DO NUCLEAR REACTIONS TAKE PLACE UNDER CHEMICAL STIMULATION?

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INTRODUCTION

In the first years of this century it was thought that atoms were indivisible entities, but Rutherford found that a great deal of an atom was free space although it contained at its center a particle, the nucleus making up the majority of the mass of the atom. He attempted to see what was inside this tiny particle by striking it with an energetic stream of energetic particles and produced, in his first "atom splitting" reaction, O^{17} from N^{14} [1].

This seminal achievement founded the field of high energy physics, but it also created a mindset that breaking into nuclei needed colossal energy, about a million times more energy than is given out in a chemical reaction. Large machines (cyclotrons) and nuclear reactors have been thought to be necessary to cause nuclear reactions to occur. A remarkable change appears to be coming across nuclear physics. It was suggested by Fleischmann and Pons [2] in 1989 that palladium heavily loaded with deuterium was the site of a nuclear reaction and Bockris et al. [3] found that deuterium evolved from D_2O-LiOD in aqueous electrolysis contained up to 10^{-9} mole fraction of a tritium-containing species, i.e., a neutron had been introduced into a nucleus "in the cold."

It now appears that there are situations in which nuclei split open at the stimulus only chemical energies. This paper is a very brief presentation of the evidence for this seminal idea.

THE DEUTERIUM PALLADIUM SYSTEM

This system has been examined widely since 1989 and there are some 1,000 reports and papers concerning it already published. However, the system is awkward to use since it needs several weeks of electrolysis to "turn on" and even then nuclear products are formed only if the palladium has a sufficiently small number of cracks so that the D/Pd ratio exceeds 0.9.

On the way to that ratio, but at D/Pd > 0.7, tritium begins to form at very low yield [2]. The tritium formation is not sufficient in amount to explain the anomalous heat [4] evolved. Miles and Bush [5] have found that He^4 is contained in the D_2 gas stream from the electrolysis as well. The amount produced with the observed heat if the heat producing reaction is

$$D + D \rightarrow He^4 + \gamma$$

There are other ways in which the occurrence of nuclear reactions inside palladium are manifest. Bush and Eagleton found more than a kilowatt per cc of heat from D-Pd in thin layers [6]. A low level evolution of neutrons (10^8 less than expected) accompanies the heat [7].

TRANSMUTATION IN SOLID LATTICES

One of us (RM) pointed out in 1990 that a "cold nuclear reaction" had already been claimed by Borghi [8]. The most well known name in pre 1989 work is that of Kevran [9]. Strong evidence of nuclear reactions in Pd in gaseous D_2 has been presented by Karabut et al [10]. An example of a reaction supported by the finding of micro quantities (10^{10} atoms/cc) of new nuclei is:

$$^{46}Pd + D \rightarrow {}^{42}Mo^{95} + {}^{5}B^{11}$$

Many other reactions involving the nuclear formation of, e.g., selenium, zinc, chromium, zirconium, germanium, and ruthenium from D-Pd have been reported by the same authors.

Bush and Eagleton [11] have found the formation of Sr from Rb, with the Sr showing an isotopic abundance frequency which differs from that of solar-derived Sr.

Dash [12] has reported the formation of silver and gold from palladium electrodes during electrolysis of light water. Ohmori and Enyo [13] have found that iron is formed in gold electrodes during electrolysis. Stringham and George [14] found helium and cadmium in a palladium electrode under sono-illumination. Iron has been found from carbon by arcing two carbon electrodes under very pure water. Precautions taken here by Sundaresan and Bockris [15] to avoid contamination were extreme.

THE GUN POWDER METHOD

A remarkable, if uncertain, method was introduced into the author's laboratory by J. Champion [16] in 1992, the experimental study being carried out by Guang Lin and Ramesh Bhardwaj [17]. A mixture of carbon potassium nitrate, sulfur, silica, cadmium, lead chloride and cadmium oxide was utilized and after ignition of the mixture the noble metal content after 2-3 days was up to 300 ppm. Some radioactivity (emission) was heard from the mixture. Success in this method appears to need a sufficiently rapid explosion.

NUCLEAR CHANGES IN BIOLOGICAL ORGANISMS?

Evidence that nuclear reactions occur in the cold in some biological reaction was first described in detail by Kevran [9]. Among modern workers are Komaki [18] who has worked with microorganisms grown in media which lack one of several nutrients needed. He finds that the needed nutrient atoms arise in the organisms although not present in the nutrient fluid.

Work giving some support to earlier claims includes that of Alper [19]. Here, a microorganism called pedomitropiom appears to produce metallic gold.

THEORETICAL COMMENTS

All these happenings are anomalous in terms of ideas of the structure of nuclei given in present textbooks. The production of tritium in palladium at room temperatures from deuterium is regarded as not feasible because of the difficulty of penetrating the coulomb barrier between two D^+ ions. However, although only the palladium deuterium system that has been subject to extensive confirmatory work worldwide, it appears time to put forward the more tentative proposition that nuclear change in lattices at room temperature is a widespread phenomenon.

Theories of the production of heat in palladium can be divided into three classes of which an example can be given in each one.

In the first, screening [20] of the nuclear charge by electrons of the metal is the center of attention. A metal contains around one mobile electron per atom. This does not seem to give a screening charge but to produce 1 kilowatt per cc of heat. Only one collision in 10^{21} need be nuclear so that a fluctuation in which, say, several electrons exist momentarily between two ions (hence greatly reducing the Coulomb barrier) is more easy to accept.

Hagelstein [21] has suggested that the virtual neutrons which must persist in a metal system exist for $\tau > 10^{-21}$ sec (Uncertainty Principle). If they existed for, say, 10^{-17} seconds then they would have a roaming radius of up to 100Å around the metal and could enter nuclei.

It was first shown by Bohm [22], but when the internuclear distance between two atoms and lattice attains a certain value there, the reflected amplitude of the deBroglie waves interfere destructively with the incident wave whereupon the barrier becomes transparent to charged particles Turner [23], Bush [24].

Concepts forming in the effort to interpret new facts have been forming in a parallel way in some physics laboratories where the stability associated with the model of Rutherford has been subject to some reservation since about 1980. The evolution of thought has been described by Greiner and Sandalescu [25]. The key is to understand that the nucleus is a small, stable sphere only in the ground state. Some atoms appear to transfer to an excited state, whereupon the nucleus becomes elliptical in shape. Nuclear protons are normally held together against their coulomb repulsions by the strong nuclear force at differences of ~ 1 Fermi. In the elliptical excited state the protons are apart by ~ 10 Fermi. Then, the short range strong force is greatly decreased and the nuclear repulsion becomes dominant, the nucleus unstable. In fact, the above article mentions "cold fission" experiments described in the recent nuclear literature which parallel the concepts which form the basis of the present chemical approach.

SUMMARY

According to classical nuclear physics, nuclei can only be split apart by forces corresponding to energy changes of an order of 10^6 ev. For about five years now it has been shown that it is possible to observe nuclear reactions within the stimulating energies in order of 5 ev so long as the particles are in a solid lattice. Thus, assisted nuclear transformations, occurring near room temperatures, have been widely observed. Interpretations may involve transmission resonance screening of nuclear charge, long lived virtual neutrons or activated nuclei elliptical in shape, which readily decompose.

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