LENR Products: Lattice Confinement Fusion (LCF), Fission, or Both?

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Lattice Confinement Fusion (LCF) or Low Energy Nuclear Reactions (LENR) generate heat from the high energy products they produce. Conventionally, d-d fusion reactions may produce either 2.45 MeV neutrons, 3 MeV protons, or high energy gammas. Generally, fission will give 5-10x the excess energy of fusion. However, aneutronic "cold fusion" would provide 24 MeV/reaction, $D(d,\gamma)^4He$, where the gamma is suppressed. In a series of pressurized gas cycling experiments with a palladium silver (75 wt.% Pd and 25 wt.% Ag or Pd25Ag) alloy [1], samples cycled with deuterium showed excess heat via unexplained temperature rises. Post-test analysis of the Pd25Ag samples using a Scanning Electron Microscope (SEM/EDX) showed several molten features containing anomalous elements other than Pd and Ag. Researchers such as Liu et al [2] have also observed transmutations under similar conditions. These molten areas and anomalous elements suggest Pd fission. This nuclear process has been referred to as nuclear disintegration. Either nuclear fission or disintegration may result in neutron rich fragments. The fragments would rapidly beta decay to shorter lived daughters until they reach stability.

We've observed evidence of both fusion and fission products [3]. Figure 1 shows neutron spectroscopy showing fusion and boosted neutron energies in bremsstrahlung-initiated fusion of TiD_2. Figure 2 shows possible fission products from D_2 gas cycled Pd25Ag alloy.

Alternatively, Oppenheimer-Phillips stripping reactions, enhanced by electron screening [4] may also occur. In this case, the 8.6 MeV binding energy per Pd or Ag minus the 2.2 MeV deuteron binding energy leaves 6.4 MeV distributed between the reaction products. The energy is shared inversely proportional to the masses of the stripped off nucleon, p or n, and the new target nucleus.

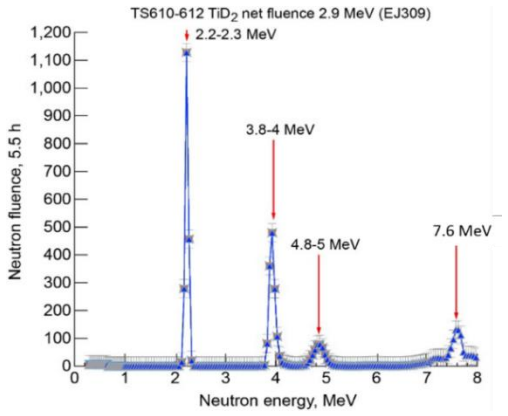

Figure 1. Neutron spectroscopy data showing d-d fusion neutrons and boosted or Oppenheimer-Phillips neutrons from 2.9MeV gamma beam irradiatedTiD_2.

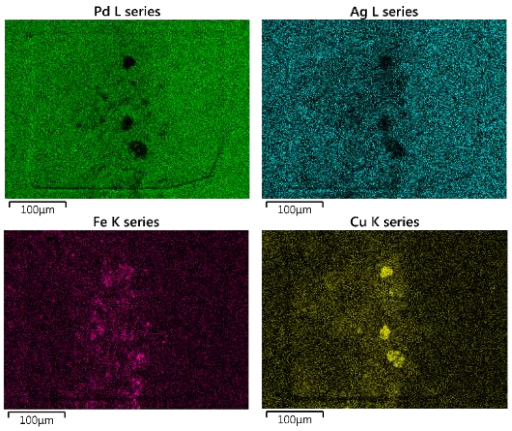

Figure 2. SEM/EDS color maps of exposed Pd25Ag tube with a FIB trench showing Pd, Ag, Fe, and Cu.

[1] G. Fralick, et al, "Transmutations observed from pressure cycling palladium silver metals with deuterium gas", International Journal of Hydrogen Energy, vol. 45, no. 56, pp. 32320-32330, 2020.
[2] B. Liu, et al, "Nuclear transmutation on a thin Pd film in a gas-loading D/Pd system", J. of Condensed Matter Nuclear Science, 13, pp. 311–318, 2014.
[3] B. Steinetz, et al, "Novel Nuclear Reactions Observed in Bremsstrahlung-Irradiated Deuterated Metals", Phys Rev C, 101, 044610, 2020.
[4] V. Pines, et al, "Nuclear fusion reactions in deuterated materials," Phys Rev C, 101, 044609, 2020.