On a Mechanism of the Electrochemically Induced Nuclear Fusion

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Synopsis

A mechanism is proposed to explain a d-d fusion in a process of D_2O electrolysis with Pd (or Ti) cathode. Experimental data obtained by Jones et al. were explained qualitatively.

1. Introduction

A provable mechanism is proposed which is capable of explaining qualitatively the electrochemically induced nuclear fusion of deuterons reported recently[1] again after 60 years from the first discovery of the same phenomenon[2].

In the paper[2] Paneth et al. reported a curious result of the detection of He atoms in an experiment of the electrolysis of water (H_2O+D_2O) using palladium metal as a cathode. They had pursued this phenomenon chemically and reported an upper limit for the helium production in several succeeding papers[3-5] but could not prove the transmutation of hydrogen into helium. Though the work was very interesting chemically, the meaning of the result was not taken serious at that time.

In the paper[1], Jones et al. rediscovered the same result as Paneth et al. using heavy water (D_2O) and modern techniques developed after the discovery of the neutron. In the process of D_2O electrolysis with Pd (or Ti) cathode, they confirmed one of the reactions

$$d + d \rightarrow {}^3He + n \quad (1)$$

and

$$d + d \rightarrow p + t \quad (2)$$

detecting neutrons liberated in the reaction (1).

Their results are summarized as follows: 1) Neutrons were observed only when the electrolysis of D_2O was proceeding, 2) when the surface of Pd (or Ti) cathode was covered with a coating, the neutron was not detected, and 3) Pd metal occluded with deuterium did not give any neutron if there were no electrolysis occuring.

2. Model and Discussion

To explain experimental results 1) - 3) in which fusion cross section was extraordinary large that was difficult to understand with our knowledge of nuclear fusion, we propose here a qualitative mechanism which explains those data consistently.

It is well known that the hydrogen isotope atoms are occluded in Pd (or Ti) metal very easily and they move very fast in the metal. And also in the stable state, the occluded hydrogen atoms locate at the interstitial positions. So, it is reasonable to consider a deuteron behaves as a neutral particle (d*) with electron cloud around it. In the atomistic view, the deuteron in the Pd lattice attracts electrons and its electrostatic field is screened out almost in the 'Debye length' in the metal.

On the other hand, the electric field in the electrolyte produced by the cathode is confined in a sheath whose width is of the order of a Debye length in the electrolyte. A deuteron accelerated by the electric field in the sheath enters into the palladium metal and wears electron cloud made of free electrons in the metal not loosing much energy in the process. The deuteron then enters into a 'channel' among lattice points and collides with deuterons occluded and situated at an interstitial position in the metal. The electrostatic repulsion which opposes d-d fusion in an ionized state is now largely reduced at large distances by the electron cloud which is screening deuteron charge. Collision probability is largely enhanced by the existence of the channel. Once a collision occurs, the fusion probability is strongly enhanced by the reduction of the width of an electrostatic barrier between two nuclei.

The interaction between two d* particles is different from that between two D atoms. In the latter case, two-electron correlation creates an interaction potential with a minimum at 0.74 A and a strong repulsive hill at small distances. In the former case. the many electron effect of the metallic free electrons and/or lattice vibration effect might be more effective to reduce repulsive potential untill two d* particles approach very close into the effective screening radius.

The mechanism proposed above explains qualitatively the experimental features 1) - 3). Deuterons in the electrolyte are accelerated by the electric field in the sheath of the cathode. They enter into the cathode metal with high-energy and wear there electron cloud to neutralize their charge. They move in the metal through channels among lattice points. They then collide with d* (deuterons with electron cloud) on the channel already in the metal. The electron cloud screeening deuteron charge makes it easy two deuterons to react and fuse into a new nucleus. Numerical estimation will be given in the following paper[6].

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