# LENR
# (Low Energy Nuclear Reactions)

http://www.lenr-canr.org

Editorial: There is a collection of some papers on LENR (Low Energy Nuclear Reactions), also known as Cold Fusion. CANR, Chemically Assisted Nuclear Reactions, is another term for this phenomenon. These original scientific papers are reprinted with permission from the authors and publishers.

Website http://www.lenr-canr.org features a growing library of scientific papers about LENR and an extensive bibliography of journal papers, news articles and books about LENR.

## COLD FUSION: What is it and what does it mean to science and society?

**Edmund Storms**

Cold fusion is important because it promises to be a new source of pollution-free, inexhaustible energy. In addition, it is important because it reveals the existence of a new way nuclei can interact that conventional scientific theory predicts is impossible. What then is this phenomenon that suffers such promise and rejection?

Energy can be obtained from the nucleus in two different ways. On the one hand, a large nucleus can be broken into smaller pieces, such as is experienced by uranium in a conventional nuclear reactor and by the material in an atom bomb. This is called fission. On the other hand, two very small nuclei can be joined together, such as occurs during fusion of deuterium and tritium in a Hot Fusion reactor and in a hydrogen bomb. This process, called fusion, also takes place in stars to produce much of the light we see.

The fission reaction is caused to happen by adding neutrons to the nucleus of uranium or plutonium to make it unstable. The unstable nucleus splits into two nearly equal pieces, thereby releasing more neutrons, which continue the process. As every one now knows, this process produces considerable waste that is highly radioactive. The uranium used as fuel also occurs in limited amounts in the earth's crust. As a result, this source of energy is not ideal, although widely used at the present time.

The normal hot fusion reaction requires two deuterium or tritium nuclei to be smashed together with great energy. This is accomplished by raising their temperature. However, this temperature is so high that the reactants cannot be held in a solid container, but must be retained by a magnetic field. This process has proven to be very difficult to accomplish for a time sufficient to generate useable energy. In spite of this difficulty, attempts have been under way for the last 40 years and with the expenditure of many billions of dollars. Success continues to be elusive while the effort continues.

Cold fusion, on the other hand, attempts to cause the same process, but by using solid materials as the container held at normal temperatures. The container consists of various metals, including palladium, with which the deuterium is reacted to form a chemical compound. While in this environment, the barrier between the deuterium nuclei is reduced so that two nuclei can fuse without having to be forced together. Because the process causing this to happen is not well understood, the possibility is rejected by many conventional scientists. Difficulty in producing the process on command has intensified the rejection.While this difficulty is real, it has not, as many skeptics have claimed, prevented the process from being reproduced hundreds of times in laboratories all over the world for the past 13 years. As you will see by reading the reviews and papers in our Library (see http://www.lenr-canr.org/LibFrame1.html), the process continues to be reproduced with increasing ease using a variety of methods and materials.

What is the nature of this process and why has it been so hard to understand? To answer this question, a person needs to understand the nature of the barrier that exists between all nuclei. Because all nuclei have a positive charge in proportion to their atomic number, all nuclei repeal each other. It is only the surrounding electrons that hold normal matter together, with the nuclei being at considerable distance from each other, at least on the scale of an atom. When attempts are made to push the nuclei closer, the required energy increases as the nuclei approach one another. However, when deuterium dissolves in a metal, it experiences several unique conditions. The surrounding metal atoms produce a regular array that is able to support waves of various kinds. These waves can be based on vibration of the atoms (phonons), vibration of the electrons, standing waves of electromagnetic energy, or a wave resulting from conversion of the deuterium nuclei to a wave. In addition, the high density of electrons can neutralize some of the positive charge on the deuterium nuclei allowing a process called tunneling, i.e.. allowing passage through the barrier rather than over it. The mechanism of this neutralization process is proposed to involve a novel coherent wave structure that can occur between electrons under certain conditions. All of these wave processes have been observed in the past under various conventional conditions, but applying them to the cold fusion phenomenon has been a subject of debate and general rejection.

While the debate based on wave action has been underway, people have proposed other mechanisms. These include the presence of neutrons within the lattice. Normally, neutrons are unstable outside of the nucleus, decomposing into a proton, an electron, and a neutrino. Presumably, this reaction can be reversed so that neutrons might be created in a lattice containing many free electrons and protons. Having no charge, the neutron could then interact with various atoms in the lattice to produce energy. These neutrons might also be hidden in the lattice by being attached to other nuclei in a stabilized form, to be released when conditions were right. Several particles normally not detected in nature also have been proposed to trigger fusion and other nuclear reactions.

While search for a suitable mechanism has been underway, an understanding of the environment that triggers the mechanism has been sought, the so-called nuclear-active-environment. Initially, this environment was thought to exist in the bulk of the palladium cathode used in the Pons-Fleischmann method to produce cold fusion. It is now agreed that the nuclear reactions only occur in the surface region. Recent arguments suggest that this surface layer does not even require palladium for it to be nuclear-active. Nuclear reactions have now been produced in a variety of materials using many methods. The only common feature found in all of these methods is the presence of nano-sized particles of material on the active surface. If this observation is correct, four conditions seem required to produce the nuclear reactions. First, the particle must have a critical small size; second, it must contain a critical concentration of deuterium or hydrogen; third, it must be constructed of certain atoms; and fourth, it must be exposed to a source of energy. This energy can take the form of a sufficiently high temperature, a significant high flux of hydrogen through the particle, application of energetic electrons or charged particles, or application of laser light of the proper frequency. Until, the importance of these factors is understood, the effect will continue to be difficult to replicate.

# Technical Introduction to LENR-CANR

**Edmund Storms**

At low energies, the Coulomb barrier prevents nuclei from coming together and fusing to form a single nucleus. To initiate a nuclear reaction, several methods are used. Nuclear reactions are normally initiated by pushing two atoms together with enough force to overcome the Coulomb barrier by brute force, or by using neutrons which penetrate the nuclei without seeing a barrier. (Neutrons have no electrical charge, so the Coulomb barrier does not stop them.) These forces are normally provided by high-temperature plasma or by accelerating ions to high energies. In contrast, LENR describes the mechanism and conditions that cause a variety of nuclear reactions to take place with relatively low activation energy. These unique conditions reduce the need for excessive energy. The normal method forces the nuclei together, while the new method encourages them to come together. The challenge has been to understand the unique characteristics of the necessary solid structure such that this structure could be generated at will.

Because the proposed method is unique, at odds with current nuclear theory, and is still difficult to reproduce, support for studies in many countries, but not all, has been very limited. Nevertheless, considerable information has accumulated over the last 13 years since Profs. Stanley Pons and Martin Fleischmann showed the world the possibilities inherent in this phenomenon. Much understanding is buried in conference proceedings and reports that are not available to a serious student. This information will, as time permits, be made available on this site. Students of the subject are also encouraged to use this site to interact with other people in the field and provide objective critiques of the work published here.

## PHENOMENA DISCUSSED IN SOME OF THE PAPERS

At least 10 ways have been demonstrated to produce anomalous heat and/or anomalous elemental synthesis. A few of these methods will be described here. For course, not all of the claims are worthy of belief nor are they accepted by many people. Nevertheless, the claims will be described without qualifications in order to provide the reader with the latest understanding.