

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 FY2020 Joint Usage/Research collaborations of total 116 subjects (including two workshop) on Zero Emission Energy were performed with more than 263 visiting participants from 51 all-Japan Universities and Institutions including graduate/undergraduate students. Researchers from 9 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 2020". The meeting to present some of remarkable results obtained in FY2020 was planned to be held online on March 9, 2021. 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 11th International Symposium of Advanced Energy Science -Research Activities on Zero-Emission Energy during the COVID-19 Peril-" on September 15–16, 2020. This symposium was held online due to the COVID-19. This symposium consists of oral and poster sessions, and satellite meeting. 234 scientists and students including 5 foreign and 6 domestic invited speakers participated in the symposium. (http://www.iae.kyoto-u.ac.jp/zero_emission_e/ZCalendar/)

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 FY2018, the intermediate evaluation by MEXT was conducted for all the Joint Usage/Research Center Programs. Our program was given "A" evaluation. Since then, we had been continuing the effort to keep this high evaluation with the researchers of the related communities. At the end of FY2020, we submitted the documents for the evaluation of all of the second term to MEXT, hoping the high evaluation again.



Poster of the 10th International Symposium

List of Zero Emission Energy Joint Usage/Research Subjects in FY 2020

(Subject, Principal Researcher, IAE Key Person)

Photoinduced electron-transfer reactions of metal complexes as photosensitizers bound to the active site of enzyme, H. Takashima, E. Nakata

Influence of Alloying Elements on Radiation Damage Formation and Hydrogen Isotope Trapping in Tungsten, Y. Hatano, T. Hinoki

Elucidation of the energy production system in mitochondria by intracellular thermosensors, R. Sakaguchi, T. Morii

Feasibility study and development of novel technique of measuring transverse velocity field using optical vortex emitted from photonic crystal laser, H. Himura, S. Kado

Modeling and Experimental Study on Damage Rate Effects on Bubbles/Voids Formation in Fusion Reactor Structural Materials, T. Yamamoto, K. Yabuuchi

Effects of Metal Nanoparticles and Magnetic Field on Photoproperties of Dye-Metal Nanoparticle Composite Films, H. Yonemura, H. Sakaguchi

Preparation of low molecular weight glucose-glucosamine copolymer and its characterization, M. Takeda, M. Katahira

Hydrogen and helium mixed plasma irradiation effects on tungsten materials with rhenium, Y. Ueda, T. Hinoki

Protonic Function Search by Novel Synthesis of Ammonium Solvate Ionic Liquid, A. Kitada, M. Katahira

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

Study on optimization of alloying elements of tungsten alloys for improved irradiation tolerance, S. Nogami, K. Yabuuchi

Development of thermal diffusivity evaluation method using miniature specimens at elevated temperature, M. Akiyoshi, T. Hinoki

Chemical state analysis of borocarbides, R. Kasada, K. Yabuuchi

NMR analysis on conformational alteration of RNA-binding protein with inhibitor for phase separation, R. Kurokawa, M. Katahira

Study of formation process of solute clusters in stainless steel with ion irradiation, K. Fukumoto, K. Yabuuchi

High-Fluence Irradiation Behavior of Reduced Activation Fusion Reactor Materials, H. Tanigawa, T. Hinoki

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

Development of anode/electrolyte interface for advanced Na-ion battery, H. Sakaguchi, T. Nohira

Photocarrier dynamics of Kankyo semiconductor magnesium silicide single crystals revealed using plasma reflection in mid-infrared region, M. Kitaura, H. Zen

Development of hyper-efficient degradation method of biomass-related compounds by using mid-infrared free electron laser, T. Kawasaki, H. Zen

Investigation of carotenoid synthesis and microbiome changes in shrimp gut upon feeding shrimp with combined pigmented and non-pigmented *Bacillus* spores, N. Anh, Y. Takatsuka

Analysis of transition from axisymmetric torus to helical axis toroidal plasma, A. Sanpei, K. Nagasaki

Combined effect of high-temperature irradiation with heavy ion and helium on hydrogen permeation behavior in functional coating for fusion reactor blanket, T. Chikada, K. Yabuuchi

Effect of high energy He ion implantation on hydrogen isotope behavior in tungsten, Y. Oya, T. Hinoki

Solvate structure analysis of fluoride ion by NMR spectroscopy, K. Matsumoto, M. Katahira

The effects of dangling-bond on anodic dissolution of ceramics, S. Kondo, T. Hinoki

Irradiation effect of oxide particles in oxide dispersion strengthened (ODS) alloys, N. Oono, K. Yabuuchi

Development of High Temperature Ductile ODS Steels for Advanced Nuclear System, N. Iwata, K. Yabuuchi

- Development and applications of functional organic materials for energy conservation-directed light-emitting devices, M. Shimizu, H. Sakaguchi
- High-speed polarization switching using super radiant THz undulator radiation, S. Kashiwagi, H. Zen
- Thermal control of phase change material using graphite powder, M. Shibahara, T. Hinoki
- Mode-selective phonon excitation in semiconductors of energy functionality with mid-infrared free-electron laser, K. Hachiya, H. Ohgaki
- Elucidation of change in element density distribution in solid lithium electrolyte during electro dialysis by rf-GD-OES analysis, K. Sasaki, K. Mukai
- Synergistic effects of electronic excitation and displacement damage in oxide/nitride ceramics, K. Yasuda, K. Yabuuchi
- Clarification of hydrogen retention behavior for beryllium and beryllides, K. Jaehwan, K. Mukai
- Study on development of compound-based anode for K-ion battery and on compatibility with molten salt electrolyte, Y. Domi, T. Yamamoto
- Evaluation of the stability of irradiation induced point defect clusters during annealing, S. Jitsukawa, T. Hinoki
- Development of a high peak power and quasi-monochromatic compact THz laser and its applications, K. Sakaue, H. Zen
- Analysis of the binding of human replication initiation protein ORC to guanine quadruplex DNA, S. Waga, M. Katahira
- Photoenergy Conversion System Utilizing Organic-Inorganic Hybrid Nanomaterials Assembled on DNA, K. Yamana, T. Morii
- Improvement of the small-scale biogas plant for a household in a rural village, V. Vai, H. Ohgaki
- Design of physical property and functionality of atomi layered materials, S. Okada, K. Matsuda
- NMR analysis for the development of peptides and RNAs to control biomolecular functions, T. Sakamoto, T. Nagata
- The study of mechanism evaluation of material degradation in irradiation damage microstructure of tungsten for divertor, K. Tougou, K. Yabuuchi
- Observation of temporal evolution of coherent edge radiation during free-electron laser oscillations, N. Sei, H. Ohgaki
- High spacial resolution near-field imaging of exciton in atomically thin layered materials, M. Sakai, K. Matsuda
- Research and development of enzymatic activity control using VHH antibody, A. Takaori, T. Nagata
- Elucidation of correlation between quadruplex-based gene expression regulation and their structure. , Y. Tanaka, T. Nagata
- Spatially resolved measurement of atomic emission line spectra using NIR Zeeman spectroscopy, T. Shikama, S. Kado
- Quantitative relationship between plasma-produced reactive radical amount and biological/chemical reaction promotion, H. Matsuura, S. Kado
- Highly efficient photochemical reactions induced by optimal laser pulses, Y. Ohtsuki, T. Nakajima
- Electrochemical Surface Finishing of SiC electrode by controlling the lattice defects: Comparison in the effect of defect formation between DuET and FEL, K. Fukami, H. Zen
- Structural studies on hierarchical molecular architectures created in microfluidic device, M. Numata, E. Nakata
- Effect of irradiation on Coated Materials for Tritium Barrier, S. Ohnuki, K. 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, T. Imai, T. Nagata
- Nondestructive evaluation of residual elastic strain distribution around the interface between non-irradiated areas and ion irradiated area, T. Shibayama, T. Hinoki
- Development of multi-channel spectroscopic system for turbulence measurement, A. Fujisawa, S. Ohshima
- Analysis of the mechanism of ultrasound-enhanced cellular internalization of bioactive molecules, T. Ohtsuki, E. Nakata

Development of a new scheme concerning shock acceleration of ions and experiment utilizing a structured medium, R. Matsui, K. Matsuda

Development of reduced activation high entropy materials for high energy reactor, N. Hashimoto, K. Yabuuchi

Development of HeI image reconstruction technique using neural network in Heliotron J, H. Kawazome, S. Kado

Time-series data analysis of Heliotron-J plasma by statistical modeling, S. Inagaki, K. Nagasaki

Study on impurity behaviors and materials corrosion in liquid metals for advanced nuclear systems, T. Oda, J. Yagi

Mechanical Property of Ion-irradiated RAFMs by Ultra Micro-tensile Test, M. Ando, K. Yabuuchi

Clarification on retention processes of He and H in ion irradiated pyrochlore oxides, B. Tsuchiya, T. Hinoki

Strengthening and improvement of ductility by precipitation control for low-activation vanadium alloy for fusion reactors, T. Nagasaka, K. Yabuuchi

Analysis of reaction mechanism of haloacid dehalogenase, T. Nakamura, T. Morii

Effect of hydrogen on surface hardness in ion-irradiated tungsten, K. Sato, K. Yabuuchi

A study of irradiation-induced precipitation on tungsten-rhenium alloys, T. Miyazawa, K. Yabuuchi

Irradiation field dependence of microstructural evolution of ferritic steel during irradiation, Y. Watanabe, K. Morishita

Analysis of radiation induced nano-clusters in RPV steels, H. Watanabe, K. Yabuuchi

Study of periodic nanostructures on semiconductors produced by mid-infrared free electron lasers, M. Hashida, H. Zen

Preparation and characterization the enzyme immobilization by entrapment within a bio-polymer hydrogel network, T. Jannongkan, T. Hara

Study of nanomaterials toward efficient and high-performance energy conversion, S. Konabe, Y. Miyauchi

Control of electric current and heat flux using single particle diodes toward energy harvesting, N. Yonekura, Y. Miyauchi

Study of Hydrogen Isotope Separation Technology by Molten Salt, H. Matsushima, T. Nohira

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

Developmental research on microbial community structure analysis and biopest applications in medicinal plant cultivation, M. Ueno, T. Hara

Study of the suitability of different types of battery for rural electrification and its impact to the quality of life of the communities, N. Rahim, H. Ohgaki

Study for electron-hole plasma on semiconductor surface at mid-infrared region, K. Kawase, H. Zen

Development of high-speed camera image analysis method using magnetic field information, N. Nishino, H. Okada

Enhancement of High Temperature Mechanical Properties on the ODS Ferritic Steels for Next generation Nuclear and Thermal Power Systems, S. Noh, K. Yabuuchi

R&D of BN/CNTs heat dissipation sheets as heat transfer II, K. Shimoda, T. Hinoki

Feasibility and lithium analysis on the anion doped oxide - organic nano composite for energy utilization and lithium, S. Takayama, J. Yagi

Transport analysis for neutral beam heated plasmas in advanced heliotron configuration, M. Yoshikawa, S. Kobayashi

A small-molecule-based technology for live-cell imaging of energy metabolism, S. Sato, T. Morii

Development of RNA editing technology for gene regulation involved in an intracellular energy production and utilization, M. Fukuda, T. Morii

Processing of organic-inorganic hybrid materials by infrared free electron laser, J. Fuzioka, H. Zen

On-site, rapid, qualitative DNA/RNA detection in resource-poor settings, M. Hagihara, T. Morii

Investigation of current-induced electronic phase in devices based on strongly correlated electron

systems, H. Narita, T. Hinoki

Behavior of hydrogen on the surface of fusion reactor materials by computer simulations, H. Iwakiri, K. Morishita

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

Development of valleytronic devices using the layered material and nitride semiconductor, S. Mouri, K. Matsuda

Supramolecular assembling regulation of bacterial cell division protein FtsZ on DNA nanostructures, A. Onoda, E. Nakata

Development of a short nucleic acid that regulate transient protein interactions, Y. Katsuda, T. Morii

Identification and characterization of novel antimicrobial cyclic lipopeptides derived from *Bacillus* sp, K. Yokota, T. Hara

Study of basic properties of fine bubbles in the liquid, Y. Ueda, T. Morii

Novel synthesis process of ammonia at ambient condition, T. Ogawa, M. Katahira

High-Temperature Raman Spectroscopic Analysis of Silicon Coordination in Molten Salts for the Production of Solar-Grade Silicon, K. Yasuda, T. Nohira

Electrochemical preparation of Si-based energy materials in molten salt and their characterization, X. Yang, T. Nohira

Control of inner structure of apatite microcapsules fabricated by biomimetic method, T. Yabutsuka, T. Hinoki

Determination of the free energy of the late-blooming phase (2), Y. Matsukawa, K. Yabuuchi

The effect of ion beam irradiation on the properties of heavily doped nanocrystals, M. Sakamoto, T. Hinoki

Study on neutron imaging techniques for inspection of fusion blanket modules with DD neutron source, T. Tanaka, K. Mukai

Analysis of electroretinograms from the crayfish's compound eyes stimulated by mid-infrared of KU-

FEL, F. Shishikura, H. Ohgaki

Quantification of cell-surface markers using enzyme-antibody conjugates, I. Takashima, E. Nakata

Mechanism of Cycle Performance Improvement for Mechanochemically Activated LiMn_2O_4 , S. Takai, T. Morii

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

Study of experiment and simulation for the synergistic effect of displacement damage and helium on irradiation hardening behavior, E. Wakai, K. Yabuuchi

Deuterium desorption from heavy ion irradiated tungsten using isothermal desorption method, N. Ashikawa, T. Hinoki

Depth profile measurements of hydrogen isotopes of damaged tungsten, M. Yajima, T. Hinoki

Development of laser nanoprocessing technique by using short-range surface plasmons excited with few-cycle laser pulses, G. Miyaji, K. Matsuda

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

Statistical analysis on edge turbulence fluctuation data in a toroidal plasma, Y. Nagashima, S. Ohshima

Workshop on "Physics and control of non-linear and non-equilibrium plasma based on the concept of broad band energy science", Y. Kishimoto, K. Matsuda

Safety enhancement of nuclear power system by advanced ICT technology, H. Yoshikawa, K. Morishita