# 4. JOINT USAGE/RESEARCH PROGRAM

# Joint Usage/Research Center Program
# “Zero Emission Energy Research”

It is an urgent task to find out the best solutions against the energy and environmental problem for ensuring the sustainable society on the earth. The new energy system for this purpose has to be an environmentally friendly or ecological one. Here, we should consider not only the energy sources but also the efficiency in the each phase of energy usage. The former should have good quality and enough quantity. The latter should be considered including the so-called “three Rs (Reduce, Reuse and Recycle)” in the energy system;

- Reduce of energy consumption, environmental pollutant such as greenhouse gas, waste-heat, hazardous waste, etc.
- Reuse of waste heat/energy, etc.
- Recycle of fuel, etc.

In order to realize them, only the extension of the present technology is not enough. Interdisciplinary studies with innovative ideas are indispensable to realize the energy system for next generation.

We propose a new concept of Zero Emission Energy as a typical model of Advanced Energy. IAE Zero Emission Energy Research aims at the realization of environmentally friendly energy system for sustainable society with minimum emission of environmental pollutants and with maximum utilization of energy and resources. Since FY2011, we had operated a project, “Joint Usage/Research Program on Zero Emission Energy”, which is the program authorized by the MEXT. We have started the second term of the Program from FY2016 and the third phase in FY2022. Here, we aim to (1) promote interdisciplinary joint usage/research studies for Zero Emission Energy Science & Technology, (2) promote education & practical training for young researchers and (3) explore future horizon of Advanced Energy System for sustainable development. IAE provides many unique & attractive facilities for the Joint Usage/Research not only in the field of advanced plasma & quantum energy but also in the field of soft energy.

Many researchers have participated in this program. In FY2022 Joint Usage/Research collaborations of total 110 subjects (including two workshop) on Zero Emission Energy were performed with more than 350 visiting participants from 31 all-Japan Universities and Institutions including graduate/undergraduate students. Researchers from 5 foreign Universities also participated in the program. The results of these collaborations are summarized in a report "IAE Joint Usage/Research Program on Zero Emission Energy 2022". The meeting to present some of remarkable results obtained in FY2022 was held online on March 10, 2023. If you have interest to this collection, please contact to the Office of Zero Emission Energy Research.

In addition to the Joint Usage/Research collaborations, we organized "Kyoto University 125th Anniversary Commemorative Event, The 13th International Symposium of Advanced Energy Science -Research Activities on Zero-Emission Energy Network-" on September 5–7, 2022. This symposium was held as a hybrid event due to the COVID-19. This symposium consists of oral and ZE poster sessions, and satellite meeting. 324 scientists and students including 5 foreign and 6 domestic invited speakers participated in the symposium. At the student poster session, awards were given for outstanding presentations.

We are also operating “Zero Emission Energy Network” to share the knowledge of Advanced Energy and Zero Emission Energy with researchers in the fields of energy science and technology, since world-wide activities for Zero Emission Energy Research are indispensable for the realization of sustainable society.

In FY2022, the Integrated Research Center for Carbon Negative Science was established at the Institute under the new concept of energy science and engineering, which sprouted from zero-emission energy research. We will continue to promote high-quality research and high-quality collaborations in multidisciplinary academic fields and work closely with domestic and international research institutions to contribute to the related communities and to the enhancement of Japan's research capabilities.

Poster of the 13th International Symposium

## List of Zero Emission Energy Joint Usage/Research Subjects in FY 2022

(Subject, Principal Researcher, IAE Key Person)

NMR approach toward elucidation of superflat aluminum electrodeposition mechanism, Atsushi Kitada, Masato Katahira

Development of Interface Design for Improvement of High Temperature Oxidation Properties of High Melting Point Diborides, Ryuta Kasada, Keisuke Mukai

Photoinduced electron-transfer reactions of photosensitizers bound to the active site of enzyme, Hiroshi Takashima, Eiji Nakata

Deactivation of SiC Unpaired Electrons by Hydrogen Termination and the Effects on Anti-corrosion, Sosuke Kondo, Kiyohiro Yabuuchi

Evaluation of irradiation resistance of high entropy compound superconductors, Naoko Oono, Kiyohiro Yabuuchi

Elucidation of redox status-dependent mitochondrial temperature fluctuation towards the development of energy production system mimicking mitochondria, Reiko Sakaguchi, Takashi Morii

Study on development of compound-based anode for K-ion battery and on compatibility with ionic liquid electrolyte, Yasuhiro Domi, Takayuki Yamamoto

Development of anode/electrolyte interface for advanced Na-ion battery, Hiroki Sakaguchi, Toshiyuki Nohira

Fermentation of cellulase-aminating reagent via carbon fixation, Minoru Takeda, Masato Katahira

NMR analysis on regulation of the RNA-binding protein TLS-induced phase separation via methylated RNA, Riki Kurokawa, Masato Katahira

Irradiation damage effect on plasma driven hydrogen isotope permeation for plasma facing materials, Yasuhisa Oya, Kiyohiro Yabuuchi

Combined effect of irradiation and corrosion on hydrogen isotope permeation behavior in functional coatings for fusion reactor blanket, Takumi Chikada, Kiyohiro Yabuuchi

Study of the surface modification layer of lithium ion electrolyte for electrodialysis, Kazuya Sasaki, Keisuke Mukai

Development of a low-density stacked CNT targets and generation of high-pressure gas by the high-power laser irradiation, Ryutaro Matsui, Kazunari Matsuda

Structure control of persistent materials by molecular vibrational excitation, Takayasu Kawasaki, Heishun Zen

Structural analysis of lignocellulosic biomass by NMR spectroscopy toward decarbonized society, Hiroshi Nishimura, Masato Katahira

Applicaion of mode-selective phonon-excitation method in semiconductors of energy functionality with mid-infrared free-electron laser, Kan Hachiya, Hideaki Ohgaki

In-vitro investigation of safety and carotenoid-synthesis of Bacillus strains isolated from shrimp gut by whole genome sequencing for development of biomaterials applied in shrimp aquaculture, Nguyen Thi Van Anh, Yumiko Takatsuka

Generation of High intensity THz pulse by superposition of undulator superradiant, Shigeru Kashiwagi, Heishun Zen

Precision analysis of high-reactive β-1 structure in lignin for advanced biomass utilization, Yasuyuki Matsushita, Masato Katahira

Mid-infrared spectroscopy of Zintl-phase NaMgX (X=Bi,Sb) using Free-electron laser, Mamoru Kitaura, Heishun Zen

Structural basis of DNA recognision by the replication initiator ORC, Shou Waga, Masato Katahira

Study on optimization of alloying elements of tungsten alloys for improved irradiation tolerance, Shuhei Nogami, Kiyohiro Yabuuchi

Analysis of transition from axisymmetric torus to helical axis toroidal plasma, Akio Sanpei, Kazunobu Nagasaki

Dependence of the hardness increase caused by hydrogenation on irradiation temperature in ion-irradiated tungsten, Koichi Sato, Kiyohiro Yabuuchi

Identification of quadruplexes that can regulate gene expression, Yoichiro Tanaka, Takashi Nagata

Development of Solid-State Emitters Appicable to Luminescent Solar Concentrators, Masaki Shimizu, Hiroshi Sakaguchi

Study for the development of functional peptides controlling cell proliferation mechanism using NMR method, Hideki Kusunoki, Takashi Nagata

Determining the conditions of heat treatments for extending the lifetime of nuclear reactors, Yoshitaka Matsukawa, Kiyohiro Yabuuchi

Development of strong superconducting bulk mangnets with high shape-flexibility, Takanori Motoki, Toshiteru Kii

Research on enzyme-free structural alteration of glycan by infrared free electron laser, Takashi Honda, Heishun Zen

Generation and sustainment of high-energy density plasmas via the interaction between high power laser and structured medium, Yasuaki Kishimoto, Hiroshi Sakaguchi

NMR analysis of artificial biomolecules that regulate the function of biomolecules, Taiichi Sakamoto, Takashi Nagata

Study of Hydrogen Isotope Separation Technology by Molten Salt, Hisayoshi Matsushima, Toshiyuki Nohira

Irradiation and Material Variables Dependence of Bubbles/Voids Formation in Fusion Reactor Structural Materials, Takuya Yamamoto, Kiyohiro Yabuuchi

Experimental verification of hydrogen adsorption and desorption behavior for advanced neutron multipliers, Jae Hwan KIM, Keisuke Mukai

Fabrication of functional organic thin films using infrared free electron pulsed laser deposition method, Takashi Nakajima, Heishun Zen

Analysis and Design of Electrode/Electrolyte Interface for All Solid State Battery, Ikuma Takahashi, Keisuke Mukai

Development of the crystalline cellulose degradation system consisting of the psychrophilic fungus-type hybrid enzymes., Masataka Horiuchi, Takashi Nagata

Analysis of processing mechanizum in h igh polymer material by using infrared free electron laser, Jun Fujioka, Heishun Zen

Study of solvation structure and dynamics of room-temperature ionic liquids using MIR free-electron laser, Sakhorn Rimjaem, Hideaki Ohgaki

Measurement of scintillation response by fast neutron, Ken Ichi Fushimi, Keisuke Mukai

Study of nanomaterials torward efficient and high-performance energy conversion, Satoru Konabe, Yuhei Miyauchi

Hydrogen and helium mixed plasma irradiation effects on tungsten materials with rhenium, Yoshio Ueda, Kiyohiro Yabuuchi

Design of physical properties of atomic layer materials by intelayr stacking arrangement, Susumu Okada, Kazunari Matsuda

Influence of Alloying Elements on Radiation Damage Formation and Hydrogen Isotope Trapping in Tungsten, Yuji Hatano, Kiyohiro Yabuuchi

Highly efficient photochemical reactions induced by optimal laser pulses, Yukiyoshi Ohtsuki, Takashi Nakajima

Extension of operation regimes for advanced heliotron plasmas using stochastic electrostatic acceleration, Masayuki Yoshikawa, Shinji Kobayashi

Luminescent nanoporous diamond formed by anodization, Kazuhiro Fukami, Hiroshi Sakaguchi

Development of an RNA eiding oligonucleotide to regulate the production and utilization of biological energy, Masatora Fukuda, Takashi Morii

Nondestructive evaluation of residual elastic strain distribution around the interface between non-irradiated areas and ion irradiated area III, Tamaki Shibayama, Kiyohiro Yabuuchi

Structural studies on hierarchical molecular architectures created in microfluidic device, Munenori Numata, Eiji Nakata

Optimization of reactive oxygen radical production process by atmospheric pressure plasma irradiation, Hiroto Matsuura, Shinichiro Kado

Development of reduced activation high entropy materials for high energy reactor, Naoyuki Hashimoto, Kiyohiro Yabuuchi

Development of 3 dimensional radiative distribution measurement system using incoherent digital holography in Heliotron J., Hayato Kawazome, Shinichiro Kado

In-situ measurement of periodic nanostructures on semiconductor surface induced by mid-infrared free electron lasers, Masaki Hashida, Heishun Zen

A small-molecule-based technology for live-cell imaging of energy metabolism, Shin ichi Sato, Takashi Morii

Study of temporal evolution of amplified coherent edge radiation during free-electron laser oscillations, Norihiro Sei, Hideaki Ohgaki

Counting the number of mode-selectively excited phonon by observation of anti-Stokes/Stokes Raman scattering, Kyohei Yoshida, Hideaki Ohgaki

Development of a New Method for Controlling Thermal Radiation by Quantum Metamaterials, Atsushi Sakurai, Yuhei Miyauchi

Control of humidity sorption in porous molecular crystal by intense infrared rays, Hiroshi Yamagishi, Heishun Zen

Dissolution behavior and spectroscopic measurement of boron compounds in molten salt, Yumi Katasho, Yutaro Norikawa

Hydrogen isotope pick-up and retention in He-exposed W-Mo alloys, Enrique Jimenez Melero, Kiyohiro Yabuuchi

Development of novel guanine-tethered antisennse oligonucleotides, Masaki Hagihara, Takashi Morii

Gas Ionization with Ultrafast Intense Long-Wavelegth Infrared Pulses, Ryoichi Hajima, Heishun Zen

Impact of nonlinear effect on electron cyclotron current drive (ECCD) in tokamak fusion reactor, Kenji Tobita, Kazunobu Nagasaki

Study of minor element addition (Ni, Si) on irradiation hardening of pressure vessel model steels, Ken ichi Fukumoto, Kiyohiro Yabuuchi

Study on living radical polymer production process toward development of highly durable film for lower environmental load, Yusuke Miyake, Hiroshi Sakaguchi

Investigation of wavelength converted thermal radiation based on the vibrationals strong coupling, Tomohiro Fukushima, Taishi Nishihara

Integrated Nano-Calcium Carbonate Enhanced With Rare Earth Phosphates-Lanthanide in Improving Solar Panel Efficiency, Nasrudin Bin Abd Rahim, Hideaki Ohgaki

Surface Modification and Microstructure Control of Magnesium Alloys for Bio-signal Responsiveness, Takeshi Yabutsuka, Kiyohiro Yabuuchi

Synegistic effects of electronic excitation and displacement damage in oxide/nitride ceramics, Kazuhiro Yasuda, Kiyohiro Yabuuchi

Heavy-ion irradiation and post-irradiation annealing effects in explosion-welded CuCrZr/316LN joints for ITER application, Somei Ohnuki, Kiyohiro Yabuuchi

High-Fluence Irradiation Behavior of Reduced Activation Fusion Reactor Materials and its Mechanical Property, Masami Ando, Kiyohiro Yabuuchi

Contribution of infrared laser irradiation to diabetes-related pancreatic dysfunctions, Kazuhiro Nakamura, Heishun Zen

Research and development of enzymatic activity control using VHH antibody, Akifumi Takaori, Takashi Nagata

Study of PV Hybrid Energy Systems for Rural Electrification in Cambodia, Vannak Vai, Hideaki Ohgaki

Study of phonon and thermal proerties of moire super lattice composed of layred materials, Shinichiro Mouri, Kazunari Matsuda

NMR analysis of the three-dimensional solution structure of the sequence-specific RNA-binding protein Musashi1 involved in translation control of the downstream target RNA, Takao Imai, Takashi Nagata

Elucidation of the novel competitive function between microorganisms of genus Rhizoctonia by genomic approach, Yuh Shiwa, Tomijiro Hara

Comparative study for antimicrobial activities among antimicrobial cyclic lipopeptide fengycin analogs, Kenji Yokota, Tomijiro Hara

Study of optical property of atomically thin layered materials using near-field scanning optical microscope, Masaru Sakai, Kazunari Matsuda

Study on advanced ICT-based maintetance technology for zero-emmission energy infrastructure, Hidekazu Yoshikawa, Kazunori Morishita

Development of automated algorithms for high-speed camera image analysis, Nobuhiro Nishino, Shinichiro Kado

Mechanical property evaluation of solid-state welded ODS alloys, Sanghoon Noh, Kiyohiro Yabuuchi

Hydrogen pickup of ion irradiated Zry alloys, Hideo Watanabe, Kiyohiro Yabuuchi

Evaluation of oxide formation process in alloy powder of high chromium ODS steels, Noriyuki Iwata, Kiyohiro Yabuuchi

Elucidation of the shrimp growth promoting mechanisms of dietary supplementation with Bacillus spores, Tsuyoshi Ohira, Tomijiro Hara

Supramolecular assembling regulation of bacterial cell division protein FtsZ on DNA nanostructures, Akira Onoda, Eiji Nakata

Development of New Semiconductor Power Control Devices Aiming for Carbon Neutrality, Kensho Okamoto, Kazunori Morishita

Development of Design Methods for Leading Small Molecules by RNA Aptamers, Yousuke Katsuda, Takashi Morii

Ultra Sensitive Electrochemical Nucleic Acid Sensor, Kazushige Yamana, Takashi Morii

Analysis of reaction meachanism of haloacid dehalogenase, Takashi Nakamura, Takashi Morii

Developmental research on microbial community structure analysis and biopest applications in medicinal plant cultivation, Makoto Ueno, Tomijiro Hara

Small scale water purifier system for pesticides removal: case study hill tribe at Chang Rai province, Thailand, Pannipha Dokmaingam, Hideaki Ohgaki

Evaluation of thermal resistance at the interface of candidate materials for fusion reactor divertor, Masafumi Akiyoshi, Kiyohiro Yabuuchi

Study on emission process and evaluation of light outputs for novel scintillation materials using the one electron beam, Shunsuke Kurosawa, Hideaki Ohgaki

Deuterium desorption from heavy ion irradiated tungsten using isothermal desorption method, Naoko Ashikawa, Kiyohiro Yabuuchi

Development of a method for compsiting $Li_2TiO_3$ and nanocarbon by microwave irradiation, Sadatsugu Takayama, Keisuke Mukai

Fluorescenct analyses of biomolecules and metals through signal amplification system, Ippei Takashima, Eiji Nakata

Interation of LHD divertor plasma and irradiated tungsten, Mingzhong Zhao, Kiyohiro Yabuuchi

Radial Correlation Analysis on Edge Plasma Tubulence in a Toroidal Plasma and Its Dependence on Plasma Confituration, Yoshihiko Nagashima, Shinsuke Ohshima

The effect of ion beam irradiation on the properties of hevily doped nanocrystals, Masanori Sakamoto, Kiyohiro Yabuuchi

Study of ion irradiation effects on oxide dispersion strengthened ferritic steel, Jingjie SHEN, Kiyohiro Yabuuchi

Ionic conduction mechanism of lithium ion conductive LAGP-$LaPO_4$ composite, Shigeomi Takai, Takashi Morii

Effect of FEL irradiation on the efficiency of carbon dioxide fixation in bacterial cells, Tetsuro Kono, Hideaki Ohgaki

Analyses of Electroretinograms from Crayfish's Compound Eyes Evoked by KU-FEL Irradiation-2: Fast and Late Reaction, Fumio Shishikura, Hideaki Ohgaki

Distributed Workshop on "Physics and control of non-linear and non-equlibrium plasma based on the concept of broad-band energy science", Yasuaki Kishimoto, Kazunari Matsuda

Investigation for expeirimental simulation of space plasmas using magnetically confined configurations, Kenichi Nagaoka, Shinji Kobayashi

Public outreach activity of advanced energy science for carbon neutral, Hidekazu Yoshikawa, Kazunori Morishita