Analysis on Hydric Regulations of Palladium for Lattice Assisted Nuclear Reactions (LANRs): Challenge of Google-MIT for the Future Nuclear Engineering

Tae-Ho Woo*
Department of Mechanical and Control Engineering, The Cyber University of Korea, Seoul 03051, Republic of Korea
**Corresponding author: thw_kor@hotmail.com*

1. Introduction

Hydric material based heat excess productions are investigated. Recently, Google funded multi-group consortium including University of British Columbia, University of Maryland, Lawrence Berkeley National Laboratory, and MIT have reported the prospect of nanoscale energy productions (Ball, 2019; Berlinguette et al., 2019; Brumfiel, 2004; Cartlidge, 2019; Editorial, 2019; Furth, 2019; Gorey, 2019; Hur, 2019; Johnson et al., 2019; MIT News office, 2019; Sherbo et al., 2019). Fig. 1. shows the R&D partnership between Google and MIT (Namu.wiki, 2019[a]) in which there are explanations for the Google LLC in Table 1 (Namu.wiki, 2019[b]; Wikipedia, 2019[a], 2019[b]). Although there are not any significant evidences of the nuclear fusions, the maximum hydrogen concentration of x = 0.96 +/- 0.02 in the new calibration of lattice parameter versus hydrogen concentration to PdH_x composition was found out by x-ray diffraction measurements in Fig. 2 (Benck et al., 2019).

Whereas, in this study, using the similar method by the hydrogen electrolyte, the titanium based simulations are suggested which is called the lattice assisted nuclear reactions (LANRs) in solids (Beltyukov et al., 1991; Choi, 2018; Kim, 2018; Tae, 2018). It is also called as the low energy nuclear reactions (LENRs). In the reactions, the titanium is interacted with the protons, which is considered as another kind of electrode. There is the property of titanium in Table II (Bell, 2018). That is, the tiny energy variations are investigated in the nanoscale solid sates where the phonon could be a clue for the energy production. As the thermodynamic property in the phonon, the angular frequency is written as (Wikipedia, 2019[c]),

$$\eta(\omega_{k,s}) = \frac{1}{exp\left(\frac{\hbar\omega_{k,s}}{k_B T}\right)-1} \quad (1)$$

where $\omega_{k,s}$ is the frequency of the phonon, k_B is the Boltzmann's constant, and T is the temperature. So, as temperature decreases, the angular frequency increases. In addition, previously although the Fleischmann-Pons used the electrodes of platinum and palladium using heavy water, the other kinds of electrodes could show the possibility of nuclear reaction in this study. The basis theory of typical nuclear fusion is as,

$$H_2 + H_2 \rightarrow He + \text{Excess Heat} \quad (2)$$

For details (Kikuchi et al., 2012),

$${}^2_1D + {}^2_1D \rightarrow {}^3_1T(1.01\text{ MeV}) + P^+(3.02\text{ MeV}) \quad (50\%) \quad (3)$$

$${}^2_1D + {}^2_1D \rightarrow {}^3_2He(0.82\text{ MeV}) + n^+(2.45\text{ MeV}) \quad (50\%) \quad (4)$$

These are very simple equation for the nuclear fusions. It should be done in the plasma state where the temperature is very high. In this work, the LANRs are done in the room temperature in which the proton beam is simulated instead of the deuteron which are existed in the solvents.

2. Methods and Results

There are the simulation results of the titanium material layer incorporated with proton beam as hydrogen ions in this study which is analyzed in the case of light water. That is, the ion beam based simulation work is performed where the abundant ions should be simulated and the results are obtained by graphics. In the simulations, the Stopping and Range of Ions in Matter (SRIM) code is used (Ziegler, 2013). Fig. 3 is the ion trajectories for 10 keV proton into titanium as (a) Side view, (b) 3D view of Phonon, (c) 3D view of displacement, and (d) 3D view of vacancy. Recently, there are some views on the studies (MacRae, 2014; Hambling, 2016; Ritter, 2016; Siegel and Start With A bang, 2016). Fig. 4 shows the phonons as the 10 keV proton into Ti layer. As the energy increases, the energy losses decrease in the Fig. 4(b). Fig. 5 shows the energy to recoils as the10 keV proton into Ti layer. As the energy increases, the energy to recoils decreases in the Fig. 5(b). Fig. 6 shows the collision of the 10 keV proton into Ti layer. As the energy increases, the collision decreases in the Fig. 6(b). Using 3D shape, total displacements and total vacancies are able to be shown in similar shapes. So, regarding the simulation, as the energy increases, there are several results. The proposed power-cell bundles are described in Fig. 7. There are some comparisons between this study and MIT-Google in Table III.

3. Conclusions

It has been studied for the hydrogen anomalies for the LANRs using hydrogen ions where the ions beams are applied for the fusion reactions. There are some important points in this study as follows;

- The titanium is analyzed with the

hydrogen ion reactions.

- Nuclear reactions are simulated by the material analysis.
- Lower energy is applied to the nuclear reaction
- Commercialized applications are suggested.

It has been done for the next stage of the LANRs such as the mass energy productions where it is imaginable to construct parallel-typed power cells. Although the Google funded research work was not successful, the other kinds of the possibilities could be challengeable such as the titanium based hydrogen electrolyte of this work which is in Fig. 8. That is, another kind of power cell is able to be suggested using this work in the field of nuclear industry.

REFERENCES

Ball, P., 2019. Lessons from cold fusion, 30 years on. Nature 569, 601, Springer Nature Publishing AG, Germany, <https://www.nature.com/articles/d41586-019-01673-x>.

Bell, T., 2018. Titanium Properties and Characteristics. The balance, New York, NY < https://www.thebalance.com/metal-profile-titanium-2340158>.

Beltyukov, I.L., Bondarenko, N.B., Janelidze, A.A., Gapanov, M.Y., Gribanov, K.G., Kondratov, S.V., Maltsev, A.G., Novikov, P.I., Tsvetkov, S.A., Zakharov, V.I., 1991, Laser-Induced Cold Nuclear Fusion in Ti-H2-D2-T2 Compositions. Fusion Technology 20(20), 234-238.

Benck, J.D., Jackson, A., Young, D>, Rettenwander, D., Chiang, Y.-M., 2019. Producing High Concentrations of Hydrogen in Palladium via Electrochemical Insertion from Aqueous and Solid Electrolytes. Chem. Mater. 3111, 4234-4245.

Berlinguette, C.P., Chiang, Y.-M., Munday, J.N., Schenkel, T., Fork, D.K., Koningstein, R., Trevithick, M.D., 2019. Revisiting the cold case of cold fusion. Nature 570, 45-5, Springer Nature Publishing AG, Germany, <https://www.nature.com/articles/s41586-019-1256-6>.

Brumfiel, G., 2004. US review rekindles cold fusion debate. Nature, News041129-11, Springer Nature Publishing AG, Germany, <https://www.nature.com/news/2004/041202/full/news041129-11.html>.

Cartlidge, E., 2019. 'Cold case' of cold fusion reopened by Google-funded scientists. Physics Wolrd, Bristol, UK, <https://physicsworld.com/a/cold-case-of-cold-fusion-reopened-by-google-funded-scientists/>.

Choi, H.M., 2018. Deneum, Success of developed fusion generator 'Power station', ASIATODAY, Seoul, Korea, Sept. 3, 2018.

Editorial, 2019. A Google programme failed to detect cold fusion? but is still a success. Nature 569, 599-600, Springer Nature Publishing AG, Germany, <https://www.nature.com/articles/d41586-019-01675-9>.

Furth, N., 2019. Google has been funding research into cold fusion for years. MIT Technology Review, MIT, USA, <https://www.technologyreview.com/f/613595/google-has-been-funding-research-into-cold-fusion-for-years/>.

Gorey, C., 2019. Google gives up on taboo cold fusion dream after spending $10m. Siliconrepublic, <https://www.siliconrepublic.com/machines/google-cold-fusion-failure>.

Hambling, D., 2016. In Cold Fusion 2.0, Who's Scamming Whom? Popular Mechanics, New York, NY, <https://www.popularmechanics.com/about/a2922/contact-us/>.

Hur, J.W., 2019. Google is studying on the cold fusion criticized by 'Fake science'. Korea JoongAng Daily, Seoul, Korea, <https://news.joins.com/article/23483041>.

Johnson, N.J.J., Lam, B., MacLeod, B.P., Sherbo, R.S., Moreno-Gonzalez, M., Fork, D.K., Berlinguette, C.P., 2019. Facets and vertices regulate hydrogen uptake and release in palladium nanocrystals. Nature Materials 18, 454-458.

Kikuchi, M., Lackner, K., Tran, M.Q., 2012. Fusion physics, International Atomic Energy Agency (IAEA), Vienna, Austria.

Kim, J.S., 2018. Energy production innovation company 'Deneum', Success of developed fusion generator 'Power station', FN Today, Seoul, Korea, Sept. 3, 2018.

Namu.wiki, 2019[a]. Shake hands, Seoul, Korea, <https://namu.wiki/w/%EC%95%85%EC%88%98>.

Namu.wiki, 2019[b]. Google, namu.wiki, Seoul, Korea, <https://namu.wiki/w/%EA%B5%AC%EA%B8%80>.

MacRae, M., 2014. Cold fusion 25 years larwe, ASME, New York, NY, <https://www.asme.org/engineering-topics/articles/nuclear/cold-fusion-25-years-later>.

MIT News office, 2019. 3Q: Yet-Ming Chiang on reopening the case of cold fusion, MT, USA, <http://news.mit.edu/2019/3q-yet-ming-chiang-reopening-the-case-of-cold-fusion-0527>.

Ritter, S.K., 2016. Cold fusion died 25 years ago, but the research lives on, Chemical & Engineering News 94(44), 34-39, <https://cen.acs.org/articles/94/i44/Cold-fusion-died-25-years.html>.

Siegel, E., Start With A Bang, 2016. Is Cold Fusion Feasible? Or Is It A Fraud? Forbes Media LLC, Jersey city, NJ, <https://www.forbes.com/sites/mitsubishiheavyindu

stries/2018/07/31/from-spoke--hub-to-long--thin-how-airline-routes-are-changing/#6a8aa0a73ab0>.
Sherbo, R.S., Kurimoto, A., Brown, C.M., Berlinguette, C.P., 2019. Efficient Electrocatalytic Hydrogenation with a Palladium Membrane Reactor. J. Am. Chem. Soc.2019141197815-7821.
Tae, H.J., 2018. Small nuclear fusion generator 'Power station', Future energy source, DongA.com, Seoul, Korea, Sept. 10, 2018.
Wikipedia, 2019[a]. Google, <https://en.wikipedia.org/wiki/Google>.
Wikipedia, 2019[b]. List of Google products, <https://en.wikipedia.org/wiki/List_of_Google_products>.
Wikipedia, 2019[c]. Phonon, <https://en.wikipedia.org/wiki/Phonon>.
Ziegler, J.F., 2013. Stopping and Range of Ions in Matter (SRIM) code, < http://www.srim.org/>.

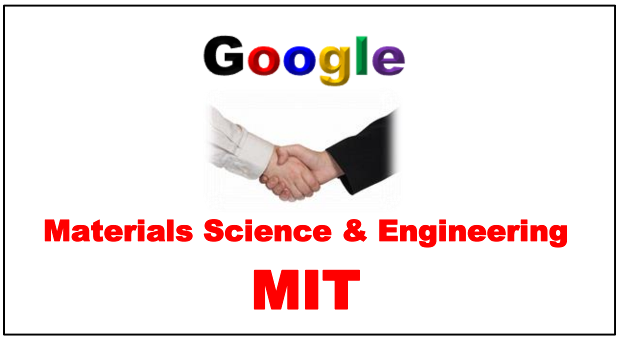


Fig. 1. R&D partnership between Google and MIT.

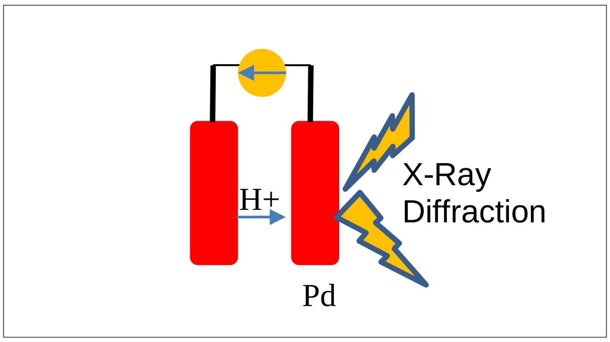
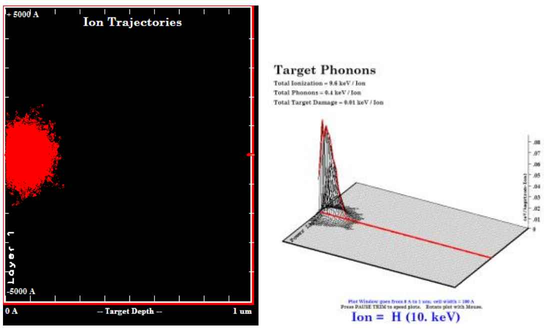
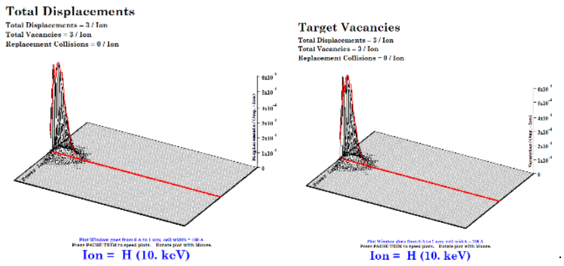


Fig. 2. Schematic view of MIT-Google experiment.

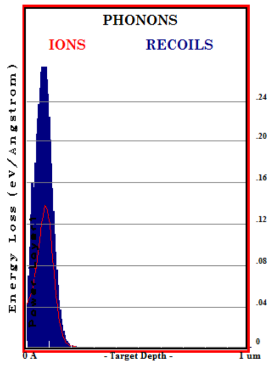


(a) (b)

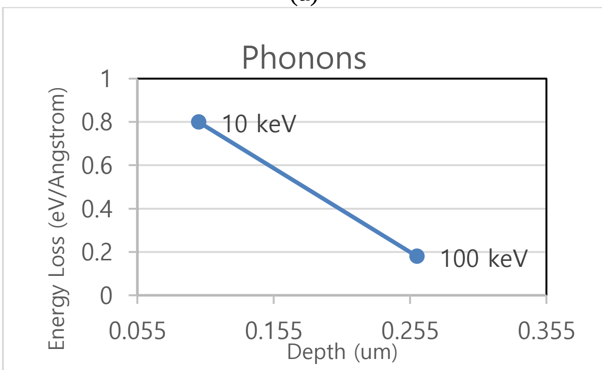


(c) (d)

Fig. 3. Ion trajectories for 10 keV proton into Titanium (a) Side view, (b) 3D view of Phonon, (c) 3D view of displacement, and (d) 3D view of vacancy.

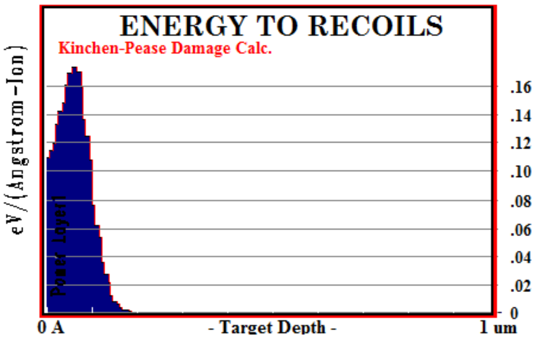


(a)

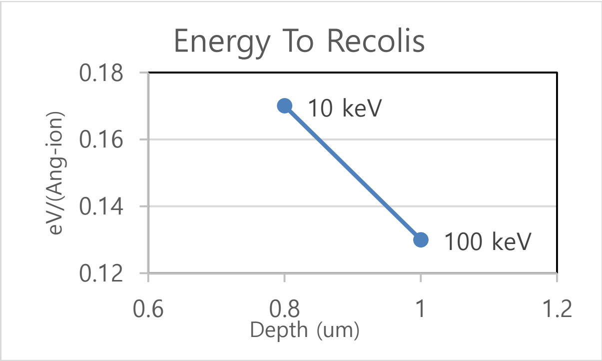


(b)

Fig. 4. Phonons (a)10 keV proton into Ti and (b) Comparison graph.

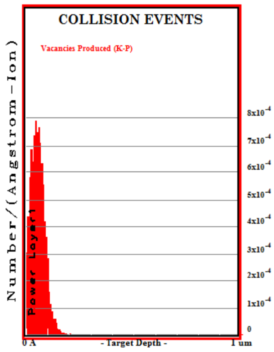


(a)

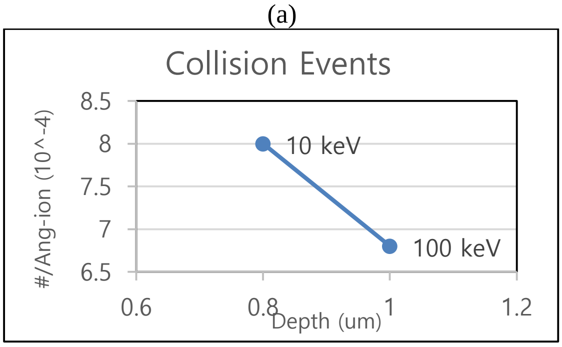


(b)

Fig. 5. Energy to recoils (a)10 keV proton into Ti layer and (b) Comparison graph.



(a)



(b)

Fig. 6. Collision (a)10 keV proton into Ti layer and (c) Comparison graph.

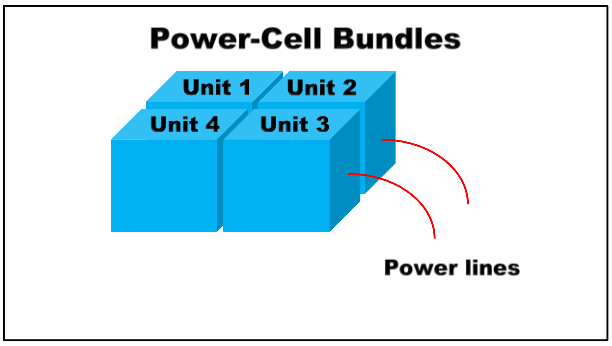


Fig. 7. Proposed power-cell bundles.

Fig. 8. New technology for the future.

Table I: What is Google?

Content	Number
Founders	Larry Page, Sergey Brin
Headquarter	Mountain View, CA, USA
Employees	99,771 (2018)
Assets	$ 147.66 Billion (2015)
Market capitalization	$ 662.1 Billion (2017)
Capital	$ 120.33 Billion (2015)
Founded	September 4, 1998, Menlo Park, CA, USA
Products	Google Search, YouTube, Google Shopping, etc.

Table II: Property of Titanium

Content	Number
Atomic number	22
Element category	Transition metal
Density	4.506 / cm^3
Melting point	1,668 °C
Boiling point	3,287 °C
Moh's hardness	6

Table III: Comparison between Woo and MIT-Google

Content	MIT-Google	Woo
Electrode	Palladium	Titanium
Solute	Hydrogen Compound	Light water
Experiment	Yes	Simulations
Radiation Production	Possible	Yes
Neutron Production	None	None