Lattice Confinement of Hydrogen in FCC Metals for Fusion Reaction

#Han H. Nee[1] , Arsen V. Subashiev[1] , Francisco M. Prados- Estévez[1]
[1]Target Technology Company LLC, 564 Wald, Irvine, CA 92618, U.S.A
Email: hannee@ targettechnology.com

The experimental data for the nuclear fusion cross sections at energies ≤10 keV in a number of face-centered cubic (FCC) metals manifest huge enhancements and indicate large values of the screening potential. This could imply the possibility of nuclear fusion in the metals with clusters of hydrogen isotopes with high local densities and high screening.

Our studies of the hydrogen segregation at divacancies (V_2) and impurity-vacancy (V-I) clusters in nickel using *ab-initio* calculations [1] showed a very high local concentration of hydrogen isotopes segregated to monovacancies and divacancies in FCC metals such as Ni and Pd with densities of $\approx 6 \times 10^{23}$ atom/cm^3. This is much higher than for the other known phases of H except for the core of the Sun. Calculated binding energy varies from ≈ 0.27 eV for *m*H-V clusters to 0.4 eV for *m*H-V_2 clusters and shows a sufficient stability of these clusters. The average H concentration can be further increased by doping impurities with enlarged binding energy of *m*H-V-I clusters.

These findings were confirmed by a large series of experiments on Ni samples and Ni samples with Li and Al impurities loaded with hydrogen with subsequent thermal desorption. Achieved average H concentration in Ni was $\approx 10^{21}$ atom/cm^3 , which corresponds to ≈ 1 at % of the *m*H-V and *m*H-V_2 cluster concentration.

The *m*H-V and *m*H-V_2 clusters can be viewed as the “Nuclear active environments” suggested in the review paper by E. Storm[2] and can shed light on a number of published experimental results[3].

We estimated the cross sections and reactivities for the nuclear reactions between light nuclei in Ni and Pd using the screening model based on the mean field potential of the electron cloud in the metal plasma and the experimental values of the screening potential[4]. The maximum values of the enhancement factor for the reactivity in D-D reaction was found to be for the average excitation energy E_{ex}= 2.3 eV for Ni and E_{ex}= 4.7 eV for Pd.

The ignition of the nuclear reaction requires the energies in D nuclei at least several eV, which is far above what can be achieved in the thermal heating experiments. The reaction rate for a single 6D-V cluster in Ni is estimated to be $R = 3\times 10^{13}$ s^{-1}. This high burning rate indicates that the average reaction rate in a crystal will be determined by the diffusion and segregation of H isotopes at the *m*D-V and *m*D-V_2 clusters. Thus, these clusters make the most probable environments for the LENR.

[1] A. Subashiev, and H. Nee, “Hydrogen trapping at divacancies and impurity-vacancy complexes in nickel: First principles study,” J. of Nuclear Materials, vol. 487, pp. 135-142, 2017.
[2] E. Storms, “An Explanation of low-energy nuclear reactions (Cold Fusion),” J. Condensed Matter Nucl. Sci., vol. 9, pp. 86–107, 2012.
[3] F. Prados-Estévez, A. Subashiev, and H. Nee, “Nuclear fusion by lattice confinement,” J. Phys. Soc. Jpn., vol. 86, no. 7, pp. 074201-074211, 2017.
[4] F. Prados-Estévez, A. Subashiev, and H. Nee, “Strong screening by lattice confinement and resultant fusion reaction rates in fcc metals,” Nucl. Instr. Meth. Phys. Res. Sec. B, vol. 407, pp. 67-72, 2017.