What is believed about cold fusion?

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In 1989, Fleischmann and Pons[1-5] claimed to initiate a fusion reaction between deuterons in palladium that resulted in an unusual amount of heat. This claim was rejected because insufficient supporting experimental information was provided, the claim was very difficult to replicate, and no plausible explanation could be proposed. During the 20 years since then, studies in at least 8 countries has provided a rich collection of information, improved reproducibility, and encouraged many explanations. This work has been reviewed by Storms[6] in 2007 based on over 1000 citations and will not be repeated here. This paper provides a brief and focused summary of what is believed to be true about the effect at the present time.

Energy production in the form of heat is the most often investigated indication of a novel effect. The reported power ranges from a few milliwatts to over 100 watts with most studies reporting values at the low end of this range. The large range in values is caused by accidental creation of the necessary physical structures that are required to initiate the heat producing reactions, called the nuclear active environment (NAE). This environment requires a very large concentration of deuterons and involves structures having nano-sized dimensions. Although focus has been applied mostly to palladium, other elements are apparently involved. Identification and creation of the NAE is essential to being able to achieve the effect with reliability and at high levels. Therefore, this effect is controlled by the nature of a special material and the existence of heretofore unrecognized processes that can allow the chemical environment to interact with nuclear processes.

When the power is maintained for sufficient time, the amount of energy is found to be much greater than can be produced by any known chemical reaction. This was the first indication of a nuclear reaction being the source of energy. Many studies have shown the main heat producing reaction results in helium-4 without significant radiation being detected outside of the apparatus. Tritium is also produced occasionally in small amounts. Even fewer numbers of neutrons are detected and these apparently result from secondary reactions caused by energetic particles resulting from the primary fusion reaction interacting with ambient deuterium. Although this primary radiation is not easily detected, use of proper detectors located very near the source has shown the presence of X-rays and energetic particles. Therefore, nuclear reactions clearly are being initiated in special materials under normal, ambient conditions.

In addition to evidence for a fusion reaction involving deuterons, nuclear products resulting from transmutation are also detected. These isotopes result from addition of deuterons and perhaps protons to the nucleus of targets of opportunity in the NAE. Most of the products are stable isotopes but occasionally radioactive isotopes are produced other than tritium. These isotopes result from clusters of deuterons up to 10 members entering the nucleus at the same time. Evidence for addition of a single deuteron or proton has also been reported. The mechanism producing this rare type of reaction is still a challenge for theory.

At least four different methods have been found to initiate the process, each with several variations. The original method based on electrolysis, as used by Fleischmann and Pons, has received the greatest attention and has the greatest success. Reproducibility of heat production near 75% is now claimed using this method. Excess energy and nuclear products have also been produced using low-voltage gas discharge in low-pressure deuterium gas. Success is sensitive to the nature of the electrodes. Recently, nano-sized palladium and an alloy of palladium have been found to produce excess energy and helium when exposed to pressurized deuterium gas at room temperature. Success of this method is growing, giving a potential for better understanding and a commercial method for energy production. Implantation of deuterium into various materials using bubble collapse against a surface has resulted in heat and helium production. Unfortunately, the method has not received significant attention or replication.

When various compounds are bombarded by low energy deuterons, the resulting hot fusion process has been found to be very sensitive to the chemical characteristics of the target.[7, 8] Apparently, the presence of suitable electron numbers and structures can partially hide the Coulomb barrier between deuterons and result in an increased fusion rate when the bombarding energy is small. While this process provides one more example of a chemical environment having influence on a nuclear reaction, the relationship of this energetic process to cold fusion is not clear.

References

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