The 24th Meeting of Japan CF-Research Society

JCF24 ABSTRACTS

December 1-2, 2023

Research Center for Electron Photon Science,
Tohoku University

Japan CF-Research Society

Program of JCF24 Meeting

Japan CF-Research Society

Date;	December 1-2, 2023
Place;	Mikamine Hall, Research Center for Electron Photon Science, Tohoku University, Sendai, Japan
Presentation;	Oral presentation 25 min. + Discussion 5 min.
Language;	English or Japanese
Abstract Book;	Only available at JCF home page (http://jcfrs.org/)

December 1 (Fri), 2023

12:00-13:00 **Registration**

13:00-13:05 **Opening Address** Y. Iwamura (Tohoku University)

Session 1 *Chair: M. Kishida (Kyushu U.)*

13:05-13:35 **JCF24_01** K. Naitoh et al. (Waseda U.)
Fluid mechanics on anomalous temperature increase in metal composite powder exposed to pulsed high-pressure hydrogen gas

13:35-14:05 **JCF24_02** Y. Iwamura et al. (Tohoku U.)
Anomalous heat generation experiments with Ni-based nanostructured metal composites and hydrogen gas: consideration by material and gas analysis

14:05-14:35 **JCF24_03** T. Itoh et al. (Tohoku U. / Clean Planet Inc.)
IR and Light Radiation Analysis for Spontaneous Heat Burst during Hydrogen Desorption from Nano-sized Metal composite

14:35-14:50 ***Break***

Session 2 *Chair: Y. Iwamura (Tohoku U.)*

14:50-15:20 **JCF24_04** F. Celani et al. (INFN-Frascati, Italy)
Attempts of self-replication of AHE generation by pulsed operations on Constantan wire inverse coaxial geometry, under H2-Ar gas at high temperatures: role of pulse polarity and shapes

15:20-15:50 **JCF24_05** T. Nemoto et al. (Iwate U.)
Improving Excess Heat Measurement in Hydrogen Desorption Experiment

15:50-16:05 ***Break***

Session 3 *Chair: S. Narita (Iwate U.)*

16:05-16:35 **JCF24_06** S. Higashi et al. (Kobe U.)
Detection of He-3 Trapped in CuNiZr Materials by Thermal Desorption Spectrometry

16:35-17:05 **JCF24_07** H. Miura
Computer Simulation on the Reactions of Band Gaps Collided by Protons/Deuterons

17:05-17:35 **JCF24_08** R. Furui (Nano Fusion Design)
The Design of a Low-Energy Nuclear Battery

17:35-18:00 **JCF Annual Meeting**

18:00-20:00 **Reception**

December 2 (Sat), 2023

Session 4: Industrial Application Session

Chair: K. Naitoh (Waseda U.)

9:30-10:00 **JCF24_09** A. Takahashi (New Hydrogen Energy Inc. / Osaka U.)
New Hydrogen Fusion Energy

10:00-10:30 **JCF24_10** G. Terabayashi (Smart Fiber Design Associate Co., Ltd.)
Climate change measures and expectations for new energy

10:30-11:00 **JCF24_11** K. Ooyama (Ooyama Power Inc.)
Metal Crystal confinement Fusion Reactor

11:15-11:45 **JCF24_12** T. Yoshizawa (Z Mechanism Technology Institute Co., Ltd.)
Development of a low-vibration new type internal combustion engine by using Z-Mechanism and potential applications of this mechanism

11:45 ***Adjourn***

Fluid mechanics on anomalous temperature increase in metal composite powder exposed to pulsed high-pressure hydrogen gas

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Anomalous heat generation was observed in several reports including those of Miley (Miley and Patterson, *J. New Energy*, 1996), Arata (Arata and Zhang, *J. High Temp. Soc.*, 2008), and Kitamura (Kitamura et al., *Physics Letters A*, 2009).

We have developed a reaction system with a small chamber (Fig. 1) and have conducted some fundamental experiments to evaluate the anomalous heat in the hydrogen gas absorption of metal powder, while a high-speed of hydrogen gas jet injected into a constant volume of reaction chamber hits the solid wall at the bottom of the chamber. This impact of jet on the solid wall is identical to collision of two opposite jets, because of imaginary image. In our previous report, we conducted experiments on high-pressure (≒ 8 MPaG) hydrogen gas absorption by Pd-Ni-Zr composite powder (PNZ10r, provided by Technova Inc.) with pulsed flow generated by the solenoid valve into the reaction chamber under the condition of 300 °C of initial temperature. About 150 K of temperature rise was observed after the injection of hydrogen gas jet, with only 3 g of PNZ10r set in the chamber, when the K-type of thermocouple is employed while heat generation is also estimated. More temperature increase is observed with non-contact thermometer (Kobayashi et al., *ICCF-25*, 2023). The positive correlations between the temperature rise and both initial temperature and hydrogen gas pressure are also observed in past experiments, while faster opening speed of valve for gas injection leads to more temperature increase (Kobayashi et al., *J. Condensed Matter Nucl. Sci.*, 2022).

However, pressure increase after hydrogen gas injection is fairly small. This report explains the reason based on compressible fluid-mechanics.

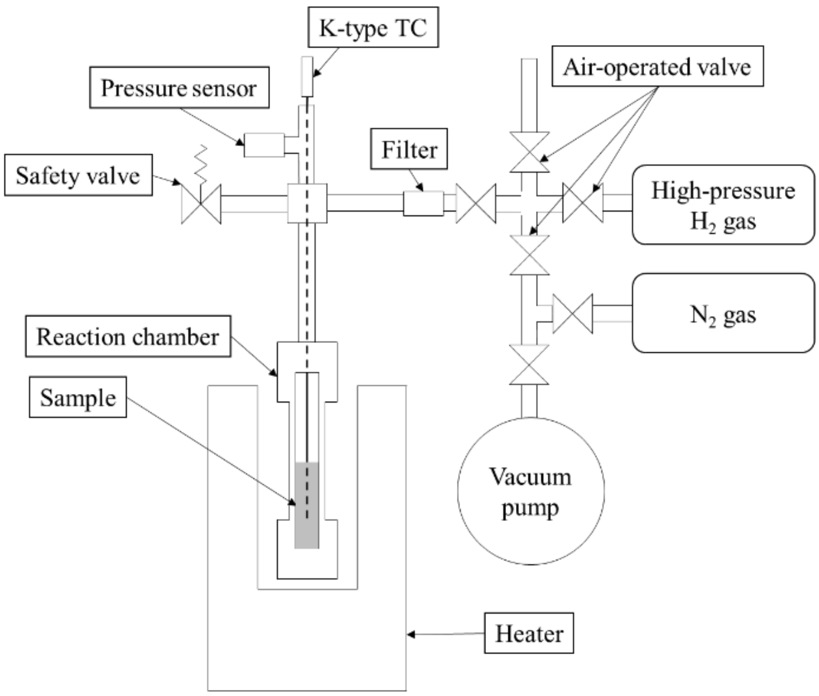

Fig. 1. Reaction system for experiments with high-pressure hydrogen gas

Anomalous heat generation experiments with Ni-based nanostructured metal composites and hydrogen gas: consideration by material and gas analysis

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We have been studying an anomalous heat generation phenomena induced by the diffusion of hydrogen by rapidly heating nanostructured Ni-based metal composites preloaded with hydrogen gas. Anomalous heat generation exceeding 20 keV/H that cannot been explained by any known chemical reactions has been observed. It has become possible to induce not only steady-state heating but also intentional heat bursts. Recently, it has been found that samples in which anomalous heat and/or heat bursts have occurred often show regions of high oxygen concentration (RHOC) after experiments, according to SEM-EDX and TOF-SIMS analysis [1]-[3].

Quadrupole mass spectrometer (BGM-202, ULVAC) was applied to the gases released during excess heat generation. Samples were observed under SEM/EDX (JSM-6500F, JEOL), then specific regions with common characteristics were identified in the samples that produced excess heat. These areas were investigated also by TOF-SIMS (TOF.SIMS 5, ION-TOF GmbH) analysis.

The oxygen concentrations in the RHOC were greater than 10% by EDX and in some cases close to 40%. Furthermore, the depth profile obtained from TOF-SIMS revealed that intensity of O is also higher in the RHOC. The elements C, Al, Si, Mn detected by EDX or TOF-SIMS were presumed to originate from the Ni bulk or surface contaminants as impurities. However, the O ratios at the RHOC seem to be quite higher than what could result from impurities from Ni bulk or surface contaminants. Besides, the gas analysis results also suggest that oxygen gas is released from the sample, supporting the EDX and TOF-SIMS results.

Experimental results by gas analysis up to now showed that samples that produced large excess heat tended to have higher oxygen concentrations in released gas. For samples with less excess heat, the oxygen concentration in the gas released during the experiment was lower.

It is difficult at this stage to determine the origin of the oxygen in the high oxygen concentration regions. If we consider only the EDX and TOF-SIMS results, we must assume that only certain regions (RHOC) may be oxidized, that hydrates may form after the sample is removed from the experiment, or that oxygen inside the Ni bulk may diffuse and accumulate at certain locations (RHOC). After examining whether these phenomena occur or not, the possible contribution of nuclear reactions will be discussed.

References

[1] Y. Iwamura, Cold Fusion: Advances in Condensed Matter Nuclear Science, Elsevier, Amsterdam, (2020)157-165.
[2] Y. Iwamura et al., J. Condensed Matter Nucl. Sci. **33**, 1-13 (2020).
[3] Y. Iwamura et al., J. Condensed Matter Nucl. Sci. **35**, 285–301 (2022).

IR and Light Radiation Analysis for Spontaneous Heat Burst during Hydrogen Desorption from Nano-sized Metal composite

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We have been conducting research on anomalous excess heat (AEH) generation phenomena using hydrogen and nano-sized metal composite. Up to the present, we have observed the AEH that cannot be explained by the chemical reaction [1,2]. Recently, we have constructed a measurement system to observe IR and visible light emitted from the sample surface, and using this system, we have observed that the intensity of radiation from the surface increases during heat generation. [3,4,5].

In this experiment, we used Cu/Ni or Cu/Ni/CaO nano-multilayer films, deposited using magnetron sputtering. We fix the two nano-sized multilayer films on both sides of a ceramic heater in a sample holder installed in the vacuum chamber (Fig 1(a)). After hydrogen absorption into the sample, we heat the samples up and keep the heater input power constant, while evacuating the chamber to release hydrogen from the samples: This induces the AEH generation. For the observation of photon radiation, we used FTIR spectrometer for near-IR (1.5-2.5 μm), and a spectroscope for visible light (0.3-0.9 m), and 2 photodetectors for mid-IR (wavelength 3-5.5 μm). The two mid-infrared photodetectors are placed on both side of the heater so that the radiation from surfaces A and B can be detected simultaneously.

In these experiments, we often observed heat burst phenomena, in which the heater temperature and Photon radiation suddenly rises [2]. As reported in [4,5], we find that the visible, near-infrared, and mid-infrared radiant intensities increase synchronously with the occurrence of heat bursts. Observing this phenomenon in detail is one of the ways to understand the mechanism of the AEH production.

Fig.1(b) shows an example of heat burst phenomenon. In this experiment, 2 heat bursts were observed, and the emission of mid IR from surfaces A and B increased synchronously with the heater temperature rise. Fig.1(c) is an enlarged view of the second heat burst. There is a sharp rise in radiation at surface A, then the heater temperature increases, and finally the radiation at surface B increases. This suggests that a heat burst occurs on surface A. Furthermore, it should be noticed that the radiation at surface A drops first, several seconds before the burst, and then rapidly increases as the burst. Details of the results and analysis will be reported.

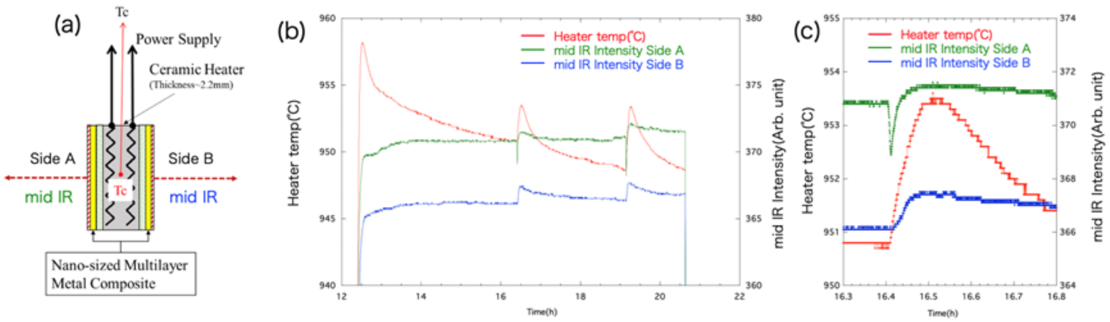

Fig. 1 (a) Schematic diagram of the experiment (b)Time evolution of Heater temperature, mid-infrared intensity (c) Enlarged view of the second heat burst.

[1] T. Itoh, et.al., J. Condensed Matter Nucl. Sci. 24 (2017) 179–190.
[2] Y. Iwamura, et.al, J. Condensed Matter Nucl. Sci. 36 (2022) 285–301
[3] T. Itoh et al., Proceedings of the 21st Japan CF Research Society, JCF21, p.15-25.
[4] T. Itoh et.al, J. Condensed Matter Nucl. Sci. 36 (2022) 274–284
[5] T. Itoh et.al, Proceedings of the 23st Japan CF Research Society, to be published

Attempts of self-replication of AHE generation by pulsed operations on Constantan wires, inverse coaxial geometry, under H2-Ar gas at high temperatures: role of pulse polarity and shapes.

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The experiments on Cold Fusion, later LENR-AHE, started at INFN-LNF Laboratory (Italy) since March 1989 using mainly Pd (or Pd-Y) alloy, at the beginning in electrolytic environments and later-one under gas (H2, D2, pure and/or mixed with Ar, Xe). Since 1993 we used wires because had some peculiarity in respect to electromigration of H or D, inside the bulk material, to promote large non-equilibrium situation and flux of active gas, specially under pulsed conditions. On 2011 we moved to lower cost active materials, in respect to precious metal Pd, and focused on Cu-Ni-Mn alloys (Constantan), high temperatures and gas environments. Since 2019 we developed inverse coaxial geometry in order to get compact geometry using anode-cathode configurations.

Following the results presented by our experimental group at the recent ICCF25 International Congress (26 August-1 September 2023, Szczecin-Poland, DOI: 10.13140/RG.2.2.17658.26560/1), we focused on some of the key aspects discussed during the presentation:

a) Reproducibility of AHE, starting from a new wire with limited surface treatments;
b) Role of 50 Hz symmetric (i.e. rise time=fall time) pulses on AHE, changing the polarity;
c) Explorative test using the (modified) Power Dimmer to generate unipolar and/or bipolar pulses. The use of Power Dimmer, directly connected to the ac main, have some advantages regarding the large energy usually “wasted” to generate the proper pulses necessary to induce AHE, especially on surface-treated and bulk-conditioned Constantan wires.

One of the key aspects of Power Dimmer, apart higher energy efficiency in respect to usual sequence of AC Line main->Variac->Galvanic insulation transformer, is the fact that, in proper conditions, the rise-time of the pulse is less than 1 μs while the fall time follows mainly the 50 Hz line (i.e. ms range).

We will show some of the recent results obtained, even under the situation that the usual conditioning time of the wire, usually quite long (up to several months), was (under necessity) largely shortened because the new wire used just after the Conference abruptly was broken at October 4 during a specific test of aging (previously planned).

Acknowledgments: At INFN-LNF: Dr. Augusto Marcelli for several scientific suggestions; Ing. Ruggero Ricci and Collaborators (Electrotechnical group, electric safety problematics); Donato Pellegrino, Dr. Giovanni Franzini, Thomas De Nardis, Gianluca Grill (SELCED Laboratory) for helping in the new instruments developing and data analysis. Economical supports were given by: CleanHME (EU Grant Agreement #951974); NEMC (Metallurgical Company, Italy); IFA-Innovatiogen Srl (Italy); Anthropocene Institute (USA).

Disclaimer: The document was written under the sole responsibility of the Authors and does not necessarily represents the opinion or position of the entire CleanHME project.

Improving Excess Heat Measurement in Hydrogen Desorption Experiment

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We have conducted hydrogen (H) absorption/desorption experiments using a sample of Pd foil coated with Ni membrane with fine-structure of their interface. The fabricated samples were exposed to hydrogen gas at 5 atm for ~24 h for loading. The loading ratios were typically 0.6-0.7. After loading, the sample was placed into a chamber evacuated by a Turbo-Molecular-Pump (~10^{-4} Pa). In the chamber, the sample was heated by applying a direct current at constant power (0.6 W) to stimulate the hydrogen diffusion. The sample temperature and chamber pressure were continuously monitored for ~24 h. A thermo-couple and an infrared thermometer were used for the temperature measurement. As a result, we have observed a short- period intermittent fluctuation in temperature, which might indicate that a prompt deuterium diffusion occurred bidirectionally between the Pd foil and the membrane [1]. We have estimated the excess power from comparison with the results for unloaded sample, and obtained preliminarily up to a few hundred mW so far, a quantitative and precise method for analyzing it has not been established, and we have not obtained any results indicating that excess heat was significantly generated [2].

We have recently modified the experimental method for improving reproducibility of measurement results and more accurate excess heat evaluation. The temperature behavior with blank experiments and the accuracy of calibration data between sample temperature and heat generated have a significant impact on the excess heat calculation. Therefore, by conducting the three experiments, i.e. desorption experiment, blank experiment, and calibration experiment, consecutively, which had previously been conducted independently of each other, we eliminated the influence of differences in the experimental environment.

In present paper, we report the recent results in the modified experimental method.

References

[1] M. Endo et al., Proc. of JCF19, (2018) 53.
[2] S. Narita et al., Proc. of JCF22, (2022) 50.

Detection of He-3 Trapped in CuNiZr Materials by Thermal Desorption Spectrometry

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The anomalous heat generation due to the condensed nuclear reaction energy of hydrogen, so-called nano-metal hydrogen energy (MHE), has been confirmed with high reproducibility through research progress over the past few years. It will be a revolutionary new carbon-neutral technology, providing a practical use as a heat source and others. In a CuNiZr (CNZ) material that absorbs hydrogen, the observed excess anomalous heat were 10 to 1000 times higher than conventional chemical reaction. The tetrahedral condensation (4H/TSC) model theory of four hydrogen atoms has been proposed to explain the excess heats in CNZ materials [1]. It is a type of nuclear fusion reaction in which hydrogen reacts specifically within nanostructured solid crystals.

According to the 4H/TSC reaction theory, the formations of ^{3}He with a proton, or deuteron with two protons are predicted (That is, it does not produce radioactivity). However, these expected reaction products have not been confirmed experimentally. To demonstrate the 4H/TSC reaction theory, the most suite method is the direct observation of ^{3}He, which rarely exists on the earth. It is well known that the doped He in metals are strongly trapped in vacancies, then nano-scale He bubbles are produced with increasing the density [2, 3]. The bubbles are stable and hardly released at temperatures of several hundred degrees of Celsius [2, 3].

A new thermal desorption spectroscopy (TDS) device has been developed aiming to directly detect ^{3}He from CNZ materials after MHE reactions. Our TDS device can heat the samples up to 1400°C, close to the melting point of Ni, using an infrared guide heating device (GVL298, THERMO RIKO, Japan). It has two different quadrupole mass spectrometers (PrismaPro QMG250M2, Pfeiffer Vacuum, Germany & Microvision 2, MKS Instruments, USA) to analyze gaseous components. A 380 L/sec TMP is equipped as a main vacuum pump to generate ultra-high vacuum. In this presentation, we will provide the specification of the TDS device and present some preliminary results.

References:

[1] A. Takahashi et al, ICCF24, (2022).
[2] T. Yamauchi et al, J. Nucl. Mater. 174, 53 (1988).
[3] T. Yamauchi et al, J. Nucl. Mater. 179-181, 308 (1991).

Computer Simulation on the Reactions of Band Gaps Collided by Protons/Deuterons

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It has recently been reported that Low Energy Nuclear Reactions (LENR) in hot Ni metal may be caused by neutrinos produced by energy changes occur in collisions of thermal electrons in the metal [1]. It has also been pointed out that neutrinos can also be produced from electron transitions in excited atoms, although very slightly [2]. Under such circumstances, band gaps have been reported in some metal hydrides so far, and we have confirmed that the band gaps are generated in the metal hydrides such as Pd, Ni, and Cu by computer simulation using a personal computer (PC) [3]. Therefore, we decided to investigate by the computer simulation with Geant4 (GEometry ANd Tracking) based G4CMP (Geant4 Condensed Matter Physics) Monte Carlo simulation toolkit using a PC whether the LENR in the metal hydrides may be caused by neutrinos produced by electron transitions over the band gaps of them. The Geant4 is a base-toolkit software that can trace the reactions of elementary particles, and the G4CMP is a program library that runs on Geant4 and can investigate the emission and transportation of phonons and electron/hole pairs by the collision of low-energy electrons, protons/deuterons, or ions with the semiconductor crystals of lattice structures [4]. This time we show only the preliminary simulations that investigate how the band gaps react to the collision of deuterons.

References

1) A. G. Parkhomov, Weak interactions as Essence of LENR, International Journal of Unconventional Science, E4, 3 (2019).
2) M. Yoshimura, Neutrino Pair Emission from Excited Atoms, Phys. Rev. D 75, 113007 (2007).
3) H. Miura, Computer Simulation on the Metal Hydride Band Gaps of Pd, Ni and Cu Metal Lattices, Proc. of JCF 22, 58 (2022).
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The Design of a Low-Energy Nuclear Battery

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This study presents a new battery design that harnesses the potential of low-energy nuclear reactions (LENR) as a clean and efficient energy source. Rather than solely focusing on maximizing the heat generation capabilities of LENR, our goal is to integrate it into a battery that offers higher energy density, longer lifetimes, and lower costs than existing battery technologies. To achieve this, we propose using hydrogen gas as the fuel and incorporating graphene and a terahertz (THz) source into the design. Specifically, we plan to create p-n junction plates made from materials such as silicon carbide (SiC) or gallium nitride (GaN) and to place them under a graphene sheet (GPJ layer) to generate an electrical current through an electron-beam-induced effect (Fig. 1).

The materials for the low-energy nuclear battery (LENB), hydrogen and carbon, are expected to have weak interactions according to the assumption that protons are neutralized by electron capture prior to undergoing fusion [1][2]. Therefore, we expect to observe beta decay processes that emit electrons through proton-proton chain reactions (p-p cycle) in plasmons excited by THz on the surface of graphene. At low energies, neutralized protons are expected to undergo neutron-neutron fusion (n-n fusion) more frequently. We consider the n-n fusion reaction $n + n \to d + e^- + \bar{\nu}_e$ for neutrons of low energies. The maximum energy of the outgoing electron is estimated to be 3.52 MeV [3]. In addition, proton captures during this cycle are more likely to result in neutron captures.

A schematic of the experimental setup is shown in Fig. 2. At this stage, the device is still in the planning stages, but the basic design is similar to that of a common LENR device [4], except that it produces electricity.

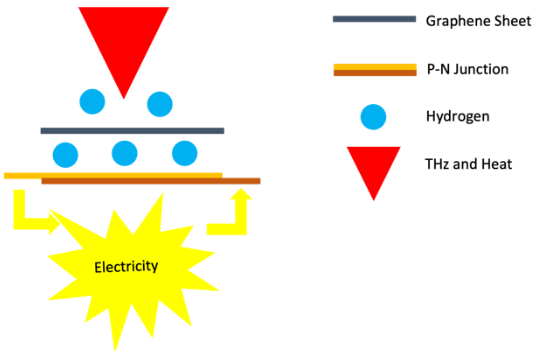

Fig 1. The core design of the LENB.

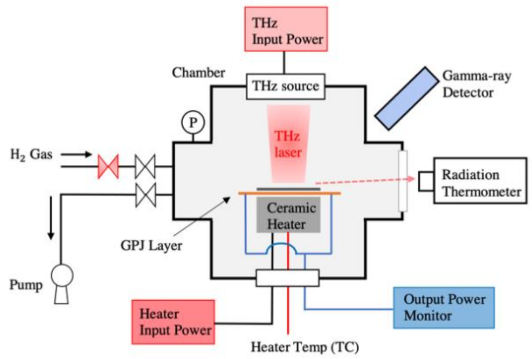

Fig 2. A schematic of the experimental setup.

References

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New Hydrogen Fusion Energy

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Almost all human energy source on this planet is from nuclear fusion energy of Sun. Secondary energy converted from sun energy as fossil, solar cell, wind power, hydro plant and so on are with so low energy density that large amount of materials have to be consumed and environmental pollution increases accordingly.

Human-made fusion energy with high energy density on earth will be the most desirable solution for eco-friendly primary energy source. After 34 years study on Cold Fusion since 1989, we have reached at a wonderful solution of New Hydrogen Fusion Energy (NHFE). NHFE is clean portable fusion energy by using a small amount of nano-metal catalyst with light-hydrogen (H_2) gas as nuclear fuel. Excess thermal power level of 400-1000 W/kg-sample and COP (output-power/in-put-heater power) 1.5-1.7, lasting several days are latest R&D data [1, 2, 3]. Specific reaction energy is far over 10 keV per consumed hydrogen atom. First mile stone data are 1.0 kW/kg-sample with more than 2.0 COP, for proto-type portable desk-top size heat generator.

The TSC theory prediction is making good guidance to experimental trials and matched well with observed thermal energy production patterns under correlated hydrogen loading ratio (over 1.0). Typical latest results of thermal energy generation and running conditions are shown [1, 2, 3]. Social implementation of NHFE with further R&D is very promising now. Start-up of our VB (New Hydrogen Energy Inc. at Kobe University) is highly expected.

Reference review papers :

[1] (PDF) Summary report of lectures on TSC theory (researchgate.net)

[2] (PDF) Views on Cold Fusion at 1994 vs 2023 (researchgate.net)

[3] (PDF) MHE nuclear-like thermal power generation and guiding TSC theory (researchgate.net)

This is abstract to paper for the Industry Application Session of JCF24 Meeting, Sendai, December 1-2, 2023.

Climate change measures and expectations for new energy

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Summary

Introducing global trends on climate change and recent activities in the Japanese automobile industry.

About climate change

1. In recent years, natural disasters such as massive typhoons, landslides caused by heavy rains, and large-scale wildfires have occurred frequently around the world, causing tremendous damage. The main cause of these disasters is considered to be climate change due to global warming.
2. In fact, the average annual temperature in the world has risen by more than 1°C compared to before the Industrial Revolution (late 18th century). If this trend continues, it is expected to rise by about 5°C from the current level by 2100.

Related regulations

1. In 1997, the Kyoto Protocol was adopted, and all advanced countries that participated in the third United Nations Framework Convention on Climate Change (COP3) were required to reduce greenhouse gas emissions from six types of gases by at least 5% compared to 1990 levels by 2012.
2. In 2015, the Paris Agreement was agreed upon, and it became the first framework in which all 196 countries that are members of the twelfth United Nations Framework Convention on Climate Change (COP3) participated.
3. The Paris Agreement stipulates that efforts should be made to keep the rise in average global temperature since the Industrial Revolution below 2°C. Efforts should be made to keep it within 1.5°C if possible.

Examples of corporate activities for 2050

1. Environmental Toyota Challenge 2050

Factory status of high-energy-type factories

1. Toyota Motor Corporation’s factories (entire multiple factories)
2. Toyota Motor Hokkaido’s factories mainly for casting and die-casting parts
3. Factories specializing in casting

References

[1] Cited from Toyota Motor Environmental Report 2020
[2] Cited from Toyota Motor Hokkaido Environmental Report 2021
[3] Data from Resource Energy Agency for Fiscal Year 2019
[4] Data for Fiscal Year 2030 from Basic Energy Plan of Ministry of Economy, Trade and Industry

Metal Crystal confinement Fusion Reactor

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Due to the misleading description in the first paper by S. Pons and M. Fleischmann in 1989 [1], much of the research in this field has stalled, entering areas that have no commonality with their electrolytic experiments. For the suggestion of cold fusion as a heat source, it is necessary to look back at their 1994 paper “Heat after Death [2]". The heat after death is the heat generated after the electrolyte evaporates. The reason why a long electrolysis time is required as a condition for the heat generation is because it is necessary for Li to form a solid solution in the Pd cathode. By inferring the gas surrounding the cathode when the heat is generated, it can be estimated that the state of Pd is in the α phase in which deuterium is not significantly dissolved in solid solution. The probability of occurrence is not 100% because high-energy ions are required at the right time.

We infer that the heat generation is accompanied by a nuclear fusion chain reaction, and we predict the formation of ^{6}Li, and have found evidence of its formation in past papers [3]. Furthermore, we have constructed the experimental reactor and confirmed its start [3].

We believe that to complete the nuclear fusion chain reaction theory [4], it is necessary to elucidate many unexplained phenomena that remain in the world of nuclear physics; for example, the deviation of the shielding energy in the metal from the theoretical value, the generation of particles by DDD3 nuclear fusion in the metal, the reaction cross section of neutrons to low-mass nuclei, and the DT fusion cross section. In addition, to promote industrial use of the "Metal Crystal confinement Fusion Reactor", it is necessary to find a metal substitute for Pd that is cheaper and has a higher operating temperature. In addition, many tasks remain to be done, including the creation of a correct Pd-Li phase diagram and Pd-Li-D ternary phase diagram.

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Development of a low-vibration new type internal combustion engine by using Z-Mechanism and potential applications of this mechanism

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The most recognized industrial machinery that supports our life is the reciprocating engine. Most of the current internal combustion engines (ICE) are reciprocating engines, and the number of new cars sold worldwide is 72.66 million in 2020, making them the largest amount of industrial machinery that support our daily lives. The mechanism of an ordinary internal combustion engine consists of (1) piston, (2) connecting rod and (3) crankshaft and is called a piston-crank mechanism in kinematics. This mechanism was put to practical use in the Industrial Revolution and has been used in various machines such as internal combustion engines, compressors, and pumps. The basic motion of this mechanism is quite simple: thermal energy is applied to the piston to generate linear motion, which is transmitted by the connecting rod to the crankshaft, which converts it into rotational motion for output. However, the piston-crank mechanism has had several problems since it was invented, and humankind has faced and attempted to solve these problems for more than 240 years.

The recent shift to quieter electric motors has brought to the fore the tendency to focus on mechanism-brought vibrations, which until recently have not been regarded as a problem. As a result, the reduction of vibration in industrial machinery has become an urgent issue.

The authors have proposed two unique mechanisms called Z-Mechanisms (As shown Fig.1) that can eliminate such mechanism-brought vibrations by changing some parts [1].

These mechanisms perform mutual conversion between linear and rotary motion while suppressing vibrations and are applicable to machines using pistons and cranks. This paper describes the extremely low-vibration performance of an internal combustion engine manufactured as an application machine using this new mechanism and the potential application for energy generation.

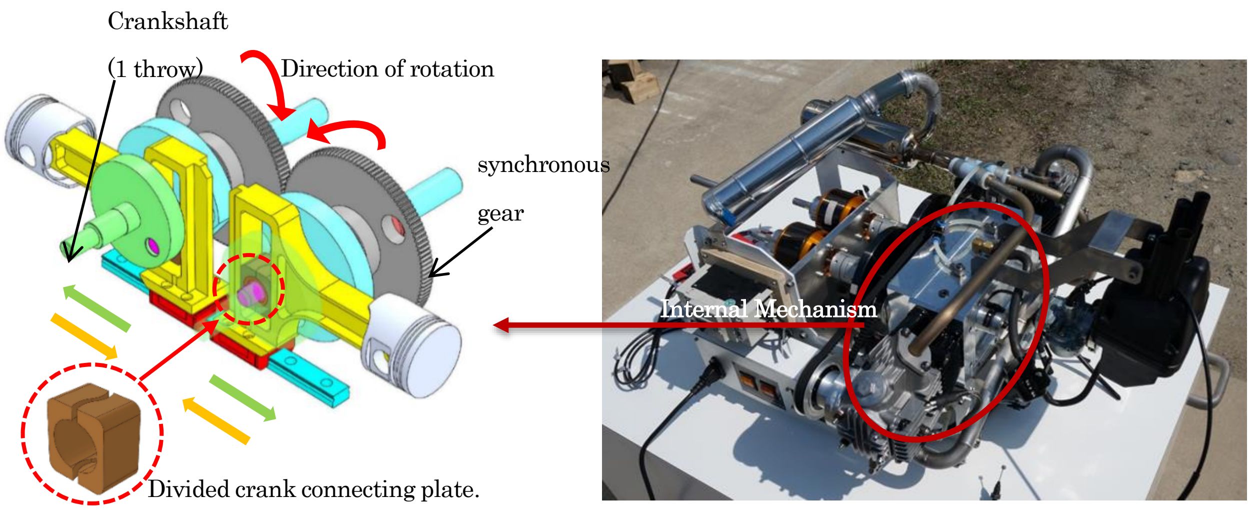

Fig1 Oblique view of Z-Mechanism (Mirror arrangement type) and manufactured ICE

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