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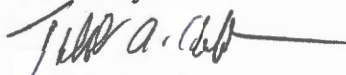
? Preproposal

No

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19 NOV 1994

Dr. Walter Polansky
Department of Energy
ER-16; F-240
Washington, DC 20585

Dear Dr. Polansky,

Enclosed is a two page description of the ion band state cold fusion process. I hope you can give it your consideration.

Sincerely.

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FUSION REACTIONS IN DEUTERIDED PALLADIUM
THE WHY OF COLD FUSION HEAT

T. A. and S. R. Chubb

This note describes a theory of cold fusion that explains how radiationless fusion can occur in metal deuterides.   Cold fusion theory can be summarized as follows:

Ground state palladium deuteride

D atoms when introduced into a Pd lattice under chemical equilibrium conditions occupy octahedral sites in a face-centered cubic lattice of Pd atoms. The D atoms exist as D^+ ions oscillating in separated potential wells in which charge neutralization is provided by the charge density of the electron cloud provided by the metal atom lattice. In this configuration the D^+ ions see mostly the local trapping environment, though they have a substantial hopping rate into neighboring vacant octahedral sites. The spatial distribution of the D^+ charge density is largely described by the zero-point motion of single D^+ ions in separated "harmonic" wells.   This normal condition, however, does not permit fusion.   The positive charges on the D^+ ions keep the nuclei too far apart for nuclear reactions to occur.   For fusion to occur, it is necessary to excite some of the D^+ ions into a higher energy, less localized state. These excited deuterons (same thing as excited D^+ ions) then behave much like electrons in a metal. The theory says that these excited deuterons are the active ingredients in heat producing reactions.

The "excited" state

In Fleischmann and Pons type experiments using palladium deuteride (PdD_x), heat release is observed when the deuterium concentration is forced to abnormally high values, i.e. at high deuterium chemical potential. As the chemical potential of D in PdD_x is made more positive by non-equilibrium chemistry or by ion implantation, the D energy is raised so that a portion of the D population is postulated to be excited into states that have a much higher "hopping rate".   These excited ions see the periodic potential provided by the lattice instead of just a local trapping potential, i.e., they see many potential wells, but they are not trapped in these wells. For this excited population no single potential well, i.e. no single unit cell, is preferred, and the ions are only trapped in the crystal as a whole. For ions in the excited state each unit cell is essentially equivalent. The change in the external potential energy term in the wave equation from one that is in essence a localized potential well to one that covers the crystal as a whole can be viewed as a change in the boundary conditions that the D^+ must satisfy. The D^+ wave functions then become Bloch functions, which reflect the periodicity of the lattice and have identical amplitude distributions in each unit cell. The sharply defined energy levels of a harmonic well configuration become replaced by energy bands.

The spatially distributed nuclear reaction

Once the D^+ ions adjust to the periodic boundary conditions, their coulombic avoidance behavior becomes reduced, provided the excited D^+ concentration is less than ~0.001 per unit cell. The coulomb barrier essentially vanishes if the crystal volume exceeds 10^5 unit cells. There is then no conventional barrier to fusion. To be specific, when there is more than one excited D^+ in such a crystal, the set of excited D^+ ions becomes a many-body system. The exchange symmetry principle of atomic physics and chemistry applies. To a first approximation, the many-body system behaves like a quantized matter field, which means that all the excited D^+ ions within a single crystal become indistinguishable, mixed, and partitioned among all the unit cells of the crystal. The excited deuteron mass resembles a continuous fluid, but one that can lose mass only in steps of 2 atomic mass units. The cold fusion reaction is $D^+\uparrow + D^+\downarrow \rightarrow {}^4He^{++}$ (arrows show nuclear spin direction), which is a direct dimerization reaction for deuterons. When fusion reactions occur, a distributed helium matter distribution forms which matches the deuteron distribution, and energy is released in 23.8-MeV steps. However, this energy release is partitioned among the N_{cell} unit cells of the crystal. When N_{cell} exceeds 10^9, the energy released per unit cell is sufficiently small that the crystal is not destroyed by the fusion events, so that periodic order is conserved during the fusion process. As a result, theory predicts no localization of the released energy and no high energy radiation. Also the "two particles in, two particles out" rule of simple binary collisions becomes replaced with the principle of conservation of proton-neutron pairs, since the distributed reaction provides no mechanism for breaking proton-neutron pairs. Only micro-chunks of energy $(=23.8 \text{ MeV}/N_{cell})$, in the range of .010 eV or less, are made available locally, i.e., in individual unit cells and at the crystal surface. These micro-chunks are able to excite lattice vibrations and serve to heat the separate crystals.

Nov. 1994