

## Research topics for graduate students for 2025

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Acceptable course(s)

- Master's Degree
- Doctoral Degree



#### Research Topics

In my group, we carry out various research related to energy problems from ammonia/hydrogen combustion, which is important for carbon neutrality, to mobile/wearable power sources using thermoelectric generation/energy harvesting. Independent self-motivated international students are always welcome to my group!

#### 1. Elucidation of flame-to-wall interaction of ammonia/hydrogen fuels

When the flame is located near the wall, there are significant chemical interactions between the flame and the wall. This phenomenon is especially important for ammonia flames, where the nitriding of metal walls is a big concern in ammonia-fueled industry furnaces and gas turbines. Detailed mechanisms of nitriding are investigated through high-spatial-resolution laser-induced fluorescence, material characterization, and first-principle analysis [1].

#### 2. Development of fuel-based mobile power source using high temperature thermoelectric module

For social implementation of autonomous robots, fuel-based mobile power sources that can substitute conventional lithium-ion batteries is required. A monolithic SiGe thermoelectric module directly-heated by catalytic combustion is developed in order to overcome limitations of previously-proposed combustion-based Bi-Te systems [2].

#### 3. Development of high-performance polymer electret and its application to vibration energy harvesting

Quantum chemical analysis and machine learning are employed to enhance the charging performance of amorphous fluorinated polymer electret. Record-high surface charge density of 4 mC/m<sup>2</sup> has been obtained [3]. With the electret material developed, a wrist-worn rotational electret energy harvester for powering low-power electronics from human arm swing is also prototyped, which can generate extremely-high output power of 1.3 mW at 1 rps.

#### Articles Related to Research Topics

- [1] Wang, D., Xing, Y., Lee, M., and Suzuki, Y., "Effects of Wall Temperature and Water Vapor on the Nitriding of Stainless Steel Induced by Ammonia Flames," Proc. Combust. Inst., Vol. 40, (2024), 105562. [[doi:10.1016/j.proci.2024.105562](https://doi.org/10.1016/j.proci.2024.105562)]
- [2] Uhida, S., et al., "High-temperature Monolithic SiGe Thermoelectric Device Directly-Heated by Catalytic Combustion," Appl. Phys. Lett., Vol. 120, Issue 5, 053901 (2022). [[doi:10.1063/5.0077157](https://doi.org/10.1063/5.0077157)]
- [3] Mao, Z., et al., "AI-driven Discovery of Amorphous Fluorinated Polymer Electrets with Improved Charge Stability for Energy Harvesting," Adv. Mater., 2303827, (2023). [[doi:10.1002/adma.202303827](https://doi.org/10.1002/adma.202303827)]

**Lab. Web page:** <http://www.mesl.t.u-tokyo.ac.jp/index.html> (Sorry, "Research Topic" in English page is obsolete.)