = 8910$ C, corresponding to the release of 1.034 ℓ of deuterium. The total mass of palladium involved is 83.24 g, corresponding to 13.557×10^6 active grains of total area 0.426 m^2. If cold fusion is a surface phenomenon, the huge surface of palladium involved in the considered electrochemical process would mean an enormous increase in sensitivity of the order of 10^3.

Alexandre E. Pozwolski

Education Nationale
3A3, 6 Rue de la Plaine
75020 Paris, France

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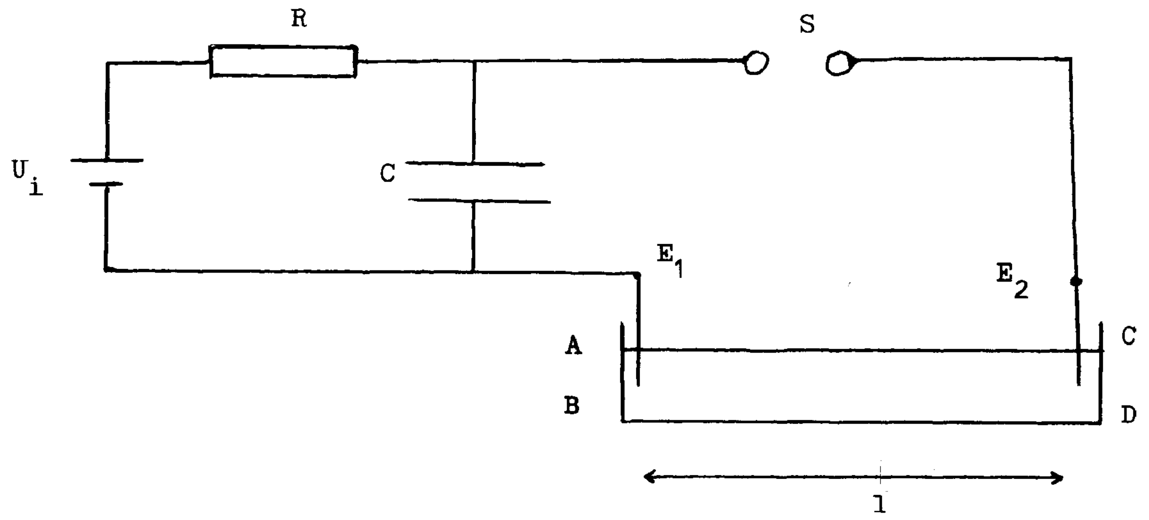

Fig. 1. Current arrives into the electrolytic container through electrodes E_1 and E_2. The spark-gap S in series with the capacitor C allows an impulse excitation. The resistance R in series with the dc power supply U_i controls the frequency of the discharge.

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COMMENTS ON THE POSSIBLE NATURE OF "COLD FUSION" PHENOMENA

At present, it is impossible to ignore some data on strange phenomena designated as "cold fusion." These phenomena are not yet explained.[1,2] It seems to us that the nature of cold fusion may be found in the framework of the modern physics of elementary particles. Almost all theories have predicted a nonzero value for the particle electric dipole moment (EDM) when CP and T violations were discovered. The existence of such particles was absolutely rejected by science before these discoveries.

We think that a fundamental neutral particle with EDM could exist. This particle would create, together with a neutrino, a new long-lived neutral boson compound system with EDM. We named it "eleptino." A number of models for a theory of grand unification predict extremely small masses of the neutral lepton (see Ref. 3). The total number of residual neutrinos in the universe is evaluated as 10^9/proton. The total number of eleptinos may have the same order of magnitude. Assuming that only 1% of all particles are captured in matter, their density in ordinary water would be of the order of $10^{30}\,\mathrm{cm}^{-3}$. Such high densities are possible because of the attractive forces of the electric charge in atoms and because of their mutual interaction due to EDM. We do not know the mass and the EDM of the eleptino, but we believe that they are very small.

The natural question of why such densities have never been observed arises. Estimates show that a Bose gas has an extremely low specific heat because of its degeneracy. In spite of the smallness of the proposed properties of the eleptinos, their existence may be checked owing to some collective effects.

Many events in the cosmos and on Earth may be related to the possibility that the eleptinos penetrate into a nuclei because the Coulomb barrier does not stop them.

Probably the cosmic flux to Earth contains the eleptinos together with other Bose particles: residual photons, which were discovered in 1965. We venture to foresee that the events described in the literature about cold fusion and the discovery of gamma-ray flashes of earth origin[4] may be the result of some "exotic" reactions of the eleptinos with nuclei. As a result of the decomposition of an eleptino, the electric charge of nuclei may change. We believe, for example, that the reaction $^2\mathrm{D}^+ + \mathrm{ept} \Rightarrow {}^2\mathrm{He}^{++} + e^-$ may destroy the nucleus of deuterium because $^2\mathrm{He}^{++}$ is unstable. This reaction is equivalent to one with neutron decay, $n + \nu \Rightarrow p + e^-$. In the framework of the four-fermion interaction postulated by Fermi for the explanation of beta decay of the nuclei, such a reaction is possible because the creation of an antineutrino and the decay a neutrino make use of the same operator.[3] The reaction $2\mathrm{D}^+ \Rightarrow {}^4\mathrm{He}^{++}$ discussed in Ref. 5 as a possible explanation of cold fusion phenomena may be related to the eleptinos. The high concentration of hydrogen ions at electrodes by electrolysis is attributed to the cold fusion phenomena.

A. V. Nedospasov

Scientific Association "IVTAN"
Moscow, 127412, Izorskaja
13/19, Russia

E. V. Mudretskaya

Scientific Productive Center "Elé"
Moscow, 119034
Butikovskii 16, Russia

May 11, 1995

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