

2026 ITS Summer School at ICT2026 Houston



We are pleased to host the 2026 ITS Summer School on Sunday, May 17, 2026, immediately preceding the 42nd International Conference on Thermoelectrics (ICT 2026). The conference will take place at the Hyatt Regency Houston Downtown Houston in Houston, Texas USA from Monday, May 18 through Thursday, May 21. The ITS Summer School, which requires advance registration, is a valuable opportunity to educate researchers about thermoelectrics, particularly students, postdoctoral fellows, and senior attendees who are new to the field or seeking latest updates. We gratefully acknowledge the generous sponsorship of the Jiang Family Foundation and MTI Corporation for supporting the Thermoelectric School.

Chair: **Professor Mona Zebarjadi**, University of Virginia

SCHEDULE

Sunday, May 17 Regency Room – 2nd Level

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| 1:00-1:10 | Professor Takao Mori , ITS President, Opening & Introductions |
| 1:10-1:50 | Dr. Chengyi Wu , MTI Corporation, "The Introduction of Thermoelectrics Synthesis: from Traditional Power Metallurgy to Automated Platform" |
| 1:50-2:30 | Dr. Christopher Caylor , DTP Thermoelectrics, "Distributed Transport Properties (DTP) to Address Limitations in Thermoelectric Cooling Efficiency and Heat-pumping Capacity" |
| 2:30-2:50 | Break |
| 2:50-3:30 | Professor Renkun Chen , University of California San Diego, "Thermal Management for Thermoelectrics: Heat Dissipation Techniques for TEG and TEC from Natural Convection to Phase Change" |
| 3:30-4:10 | Professor Masato Yoshiya , The University of Osaka, Japan, "Computational Approaches More than Simulations to Go Beyond Theories for Thermoelectrics" |
| 4:10-4:30 | Q&A with Speakers |

ABSTRACTS

Welcome and Introductions

TAKAO MORI, Ph.D., Prof.

President, International Thermoelectric Society (ITS)

Field Director, National Institute for Materials Science (NIMS), Research Center for Materials Nanoarchitectonics (MANA); Professor, University of Tsukuba & Visiting Professor, Kyushu Institute of Technology & Program Manager, JST Mirai Large-scale Program

The Introduction of Thermoelectrics Synthesis: from Traditional Powder Metallurgy to Automated Platform

CHENGYI WU, Ph.D., MTI Corporation

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Thermoelectric materials offer a sustainable pathway for waste-heat recovery, yet their efficiency is highly sensitive to stoichiometry and grain-boundary density. This presentation provides a comprehensive overview of synthesis of bulk thermoelectric materials including the traditional powder metallurgical techniques, modern nano-structuring control, and single crystal growth. In addition, as the development of AI-driven materials discovery, manual synthesis remains a critical bottleneck from design to physical realization due to low throughput and limited reproducibility. To bridge this gap, we also introduce an integrated automated platform capable of executing key synthesis stages with robotic assistance. The platform achieves a throughput of dozens of samples per day and a close-loop workflow if integrating on-site characterization. This transition from manual to autonomous synthesis allows for the rapid experimental validation of computational predictions and accelerating the development of high-performance materials for next-generation waste-heat recovery.

Distributed Transport Properties (DTP) to Address Limitations in Thermoelectric Cooling Efficiency and Heat-pumping Capacity

CHRISTOPHER CAYLOR, Ph.D., DPT Thermoelectrics

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Thermoelectric cooling has seen limited performance improvement in the past three decades, due to any new commercial TE materials and the limitations imposed by homogeneous device

architectures. DTP Thermoelectrics' distributed transport properties (DTP) technology introduces a new device paradigm that overcomes these limitations by spatially tailoring electrical and thermal transport properties within the device. This approach enables thermoelectric coolers capable of sustaining temperature lifts up to 90 K at room temperature—exceeding the <80 K limit of today's highest-performing commercial devices—while using the same established thermoelectric materials.

This talk presents an industrial perspective on how DTP architecture unlocks higher performance through optimized power factor and transport property distributions, revealing previously unrealized gains that are not captured by conventional ZT metrics alone. Experimental results demonstrate up to 3X higher heat pumping power density and 2X higher coefficient of performance at a 70 K temperature lift compared to traditional homogeneous devices.

We will also discuss scalable manufacturing pathways, including additive manufacturing and thin film and bulk-compatible processing, that enable practical deployment of DTP devices. Attendees will gain insight into potentially fruitful areas of research for advancing solid-state cooling performance, manufacturability, and cost for next-generation optoelectronics and microsystems.

Authors: BELL, Lon (DTP Thermoelectrics); CAYLOR, Chris (DTP Thermoelectrics); CRANE, Doug (DTP Thermoelectrics)

Thermal Management for Thermoelectrics: Heat Dissipation Techniques for TEG and TEC from Natural Convection to Phase Change

RENKUN CHEN, University of California San Diego

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Thermoelectric generators (TEGs) and coolers (TECs) are often introduced through materials and device design. In practical systems, however, the achievable power density, temperature differential, efficiency, and coefficient of performance are also frequently set by thermal management: how effectively heat is supplied to and rejected from the TE module. In many cases the dominant bottleneck could be the heat dissipation strategy, especially when there are constraints on mass, volume, noise, and cost.

This summer-school lecture surveys the main heat dissipation techniques used with TEGs and TECs and explains how each shapes the thermal environment at the hot and cold sides. We will compare natural convection to ambient air, forced convection with air (fans/blowers), forced convection with liquids (cold plates and microchannels), phase-change heat transfer (boiling and evaporation, including wick-fed/evaporative concepts), and radiative cooling. Using simple thermal resistance networks and scaling arguments, we will quantify how heat-sink thermal

resistance, heat spreading, parasitic power, and ambient conditions reduce the temperature difference across TE legs and thus degrade system-level performance. Wearable thermoelectric cooling will be used as a motivating example, where lightweight and form-factor constraints often force natural convection and make heat dissipation the primary limiter of cooling capacity and battery life.

Computational Approaches More than Simulations to Go Beyond Theories for Thermoelectrics

MASATO YOSHIYA, The University of Osaka, Japan

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Computations have been extensively used as tools to unveil mysteries of thermoelectrics, where multiple properties, not only of electrons and phonons, but also sometimes for thermodynamics and kinetics for synthesis and processing of materials, and for degradation of devices and modules, need to be simultaneously achieved beyond what is allowed by conventional theories of materials properties. Recent generative AI services will surely accelerate this trend in the coming years, with greater ease for you. However, it may not be satisfactory for us to simulate the realities that can also be observed by experiments and claim the agreements between them. Even though computations are often confused with theories, many computational approaches do not assume a priori conventional theories of materials properties, potentially leading to new discoveries.

In this summer-school lecture, emphasis will be placed on the importance of sorting out your purpose before the computations and of your ideas therein, rather than surveying computational techniques widely used in the thermoelectric community, which can be accomplished even without sufficient knowledge of the computational techniques. Examples of our past studies on thermoelectric materials [1-6] will be used to concisely explain the purposes set before computations and the findings that may resonate with your own interests.

References:

1. Appl Phys Lett, 2021. DOI: <https://doi.org/10.1063/5.0075854>
2. Sci Rep, 2018: DOI: <https://doi.org/10.1038/s41598-018-29259-z>
3. Adv Func Mater, 2021. DOI: <https://doi.org/10.1002/adfm.202008469>
4. Nat Commun, 2020. DOI: <https://doi.org/10.1038/s41467-020-15619-9>
5. Scr Mater, 2021. DOI: <https://doi.org/10.1016/j.scriptamat.2021.113991>
6. Adv Mater, 2023. DOI: <https://doi.org/10.1002/adma.202207646>

SPEAKER BIOS

TAKAO MORI received his Ph.D. in physics from the University of Tokyo. He is a Field Director at the National Institute for Materials Science (NIMS), a Professor at the University of Tsukuba Graduate School, and President of the International Thermoelectric Society (ITS). Mori's research focuses on controlling the structure and properties of inorganic materials, particularly thermoelectric materials. His work explores multidisciplinary enhancement principles, including magnetism, to improve band structure as well as electrical and thermal transport. He also develops thermoelectric devices, modules, and thermal management technologies for practical applications. He serves as a Program Manager of the JST Mirai Large-scale Program, a Senior Editor of *Materials Today Physics*, and an Advisory Board Member of *JSSC*, *J. Materiomics*, *Joule*, and *Device*.

CHENGYI WU is a materials scientist and technical manager for MTI Corporation. He leads a technical team focused on developing new products and providing turnkey solutions for process design and integration in inorganic materials synthesis. Additionally, he manages projects for key account customers to drive business growth and oversees the quality control and equipment services team. He received his Ph.D. in Physical Chemistry from the University of Houston, where his research focused on single crystal growth and ultrafast electron diffraction for structural dynamics of crystals and thin films.

CHRISTOPHER CAYLOR is the Business Development and Strategic Consultant for DTP Thermoelectrics. Dr. Caylor is a technical business leader with proven success in business growth as well as new product and process development. Dr. Caylor is a recognized leader in advanced TE materials systems and device integration as well as compound semiconductors (II-VI, III-V, IV and V-VI). He has been a leader of thermoelectric technology development at Research Triangle Institute (RTI), GMZ Energy, and Phononic Devices. Chris has a Ph.D. from the University of California, Berkeley in Physical Chemistry where he studied synthesis and characterization of skutterudite thin films and superlattice structures.

RENKUN CHEN, Professor of Mechanical and Aerospace Engineering at the University of California San Diego, received his Ph.D. in Mechanical Engineering from the University of California, Berkeley in 2008, followed by a one-year postdoctoral fellowship in Materials Sciences at Lawrence Berkeley National Laboratory. His current research is focused on thermal transport, which plays a very significant role in both energy production and consumption. He is interested in exploiting the fundamental heat transfer science and engineering at the micro and nano scale, and developing materials and devices for thermal energy conversion, storage and management. He is

interested in exploiting the fundamental heat transfer science and engineering at the micro and nano scale, and developing materials and devices for thermal energy conversion, storage and management.

MASATO YOSHIYA is Professor of Materials Science at The University of Osaka, Japan. He received his bachelor's, master's and Ph.D. degrees in materials science and engineering from Kyoto University. He began his research career in synchrotron-radiation spectroscopy and later expanded into computational approaches for the analysis and interpretation of experimental data. This background has shaped his collaborative approach with experimentalists. His expertise includes ab initio and first-principles calculations, molecular dynamics simulations, and phase-field modeling. His research covers a broad range of practical materials, with computational methods selected according to the purpose and scientific question of each study.