# Japan
# Member of ICHMT, AIHTC, AUTSE
# (1) Overview

(Japan Standard Time, JST: UTC+9, Population: 125 million)

### 1. Major Societies

Most of Japanese scientists and engineers in thermal science and engineering (or more specifically heat and mass transfer) belong to the Heat Transfer Society of Japan (**HTSJ**), Thermal Engineering Division of the Japan Society of Mechanical Engineers (**JSME-TED**), and Division of Thermal Engineering of the Society of Chemical Engineering (**SCEJ-DTE**). The relationships among the three major societies are expressed as shown in **Fig. 1**. Although the number of members of HTSJ are much less than that of JSME-TED, HTSJ is a core society of heat and mass transfer. This is because JSME-TED consists of a wide variety of thermal engineering applications.

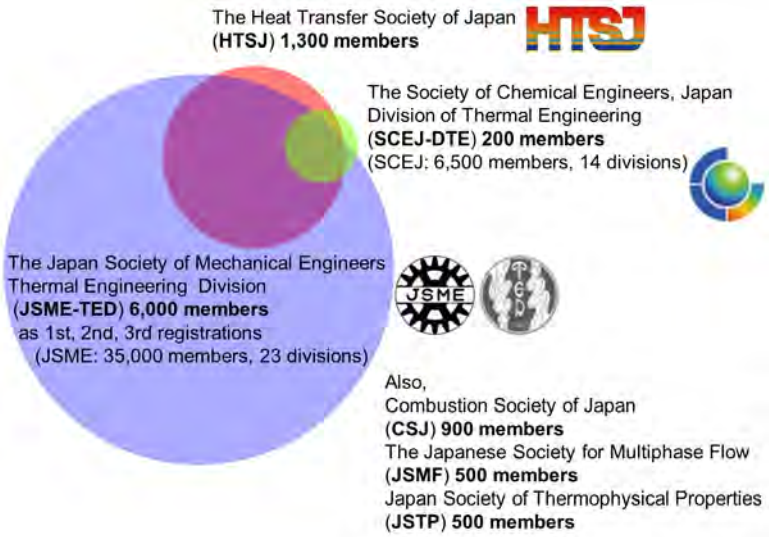



**Fig. 1** Relationships among three major societies of thermal science and engineering

### 2. Major Meetings

National Heat Transfer Symposium by HTSJ
- Since 1964, annually held (the 58th in 2021)
- Place: rotated among 8 branches (see **Fig. 2**)
- Period: three days in late May or early June
- Participants: about 800
- Paper presentations (oral): about 350

Thermal Engineering Conference by JSME-TED
- annually held
- Period: 2 days in October
- Place: University campus

Thermal Engineering Session by JSME-TED
- during Annual Meeting of JSME (in September)
- Place: University campus


**Fig.2** Eight branches of HTSJ





Thermal Engineering Session by SCEJ-DTE
- during Annual Meeting of SCEJ (in March)
- during Autumn Meeting of SCEJ (in September)
- Place: University campus

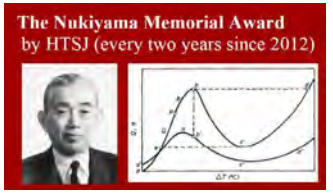



### 3. Major Journals

JSME
- The Journal of Thermal Science and Technology (JTST) (in English, every 4/6 months)
- Mechanical Engineering Journal (in English, bimonthly)
- Transactions of the JSME (in Japanese, monthly)

SCEJ
- Journal of Chemical Engineering of Japan (in English, monthly)
- Kagaku Kogaku Ronbunshu (in Japanese, bimonthly)

HTSJ
- Thermal Science and Engineering (in Japanese/English, quarterly)




### 4. Education (Undergraduate/Graduate School)

- Elementary School, 6 years; Junior High School, 3 years; High School, 3 years; Undergraduate School, 4 years. After Junior High School, there is an alternative choice of College of Technology, 5 years.
- In general, the first semester starts in April (cherry blossom season), while the second semester starts in October.
- Most of undergraduate school education is carried out by using Japanese textbooks.
- Senior students engage in bachelor theses by doing experimental/theoretical studies under his/her supervisors.
- Master course is usually 2 years, and Doctor course is 3 years on average.
- The deadlines of theses of (doctor,) master and senior students are usually in January or February.
- Traditionally, female students are not so many in the faculty of engineering, which is an urgent matter for us.

### 5. University System

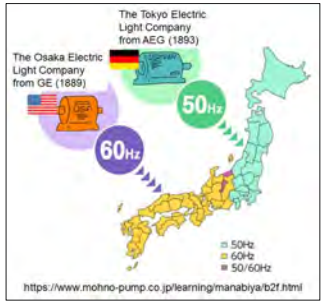
- Some laboratories are based on the chair system such as professor, associate professor, and assistant professor.
- Recently, however, laboratories based on the independent system are increasing.
- At most of universities, the retirement age is about 65.

### 6. Foundations of Scientific Research

- Ministry of Education, Culture, Sports, Science and Technology (MEXT)
- The Japan Society for the Promotion of Science (JSPS)
- Japan Science and Technology Agency (JST)
- New Energy and Industrial Technology Development Organization (NEDO)

### 7. Major Public/Private Research Institutes

- National Institute of Advanced Industrial Science and Technology (AIST)
- RIKEN (the Institute of Physical and Chemical Research)
- Japan Atomic Energy Agency
- Toyota Central R&D Labs., etc.




By-product of "war of the currents"

### 8. Addendum

Japanese language belongs to Altaic languages; one of their typical features is a subject–object–verb (SOV) structure. After Chinese characters were transferred to Japan in the 4th century, Hiragana and Katakana (Japanese characters) were developed in the 8-9th century. As a result, we combinedly use the above three characters as shown in this example.



| | | |
|---|---|---|
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| President of JSME-TED | OHARA Taku 小原 拓 | ohara@ifs.tohoku.ac.jp |
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## Japan, Member of ICHMT, AIHTC, AUTSE (2)

## 1. Accelerating international collaboration with DX
Junichiro Shiomi

## 2. Report on 59th national heat transfer symposium of Japan (NHTSJ 2022)
Yoshinori Itaya and Hirofumi Hattori

### 1. Accelerating international collaboration with DX

**Junichiro Shiomi**, Dept. of Mech. Eng., The University of Tokyo
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The pandemic took a heavy toll on the world, forcing us to change the way we work, learn, and interact with others. It has been difficult time for the international academic community as well, as many of our scheduled events had to be cancelled or postponed. While there was disappointment and confusion, especially in the initial phase of the pandemic, it was encouraging to see that the academic societies immediately rose to the occasion and organized international conferences online, not only as an alternative to on-site but also to add values to the conferences with the help of digital transformation (DX). Such was the case with the international heat transfer community. Some of the online conferences I attended might have been difficult to achieve prior to DX. One example was "*International Colloquia on Thermal Innovations* (*InnoTherm*)" series (http://meche.mit.edu/international-colloquia-thermal-innovations) organized by the colleagues at MIT (chaired by Prof. Gang Chen) aiming to stimulate and highlight innovations and advances in thermal energy conversion, storage, transport, and utilization. I had a pleasure to moderate a couple of sessions and was thrilled to see hundreds of participants from around the world vividly discussing across different disciplines.

Learning the usefulness of DX to discuss new interdisciplinary topics, Prof. Chris Dames (UC Berkeley), Prof. Tengfei Luo (University of Notre Dame), Prof. Koji Tsuda (University of Tokyo), and I organized "*NSF-JST Joint Workshop on Thermal Transport, Materials Informatics and Quantum Computing*" (https://aithermworkshop.nd.edu) in March 2021. The workshop aimed to initiate conversations between the greater machine learning, materials informatics, quantum computing community and the thermal transport community to promote international collaboration initiatives. Over the past few decades, research in thermal transport has led to significant advancement in the understanding of fundamental physics and computational tools that can predict thermal properties with high fidelity. However, applying such established knowledge and tools to design new materials for relevant applications had been rather ad-hoc. With the recent prosperity of artificial intelligence (AI) and quantum computing, there is an opportunity to leverage them to further advance thermal transport fundamental science and maximize the ability to systematically develop thermal materials and processes with desirable performance. With this in mind, we invited speakers on four topics: data infrastructure; simulation-aided materials informatics and thermal transport; AI-driven experiments; and quantum computing. The dialogue between researchers within and between each topic was very productive. Constructive discussions were also held with other stakeholders such as governments and funding agencies. The workshop output several important action plans, including a computational round-robin study, thermal transport property database, and international autonomous experimentation, which initiated the on-going world-wide collaborations including researchers from Europe and China. Such a simultaneous multi-stakeholder dialogue would have been difficult without the DX.

Of course, online events have their drawbacks. Time zones have been a major issue, especially for international conferences. Many of us have given or heard a talk in the middle of the night fighting sleepiness. Recently, there have been hybrid conferences, where the on-site and online events are held on different days, but in such cases, the online portion is usually rather empty. Now that, in many places, the on-site events are restarting, we are re-recognizing how precious it is to meet and discuss in person. In fact, we had so much fun in the recent *National Heat Transfer Symposium of Japan* held on-site (reported on the next page)!

While I very much look forward to the resumption of international heat transfer conferences on-site, an important question may be "Are we going back to where we were before the pandemic?" or "Are there ways to improve on-site international conferences utilizing DX?" The world is now facing a sustainability crisis and there are growing expectations for academia to help solve it. Not to mention, the potential contribution from the field of heat transfer is significant, and the issues need to be tackled internationally. Such social demands have been always there, but the urgency is more than ever with critical timelines, which calls for efficient international collaboration rather than competition. That requires more in-depth discussion in the international conferences, but how do we





do it? One idea is a "flip conference". Like the "flip class", DX schemes could be used to provide participants with digital contents of presentation in advance so that they can spend more time for discussion on site. This can help the participants understand better each other's work and facilitate actual collaboration. Perhaps now is a good timing to think about transforming international conferences?

### 2. Report on 59th national heat transfer symposium of Japan (NHTSJ 2022)

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NHTSJ 2022 (https://htsj-conf.org/symp2022/index_e.html) took place in face-to-face and on-line virtual ways during May 18 to 20, 2022 in Gifu (Tokai district). Totally 338 papers were presented including 9 keynotes through 30 sessions in the symposium. The share of number of the presentation in each session is seen in **Fig. 2.1**. *The Best Presentation Award Session* is a poster session presented by young researchers and students, and 6 candidates were awarded. The awarded researches were 1) 3D analysis of heat transfer in human body core, 2) molecular structure and affinity at inorganic solid/polymer interface, 3) heat transfer of latent heat storage pellets for high temperature, 4) solid-solution photon upconversion crystal for improving solar energy utilization efficiency, 5) spin caloritronics by sensitive lock-in thermoreflectance of thermochromic liquid crystal, and 6) visualization of heat transport in oscillating heat pipes by neutron radiography. The top 3 sessions in which there were the most presentations were "*hydrogen, fuel cell, secondary battery*", "*boiling and condensation*" and "*understanding and control of droplet/wetting phenomena*". The trends reflect recent needs to innovative R&D on greatly efficient energy conversion and conservation technologies for establishing carbon neutral system. Additionally, heat and mass transfer phenomena are faced to complicated systems including multiphase flow, phase change, catalytic and non-catalytic reactions, electrochemistry, electromagnetic, vibration, nano-scale dynamics etc. In the session "*workshop on HTSJ promoted research*", the research activities of groups admitted in HTSJ were reported on the following topics in this year: 1) heat transfer using microsensors and/or devices, 2) heat and physical environment in bio-cells, 3) heat transfer for solar energy utilization and 4) turbulence heat transfer, combustion and pioneer of complex fluid for future energy system. Those researches are expected to be greatly promoted and progress under funding for an innovation of heat transfer in a near future. The session of "*introduction of component and technology development by companies in Tokai district*" opened under the organization by researcher/engineers in industrial sector. Tokai district is one of the largest industrial area in Japan, and several fields of industry, i.e. automobile, machinery, steel, chemical, petrochemical, energy, ceramics, aerospace etc. are concentrated and yield the greatest percentage of Japanese GDP. Four local companies introduced their technology on 1) low density silicon thermal interface material, 2) thermal design of printing products and electronic parts, 3) compact and light heat exchanger for vehicles and products working with low power, 4) application of 1DCAE into thermal design. In this symposium, mutual exchange through earnest discussion were actively performed and could be closed successfully although face-to-face meeting had not been held for three years due to COVID-19 pandemic.

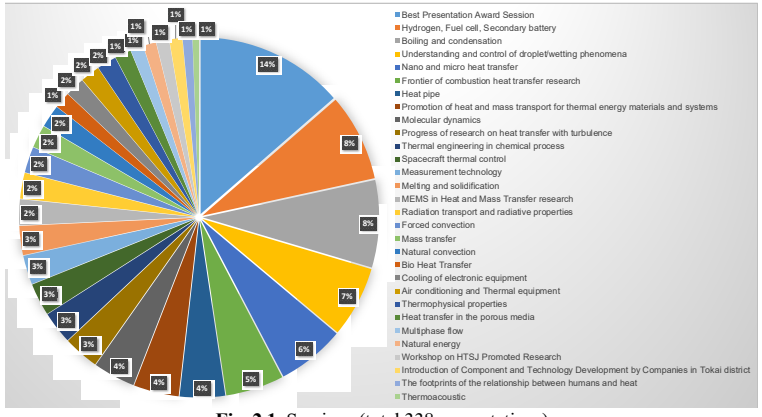


**Fig. 2.1** Sessions (total 338 presentations)

**Japan, Member of ICHMT, AIHTC, AUTSE (3)**

**1. State-of-the-Art MEMS Sensing Technology**
Osamu Nakabeppu, Tomohide Yabuki, Kazuhito Dejima
**2. Report on JSME Thermal Engineering Conference 2022, Japan**
Shigeo Maruyama, Shohei Chiashi and Ikuya Kinefuchi

## 1. State-of-the-Art MEMS Sensing Technology



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Over the past two decades, MEMS (Micro Electro Mechanical Systems) technology has advanced significantly. Thin film thermal sensors open the door to unraveling complex heat transfer processes. Here, we will focus on surface temperature and heat flux measurement using the MEMS sensors and introduce the latest status.

Microlayer formation characteristics is important for developing a reliable nucleate boiling heat transfer model which is based on accurate physical mechanisms. In our studies [1] [2], transient heat conduction analysis using the local wall temperature measured with a MEMS sensor (**Fig. 1.1**) are applied to estimate the spatial distribution of initial microlayer thickness under pool boiling bubbles and heat transfer characteristics. Recently, the hydrodynamic characteristics of microlayer formation in the pool boiling were also investigated based on the relationship between derived initial microlayer thickness and microlayer formation velocity which is determined by the transient local heat flux data (**Fig. 1.2**) [3]. It was found that the trend of microlayer thickness changes depending on the thickness of the velocity boundary layer outside the bubble foot developed with bubble growth.

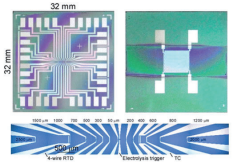


**Fig. 1.1** MEMS sensor for isolate bubble pool boiling [1].

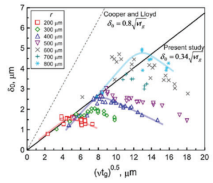


**Fig. 1.2** Relation between initial microlayer thickness and velocity boundary layer thickness [3].

The MEMS technology is beginning to be used in the development of next-generation high-efficiency automobile engines both for spark-ignition (SI) [4] and compression-ignition (CI) [5]. Wall heat transfer is one of the most important aspects for heat loss mitigation study of engines. The local instantaneous heat transfer characteristics were investigated using an originally developed thin-film RTD sensor (**Fig. 1.3**) [4]. The MEMS sensor could clearly detect the cycle-by-cycle heat flux (**Fig. 1.4**). It was found that the local instantaneous heat flux (heat transfer coefficient) had a strong cycle-to-cycle variability of the order of 0.1–1.0 MW/m$^2$ (of 0.1–1.0 kW/(m$^2$·K)), not only in fired operations but also a motored operation. In addition, it was shown that the heat fluxes at the adjacent points exhibited similar but different values, which indicates that there were turbulent eddies of sub-millimeter scale and they affected the local heat transfer. Since the local instantaneous heat transfer had quite different characteristics from the average, advanced design and control based on the understandings of the local instantaneous characteristics will be required for the further improvement of the SI & CI engine's thermal efficiency.

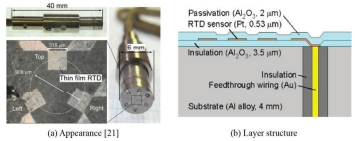


**Fig. 1.3** Three-point MEMS heat flux sensor [4].

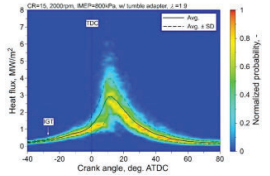


**Fig. 1.4** Probability distribution of heat flux for a lean fired condition [4].





[1] Yabuki T., Nakabeppu O. (2014) Int J. Heat Mass Transfer 76:286–297, [2] Yabuki T., Nakabeppu O. (2016) Int J. Heat Mass Transfer 100:851–860, [3] Yabuki T., Nakabeppu O. (2017) Heat Mass Transfer 53:1745–1750, [4] Dejima, K., Nakabeppu, O.(2022) Applied Thermal Eng. 201: 117747, [5] Dejima, K., Nakabeppu, O., Moussou, J., Pilla, G. (2022), Int. J. Engine Research 23:497–511.

## 2. Report on JSME Thermal Engineering Conference 2022, Japan



October 8–9, 2022 at the University of Tokyo, Tokyo

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**Shohei Chiashi**, Department of Mechanical Engineering, The University of Tokyo, chiashi[at]photon.t.u-tokyo.ac.jp
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The Thermal Engineering Conference 2022 of JSME-TED was held on October 8th (Sat) and 9th (Sun), 2022 at the Hongo Campus of the University of Tokyo. General research presentations, etc. were basically face-to-face, but were carried out in a hybrid format that also used Zoom. This time, it was the first face-to-face meeting in four years (2019 canceled due to typhoon, 2020 and 2021 held online due to COVID-19), and 431 people (including invited speakers) participated. There were 222 academic presentations, 1 special lecture, and 2 lectures at the thermal engineering workshop held on the same day. In addition, two keynote lectures were given as invited lectures from overseas (Prof. Xing Zhang, Tsinghua University, China and Prof. Sung Jin Kim, KAIST, Korea).

The academic presentations of the Thermal Engineering Conference consisted of General Session (GS) and Organized Session (OS), and this time there were 28 GS presentations and the remaining 194 OS presentations. The OS accounts for a large proportion of the conference, and we are grateful to the organizers for their cooperation in organizing the program. A new OS (OS14: Nanoscale Thermal Control) was added to the existing 13 OSs. There were 19 academic presentations at OS14, and very lively discussions were held. The Thermal Engineering Conference is a research presentation meeting, where outstanding presentations are awarded the Young Excellent Lecture Fellow Award. There were many young speakers, and 121 presentations, more than half of the total, were judged. Many judges, including chairpersons of each session, cooperated in this evaluation.

In the special lecture, Mr. Shigeru Muraki, President of the Clean Fuel Ammonia Association, gave a lecture titled "Challenges in the Era of Great Energy Transformation - Roles of Hydrogen and Ammonia toward Carbon Neutrality". The regular thermal engineering workshop was held during the lunch break on the first day. Two industrial researchers gave lectures on the thermal design of semiconductor memory devices and high-precision measurement of water-cooling modules. A get-together (opinion exchange meeting) was held on the evening of the first day, and 110 people participated. Initially, we had planned to hold a get-together at the venue on the University of Tokyo campus, but due to the influence of the COVID-19, the venue was changed to Tokyo Garden Palace. A social gathering is an important place for communication between researchers, and its importance is increasing especially after self-restraint and online life.

We would like to express our gratitude to the many executive committee members and everyone involved in the Thermal Engineering Conference 2022 who cooperated in the preparation of the venue and the many students who cooperated in the venue management during the conference.

Hiroshi Takamatsu, President of the Heat Transfer Society of Japan (HTSJ), takamatsu[at]mech.kyushu-u.ac.jp
Mamoru Tanahashi, Chair of Thermal Engineering Division of the Japan Society of Mechanical Engineers (JSME-TED), tanahashi.m.aa[at]m.titech.ac.jp
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## Japan, Member of ICHMT, AIHTC, AUTSE (4)

# Report on JSME Thermal Engineering Conference 2023 October 14 & 15, 2023 at Kobe University, Hyogo


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**JSME (The Japan Society of Mechanical Engineers) Thermal Engineering Conference 2023** was held on 14 and 15 October 2023 at the Graduate School of Engineering, Kobe University which is located on the mountainside of Mt. Rokko. Kobe is a port city in the Kansai area, which includes Osaka and Kyoto. There are two large artificial islands in the port of Kobe. On the artificial island, there is the supercomputer FUGAKU (RIKEN), a pilot-scale loading/unloading terminal of liquified hydrogen developed by Kawasaki Heavy Industries, Ltd., and a special district for advanced medical industries.

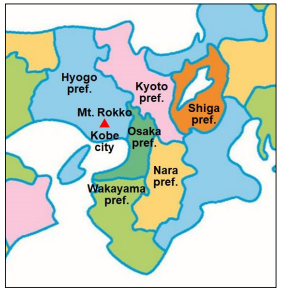


Fig. 1. Kansai area.

The conference 2023 was planned so that we can return back as much as possible to the same style before the COVID-19 pandemic. The sessions were held in person, but some of the lectures from overseas were given online. There were 233 scientific presentations in **general sessions** and **14 organized sessions** shown below: **OS-1** External combustion engine and waste heat utilization technology, **OS-2** Fire and explosion, **OS-3** Thermal management of electric devise and equipment, **OS-4** Heat, flow and mass transport phenomena in porous media and their applications, **OS-5** Progress in turbulent heat transfer research, **OS-6** New developments in research on fuel cell, electrolyzation, and secondary battery, **OS-7** New developments in micro energy, **OS-8** New developments in biomass conversion from a thermal engineering perspective, **OS-9** Heat transfer and flow with solidification and melting, **OS-10** Radiation transport control, **OS-11** Combustion for energy conversion and propulsion system of the future, **OS-12** Recent progress in the research of boiling and condensation heat transfer, and multiphase flows, **OS-13** Wettability control and liquid droplet dynamics, **OS-14** Nano-scale thermal control.

**The Thermal Engineering Collection** (Organizers: Prof. Yoshikazu Teraoka, Kanazawa Univ., Prof. Hiroyuki Kumano, Aoyama Gakuin Univ.) was held in addition to the sessions and lectures. This program was a competition of video footage on thermal engineering. There were eight applicants, each giving a five-minute presentation. The best video award was given to Prof. Takashi Suzuki of Toyohashi University of Technology for his "*Photographic Observations of Thermal Fluid Phenomena with Gas-Liquid Interfaces*" which was selected by a vote of participants at the venue. Video footages submitted as well as the best video award can be viewed on the website of the Thermal Engineering Collection of the Thermal Engineering Division of JSME at https://g.ted-jsme.jp/. Unfortunately, this website is in Japanese, but it contains many video footages that have been submitted so far.

Fig. 2. Conference session room.





The number of registrants were 269 general participants and 156 students, of which 45 were from industry. Another typical feature of this conference is the large number of young speakers. This year, 106 talks were given from young researchers who are eligible for the Young Fellow Award for Outstanding Presentation.

**The special lecture** planned by the organizing committee was given by Prof. Minoru Takeda, Graduate School of Maritime Sciences, Kobe University. The lecture was entitled "*Ocean and Hydrogen Energy*". Advanced hydrogen technology research at Kobe University was introduced.

Fig. 3. Special lecture by Prof. Minoru Takeda.

**The annual Thermal Engineering Workshop**, organized by the Workshop Committee (Chairman: Prof. Kazuya Tatsumi, Kyoto Univ.), was held during the lunch break on the first day of the conference. The presentations at the workshop were "*Introduction of Power Module Reliability Technologies*" by Mr. Takeshi Horiguchi (Mitsubishi Electric Corporation), "*Innovative SOEC Methanation Technology Pioneering E-Methane as a Game Changing Technology*" by Dr. Hisao Onishi (Osaka Gas Co., Ltd.) and "*Development of Heating and Hot Water Heat Pump Technologies towards Carbon Neutrality*" by Mr. Hirokazu Fujino (Daikin Industries, Ltd.). The general meeting of **InterPore Japan** and one special lecture from abroad were given at OS-4 (an organized session for heat, flow and mass transport phenomena in porous media and their applications).

**The 2022 awards ceremony** was held to honor the division awards. Prof. Kazuyoshi Nakabe (Kyoto Univ.), Prof. Shigeo Maruyama (The Univ. of Tokyo), and Dr. Hideaki Sato (Denso Corporation) were honored for the Meritorious Contribution Award. Prof. Hirofumi Daiguji (The Univ. of Tokyo) was honored for the Outstanding Achievement Award. And, Prof. Yoshihiro Taguchi (Keio Univ.) was honored for the Contribution Award. The award was presented by the former chair of the Thermal Engineering Division, Prof. Mamoru Tanahashi, Tokyo Institute of Technology.


Fig. 4. Winners of the division awards.

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The 2023 organizing committee was supported by many members from the Kansai branch of JSME. In particular, we would like to thank Prof. Takeyuki Ami (Kansai Univ.) for his great cooperation in general affairs and Prof. Masashi Kishimoto (Kyoto Univ.) for his great contribution in planning and corporate sponsorship. Finally, the organizing committee would like to thank all the people participated in the Thermal Engineering Conference 2023 for their cooperation and support, and many students who cooperated in preparing the venue and looking after all the events during the conference. The Thermal Engineering Conference 2024 will be held in Yamaguchi with Prof. Masato Mikami, Yamaguchi Univ. as the organizing committee chair.