

## **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. 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 FY2021 Joint Usage/Research collaborations of total 105 subjects (including two workshop) on Zero Emission Energy were performed with more than 300 visiting participants from 30 all-Japan Universities and Institutions including graduate/undergraduate students. Researchers from 6 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 2021". The meeting to present some of remarkable results obtained in FY2021 was held online on March 14, 2022. 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 "The 12th International Symposium of Advanced Energy Science -Research Activities on Zero-Emission Energy Network-" on September 7–8, 2021. This symposium was held online due to the COVID-19. This symposium consists of oral and poster sessions, and satellite meeting. 162 scientists and students including 3 foreign and 1 domestic invited speakers participated in the symposium. ([http://www.iae.kyoto-u.ac.jp/zero\\_emission\\_e/ZEcalendar/](http://www.iae.kyoto-u.ac.jp/zero_emission_e/ZEcalendar/))

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 FY2021, the evaluation of all of the second term was conducted by MEXT for all the Joint Usage/Research Center Programs. Our program was given "A" evaluation. We were also approved as the Joint Usage/Research Center for the third term, which will begin in FY2022.



Poster of the 12<sup>th</sup> International Symposium

## List of Zero Emission Energy Joint Usage/Research Subjects in FY 2021

(Subject, Principal Researcher, IAE Key Person)

Elucidation of Hopping Conduction in Lithium Excess Solvate Ionic Liquids, Atsushi Kitada, Masato Katahira

Study on lignin degradation by infrared free electron laser, Takayasu Kawasaki, Heishun Zen

Study of formation process of solute clusters in stainless steel with ion irradiation, Ken-ichi Fukumoto, Kiyohiro Yabuuchi

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

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

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

Chemical state analysis of borocarbides, Ryuta Kasada, Kiyohiro Yabuuchi

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

Functionalization of amino sugar-containing polysaccharides using environmental microbes, Minoru Takeda, Masato Katahira

Interaction analysis between cellulase carbohydrate-binding module and lignin by ultra-high sensitivity NMR for biorefinery, Takashi Watanabe, Masato Katahira

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

NMR analysis on molecular mechanism of phase separation inhibition and elucidation of its physiological significance, Riki Kurokawa, Masato Katahira

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

Structural analysis of fluorine-containing compounds by NMR spectroscopy, Kazuhiko Matsumoto, Masato Katahira

Effect of high energy He ion implantation on hydrogen isotope behavior in tungsten, Yasuhisa Oya, Kiyohiro Yabuuchi

The effects of dangling-bond on anodic dissolution of ceramics, Sosuke Kondo, Kiyohiro Yabuuchi

Development of biomaterial which improve gut microbiome and health of white-leg shrimp by using heat-stable carotenoid-producing *Bacillus* spores, Nguyen Thi Van Anh, Yumiko Takatsuka

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

Development of low-density stacked CNT target and fundamental process of the interaction by high-intensity laser irradiation, Ryutaro Matsui, Kazunari Matsuda

Electrodeposition of Si in Molten Salts Containing Silicate Ions towards the Production of Solar-Grade Silicon, Koji Yasuda, Toshiyuki Nohira

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

Advanced thermal diffusivity evaluation method using D3 miniature specimens at elevated temperature., Masafumi Akiyoshi, Kiyohiro Yabuuchi

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

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

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

Analysis of element distribution changes in solid lithium electrolyte generated by electro dialysis using rf-GD-OES, Kazuya Sasaki, Keisuke Mukai

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

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

Development of Emissive Solid Materials Applicable to Luminescent Solar Concentrators, Masaki Shimizu, Hiroshi Sakaguchi

Development of pulsed laser deposition using infrared free electron laser, Takashi Nakajima, Heishun Zen

NMR analysis of peptides and nucleic acids that modulate biomolecular functions, Taiichi Sakamoto, Takashi Nagata

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

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

Carrier diffusion process in silicide kankyo semiconductors revealed by mid-infrared free electron laser, Mamoru Kitaura, Heishun Zen

Structural study of DNA binding of the replication initiator ORC, Shou Waga, Masato Katahira

The temperature dependence of ductility in Al, Zr-added ODS ferritic steel treated under different MA atmospheres, Noriyuki Iwata, Kiyohiro Yabuuchi

Study of material development and interface design for all solid state Li ion battery, Ikuma Takahashi, Keisuke Mukai

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

Study on the impact of phase reconfiguration in unbalanced distribution systems, Vannak VAI, Hideaki Ohgaki

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

Elucidation of ablation mechanism based on vibrational excitation in molding materials and surface modification by infrared free electron laser, Jun Fujioka, Heishun Zen

Clarification of hydrogen adsorption and desorption behavior for neutron multipliers for fusion applications, Jaehwan Kim, Keisuke Mukai

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

Design and investigation of complexes comprising atom-layered materials, Susumu Okada, Kazunari Matsuda

Study on Thermal Radiation of Quantum Materials for Highly Efficient and Functional Energy Conversion, Satoru Konabe, Yuhei Miyauchi

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

Surface processing of SiC achieved by combination of phonon excitation using FEL and electrochemistry, Kazuhiro Fukami, Heishun Zen

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

The study of material degradation evaluation with irradiation hardening in tungsten for divertor, Kouichi Tougou, Kiyohiro Yabuuchi

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

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

Development of tantalum added vanadium alloys for fusion reactors, Takeshi Miyazawa, Kiyohiro Yabuuchi

Spatially resolved measurement of atomic emission line spectra using NIR Zeeman spectroscopy, Taiichi Shikama, Shinichiro Kado

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

Study of the battery technology for Improving the Solar Home System (SHS) in Rural electrification, Nasrudin Abd Rahim, Hideaki Ohgaki

Development and application of organic spintronics materials toward energy-saving devices, Yusuke Miyake, Hiroshi Sakaguchi

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

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

Clarification on retention processes of He and H in ion irradiated pyrochlore oxides, Bun Tsuchiya, Kiyohiro Yabuuchi

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

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

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

Time-series data analysis of Heliotron-J plasma by statistical modeling, Shigeru Inagaki, Kazunobu Nagasaki

Development of ultrasound-enhanced cell-internalization method and mechanism evaluation, Atsushi Harada, Eiji Nakata

Measurement of coherent edge radiation spectra during free-electron laser oscillations, Norihiro Sei, Hideaki Ohgaki

Study for the development of functional peptides using NMR, Hideki Kusunoki, Takashi Nagata

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

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

Effect of irradiation on Coated Materials for Tritium Barrier, Somei Ohnuki, Kiyohiro Yabuuchi

Quantitative relationship between plasma-produced reactive radical amount and biological/chemical reaction promotion, Hiroto Matsuura, Shinichiro Kado

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

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

Development of optical devices using the interface of layered material and nitride semiconductor, Shinichiro Mouri, Kazunari Matsuda

Ultra-Highly Sensitive DNA/RNA Sensor, Kazushige Yamana, Takashi Morii

Natural Convection Heat Transfer for Sugar Alcohols, Makoto Shibahara, Kiyohiro Yabuuchi

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

Design of Staple oligoemr based on thermodynamic analysis, Yousuke Katsuda, Takashi Morii

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

Microstructural evolution of ODS Ferritic Steels during cold working process for Next generation Nuclear components, Sanghoon Noh, Kiyohiro Yabuuchi

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

Identification and characterization of novel antimicrobial cyclic lipopeptides derived from Bacillus sp., Kenji Yokota, Tomijiro Hara

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

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

Formation and crystalline characterization of periodic nanostructures on semiconductor substrates irradiated by intense mid-infrared laser pulses, Ozaki Hashida, Heishun Zen

Development of high-speed camera image analysis method using magnetic field information, Nobuhiro Nishino, Shinichiro Kado

Development of a method for compoising Li<sub>2</sub>TiO<sub>3</sub> and nanocarbon by microwave irradiation, Sadatsugu Takayama, Keisuke Mukai

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

Dissociation of poly-amino acid aggregates by free electron laser irradiation, Kazuhiro Nakamura, Heishun Zen

Determination of the free energy of the late-blooming phase (3), Yoshitaka Matsukawa, Kiyohiro Yabuuchi

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

Fluorescent analyses of biomolecules and metals using cephem compounds, Ippei Takashima, Eiji Nakata

Study on emission process of scintillation material using the one electron beam and evaluation of scintillation properties for darkmatter search, Shunsuke Kurosawa, Hideaki Ohgaki

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

Influence of irradiation defects on the tritium removal behavior from tungsten by hydrogen isotope exchange, Mingzhong Zhao, Kiyohiro Yabuuchi

Clarification of fine structure of environmentally compatible hydroxyapatite capsules, Takeshi Yabutsuka, Kiyohiro Yabuuchi

Conductivity Enhancement Mechanism of NASICON-type Lithium Ion Conductive Composite, Shigeomi Takai, Takashi Morii

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

Carbon dioxide gas fixation by laser irradiation response to calculus forming bacteria., Tetsuro Kono, Hideaki Ohgaki

Analyses of Electroretinograms from crayfish's compound eyes evoked by KU-FEL irradiation: Fast and Late reaction, Fumio Shishikura, Hideaki Ohgaki

Measurement of scintillation response by fast neutron, Kenichi Fushimi, Keisuke Mukai

Statistical analysis on edge turbulence fluctuation data in Heliotron-J, Yoshihiko Nagashima, Shinsuke Ohshima

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

Study on how to make zero emission infrastructure more social resilient by advanced ICT, Hidekazu Yoshikawa, Kazunori Morishita

KU-FEL User Symposium 2021, Mamoru Kitaura, Heishun Zen

Investigation for experimental simulation of space plasmas using magnetically confined configurations, Kenichi Nagaoka, Heishun Zen