Modeling of Lattice Confinement Fusion-Fast Fission of NASA's NIAC 2023 Phase I for Hybrid Atomic Powers: Review of the LENR (Cold Fusion) Session at 2024 ANS Conference

Kyung Bae Jang, Chang Hyun Baek, Tae Ho Woo*
Department of Mechanical and Control Engineering, The Cyber University of Korea, Seoul 03051, Republic of Korea
**Corresponding author: thwoo@cuk.edu, thw_kor@hotmail.com*

Keywords : Confinement Fusion-Fast Fission, Low energy nuclear reactions (LENRs), NASA, Cold fusion

1. Introduction

Nuclear energy production is analyzed for highly efficient utilization in the low energy nuclear reactions (LENRs). Most recently, the 2024 ANS Annual Conference was held for the LENRs [1]. Fig. 1 shows the classifications of (a) the most popular topics and (b) nations during the last four years including the ANS conference where the Theoretical and Computational Studies topic has the most published area at 19% in ICCF-25 [2]. In addition, Table 1 shows the registrations by nations in ICCF-25 which had been kept going on as the International Conference on Cold Fusion until 2006 after the amazing announcement in 1989 by Fleischmann–Pons experiment [2] which is compared with the ANS conference.

Another kind of room temperature fusion is investigated at NASA's Glenn Research Center for seeking energy sources applicable to deep-space journeys and eventually the building of new colonies [4-6]. For exploring the icy planet, Europa, a satellite of Jupiter, the nuclear submarine machine is proposed to navigate in the water [7]. Fig. 2 shows the comparison of Fusion probability [7]. Fig. 3 shows the JPL Cryobot which could be used in Europa to move through ice by melting the surface directly in front of it, while allowing the liquid to flow around the vehicle and refreeze behind it [7-9].

2. Methods

Fig. 4 shows the feature of Erbium where the lattice is the hexagonal closed-packed (HCP) structure [10,11]. The LENRs are described in this work where the Erbium is a major element to design the LENRs reaction where the nuclear fusion could be realized with the excess heat productions in Fig. 5. It is expected the fusion reaction is [7],

$$D(d,n)^{3}_{2}He \quad (1)$$

where the energy is 4.0 MeV with 2.4 MeV neutron. In the fission reactions, the possible reactions are,

$$^{232}_{90}Th(n,\gamma)f \quad (2)$$

where the energy is 200 MeV with 1 to 9 MeV neutron. In addition,

$$^{238}_{92}U(n,\gamma)f \quad (3)$$

where the energy is 200 MeV with 1 to 10 MeV neutrons.

3. Results

The SRIM simulations are performed for the set-up for the simulation of 10keV deuterons into Erbium of thickness 10^4 Angstrom [12]. The ion trajectories of 500keV deuterons bombard into Erbium. Fig. 6 shows the classifications of (a) Events of reactions and (b) Lattice confinement fusion (LCF) region in which the size is below about 500 nm. The ionization and collision events are shown in shallow depth. This process goes to fast-fission reactions through lattices built from the metal of erbium in a molten lithium matrix in Fig. 7 which is the Fusion-Fast Fission of NASA's NIAC 2023 Phase I for Hybrid Atomic Powers [7]. When a low-energy neutron hits uranium-235, a chain reaction starts where Lithium-6 dissolves in water at 129 g/*l*. Once the enriched lithium-6 hydroxides are solved in heavy water, a propellant is created with a density of 1,239 kg/m^3 which would immediately moderate neutrons, trigger a neutron flux, and undergo clean fission from that neutron flux through a natural uranium cylinder. Fig. 8. shows the nuclear thermal propulsion systems by fission reactor.

4. Conclusions

The LENR has shown the power source in the space where the light and simple facilities are needed. For another application, the nuclear thermal propulsion system is imagined in which the working fluid of the liquid hydrogen is heated by a nuclear reactor and expands through a rocket nozzle to create thrust. It makes a higher effective exhaust velocity and is expected to double or triple payload capacity compared to chemical propellants. Fig. 8 shows the nuclear thermal propulsion systems by fission Reactor. There are some highlights in this work as follows,

- LENR is applied to space technology.
- Water and icy planets are expected to explore by the nuclear powers.
- More powerful energy is developed for the future space colony.
- The boosting strategy for nuclear industry is anticipated.

Following the global LENR developments, a variety of applied technologies are expediated in the NASA where the compact and efficient energy source is very important, especially for remote regions and deep space. Hence, LENR energy based on LCF is one of the most suitable power sources.

Acknowledgments

This study was supported by the Ministry of SMEs and Startups grant (RS-2023-00266376).

REFERENCES

[1] ANS, ANS Annual Conference. June 16-19, 2024, American Nuclear Society (ANS), Las Vegas, USA (2024), https://www.ans.org/meetings/ac2024/.

[2] ICCF25, Book of abstracts (2023), chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://iccf25.com/conf-data/iccf-25/files /ICCF25-book-of-abstracts_final.pdf.

[3] Tae Ho Woo, Analysis of Normalized Power Productions Using the Low Energy Nuclear Reactions: Review of ICCF-24 (a.k.a International Conference on Cold Fusion) and USDOE's Funding. Transactions of the Korean Nuclear Society Autumn Meeting, Oct. 20-21, 2022, Changwon, Korea (2022).

[4] ANS, 2020. NASA work on lattice confinement fusion grabs attention, American Nuclear Society (ANS), La Grange Park, USA, https://www.ans.org/news/article-447/nasa-work-on-lattice-confinement-fusion-grabs-attention/.

[5] Delebert, C., NASA Found Another Way Into Nuclear Fusion, Popular Mechanics, Hearst Magazine Media, Inc., New York, USA (2020).

[6] NASA, Lattice Confinement Fusion, Glenn Research Center, Cleveland, USA (2020), https://www1.grc.nasa.gov/space/science/lattice-confinement-fusion/.

[7] NIAC, Accessing Icy Worlds using Lattice Confinement Fusion (LCF) Fast Fission, NIAC 2023 Orientation Meeting, March 21-22 (2023).

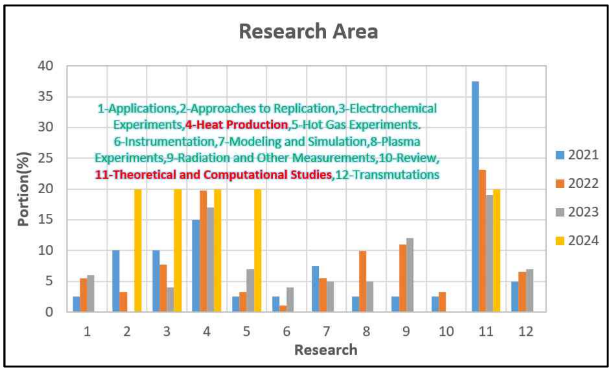
[8] JPL, Cryobot Technology Delivers Science Instruments into Icy Environments, Jet Propulsion Laboratory (JPL), USA (2023).

[9] WIRED, Cryobots Could Drill Into Icy Moons With Remote Fiber-Optic Laser Power, WIRED, Boone, USA (2012), https://www.wired.com/2012/04/bill-stone-laser-powered-europa-rover/.

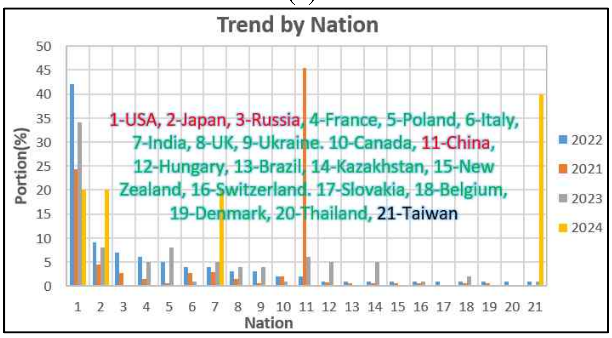
[10] RSC, Erbium, Royal Society of Chemistry (RSC), Cambridge, UK (2020), https://www.rsc.org/periodic-table/element /68/erbium.

[11] Periodictable, Technical data for Erbium, Periodictable.com, https://periodictable.com/Elements/068/data.html.

[12] Zieger, J., SRIM - The Stopping and Range of Ions in Matter (2015), http://www.srim.org/.



(a)



(b)

Fig. 1. Classifications of (a) most popular topics and (b) nations during last three years [7].

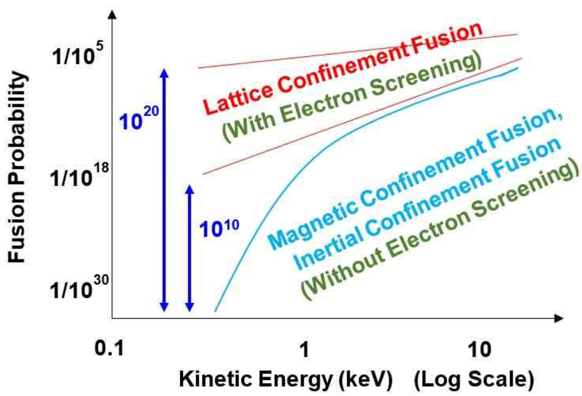


Fig. 2. Comparison of Fusion probability [7].

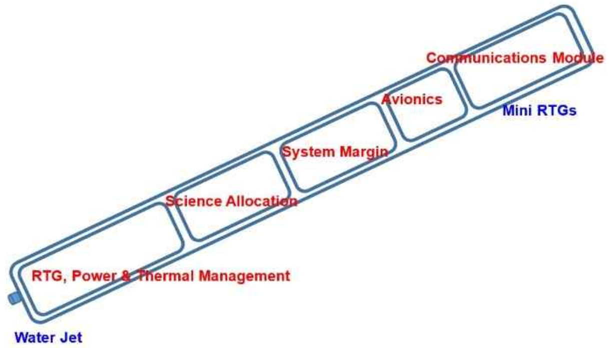


Fig. 3. Simplified configuration of Cryobot [7,8,9].

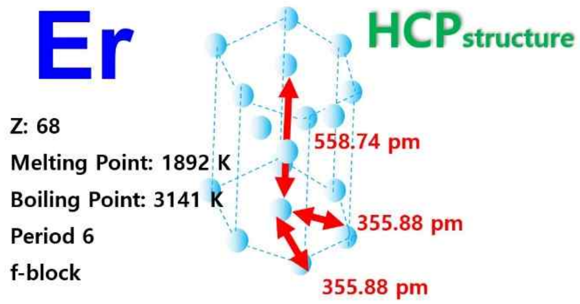


Fig. 4. Feature of Erbium.

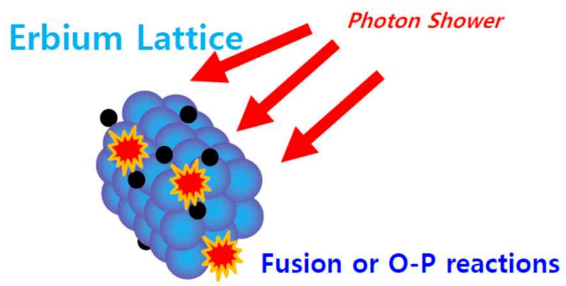
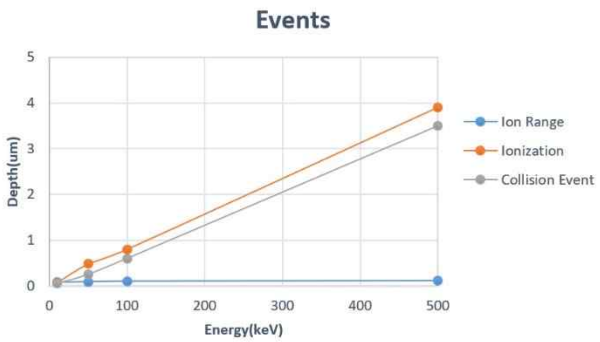
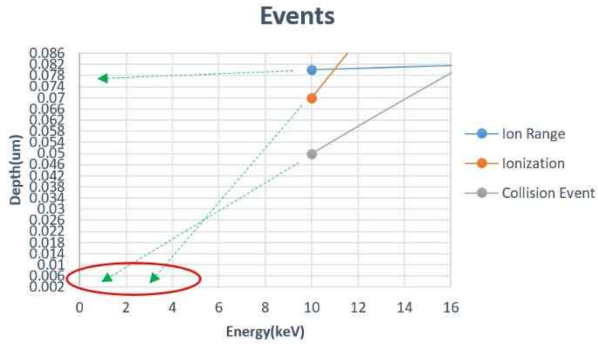


Fig. 5. Scheme of NASA's experiment.



(a)



(b)

Fig. 6. Classifications of (a) Events of reactions and (b) LCF region.

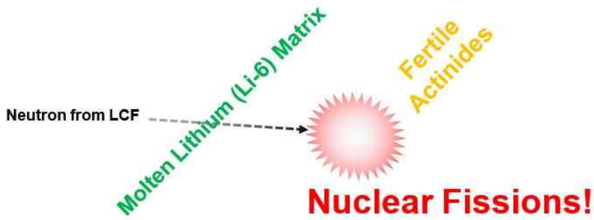


Fig. 7. Configuration of capturing nuclear fissions.

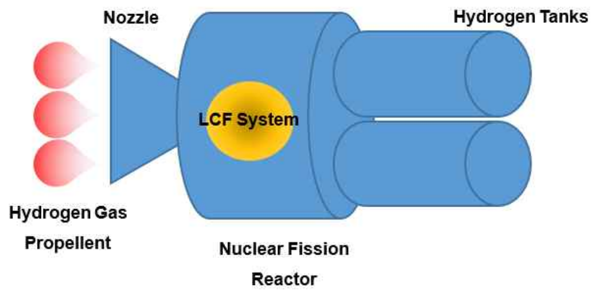


Fig. 8. Nuclear thermal propulsion systems by fission reactor.

Table I: Registrations by nations in ANS 2024 vs. ICCF-25 [2].

No.	Country	Percent (%)
1	USA	34 (20 in ANS2024)
2	Japan	8 (20 in ANS2024)
2	Poland	8
4	China	6
5	France	5
5	Hungry	5
5	India	5 (20 in ANS2024)
5	Kazakhstan	5
9	Ukraine	4
9	UK	4
11	Belgium	2
12	Canada, Finland, Germany, Iceland, Italy, Netherland, Norway, Romania, Slovenia, Taiwan, Turkey, Switzerland	~1 (40 for Taiwan in ANS2024)
Total	23 Countries	100