6. INTEGRATED RESEARCH CENTER FOR CARBON NEGATIVE SCEINCE

2022 Activities

Introduction

The center was established on August 2022 to promote research on Carbon Negative Science to accelerate the Carbon Neutral Society in 2050. Until now, the balance between emissions and absorption of carbon dioxide has been maintained. But rapid human activity since the Industrial Revolution has led to an imbalance between emissions and absorption of carbon dioxide and carbon dioxide mission has become excessive that causes serious impact on our planet, climate change. To return to a balanced state, it will be difficult to achieve with "Zero Emission" technology alone. It is necessary to create a new energy system by introducing more aggressive carbon dioxide fixation processes. The Integrated Research Center for Carbon Negative Science will work to develop such new carbon dioxide fixation technologies in collaboration with the Graduate School of Engineering and the Graduate School of Energy Science at Kyoto University. Among several carbon dioxide fixation technologies, the center focuses on 1) Solar Energy Utilization for CO_2 Capture and Conversion, 2) Conversion of CO_2 into Useful Substances, and 3) Biological Utilization of CO_2.

The Center will also work on human resource development for “Carbon Negative Energy”, which is a new concept at this time.

In this line, we set up three research projects, 1) Solar Energy Utilization for CO_2 Capture and Conversion, 2) Conversion of CO_2 into Useful Substances, 3) Biological Utilization of CO_2, and preparation of the education system of “Carbon Negative Energy” in this year.

1. Solar Energy Utilization for CO_2 Capture and Conversion

The objective of this group is to establish novel science and technology for efficient solar energy utilization required for capturing CO_2 and/or converting CO_2 into valuable materials. Upcoming research projects of this group include studies on thermo-photophysical properties of nanocarbons for solar energy applications, effective use of long wavelength light using MIR-FEL, application of laser/light to highly efficient hydrogen production, photonics and its energy applications based on nanoscience, vectorial on-surface synthesis of 2D polymer crystal as high-performance energy materials, and materials design of metal-doped catalysts for conversion of parabens and/or other compounds. All these diverse projects aim to realize new energy conversion systems using solar energy.

2. Conversion of CO_2 into Useful Substances

In this project group, we aim to convert CO_2 into useful substances. As a conversion method, we are particularly interested in electrochemical methods. For example, when molten salts are used as electrolytes, there is the potential to convert CO_2 into a variety of value-added carbon materials, such as diamonds, carbon nanotubes, and graphite. Also, when aqueous solutions, organic solvents, or ionic liquids are used as electrolytes, CO_2 can be converted into methane, ethylene, and other products. We are studying the optimal electrolyte composition, temperature, electrolysis conditions, etc. to produce the objective value-added materials more selectively, more efficiently, and faster. We also aim to elucidate the reaction mechanism to develop appropriate electrocatalysts and novel electrolysis methods.

3. Biological Utilization of CO_2

Research in this project focuses on bio-related methods, materials and enzymes with the goal to contribute to Carbon Negative Science. The scope of the research is wide, and includes the development of tools to better understand the biological cell and its energy conservation, and technology to enhance and/or prolong the activity of enzymes, particularly those related to CO_2-fixation. Membranes, reactors and processes are being developed to enhance biomass utilization and develop efficient biorefineries. The identification of new microbial enzymes or metabolic pathways that can contribute to CO_2-fixation is also a major goal. Although the individual groups may specialize in diverse areas of research, they share common goals, and collaborative research is ongoing to contribute towards developing a bio-based society.

4. Education Activity

This group reformed the existing undergraduate class, “Advanced Energy Science” to adopt the Carbon Negative Energy concept. The new lecture series will start in the 2nd semester of 2023. As the graduate level lecture course, the Graduate School of Energy Science prepared the “Socio-Environmental Energy Science I and II” to include “Carbon Negative Energy” in this year. We also advertise the concept of “Carbon Negative Energy” to the visitors to the institute.

5. Other activities

The center secured the collaborative research rooms, etc. and started maintaining the research infrastructures and equipment in the main building at Uji Campus. Specifically, they are Laboratory 1-5,

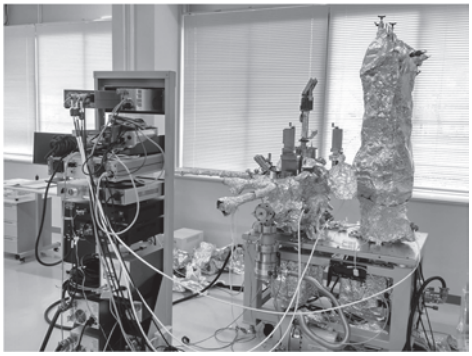

Fig. 1-1 STM

Fig. 1-2 GC-MS

Fig. 1-3 Waiting Room

Waiting Room 1-2, and Program-Specific Associate Professor's Room. The equipment includes STM, GC-MS, digital microscope, etc. as shown in Fig. 1-1, 1-2, 1-3.

ICaNS Events

June: Abbreviated name ICaNS and the logo was decided
September 28 1st Steering Committee meeting
October 1: Appointed to a full time and concurrent professors
October 1: Program-Specific Associate Professor was appointed.
October 8: Opening Ceremony
March 10, 2023: Annual Activity Report Meeting