Exploring new materials for future energy-saving society

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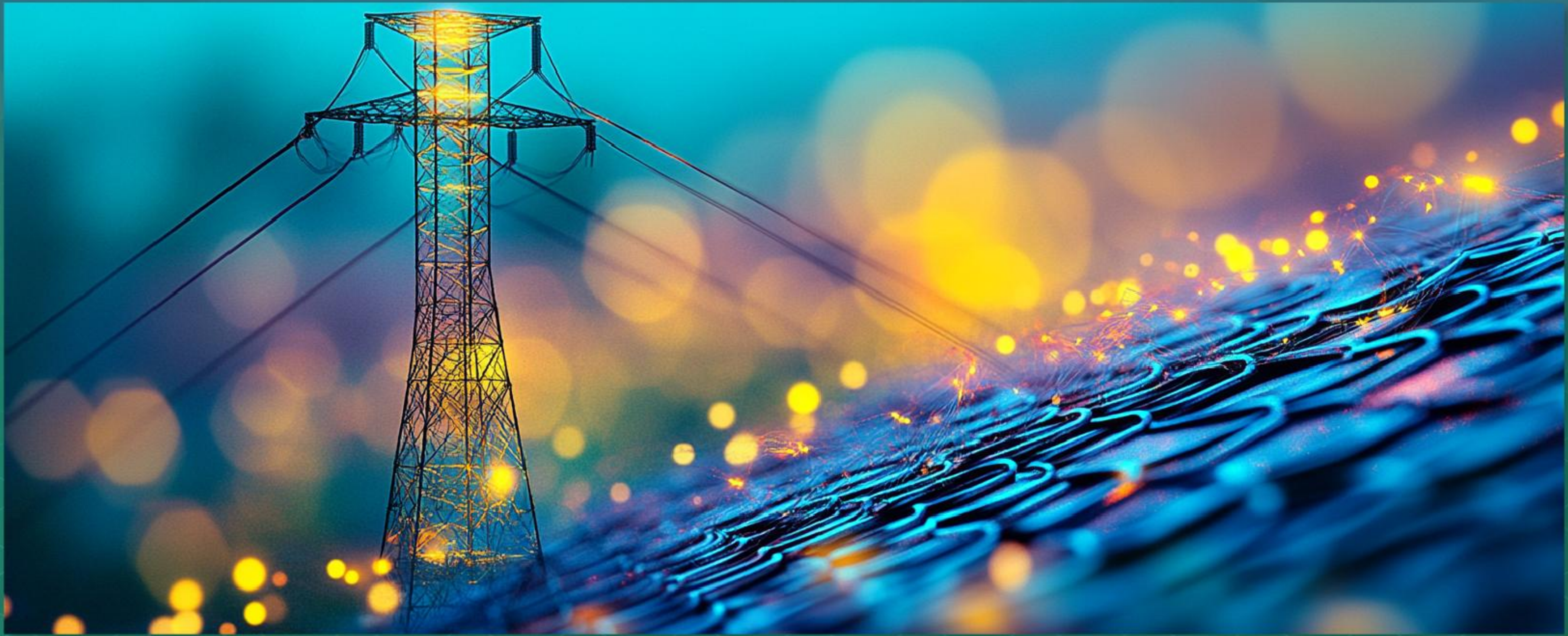
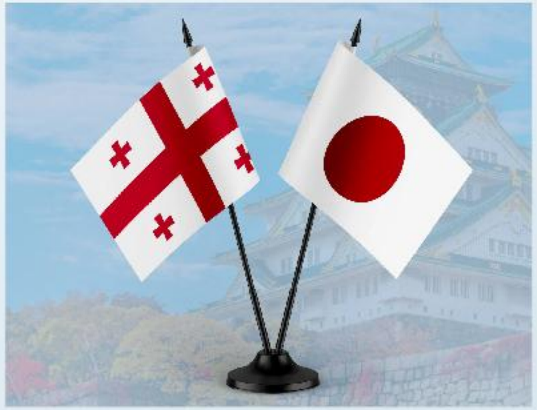


Georgia - Japan collaboration to develop thermoelectric materials for converting waste heat into electricity

Funded by Japan

SDGs

Institute of Cybernetics, Georgia Technical University, Georgia

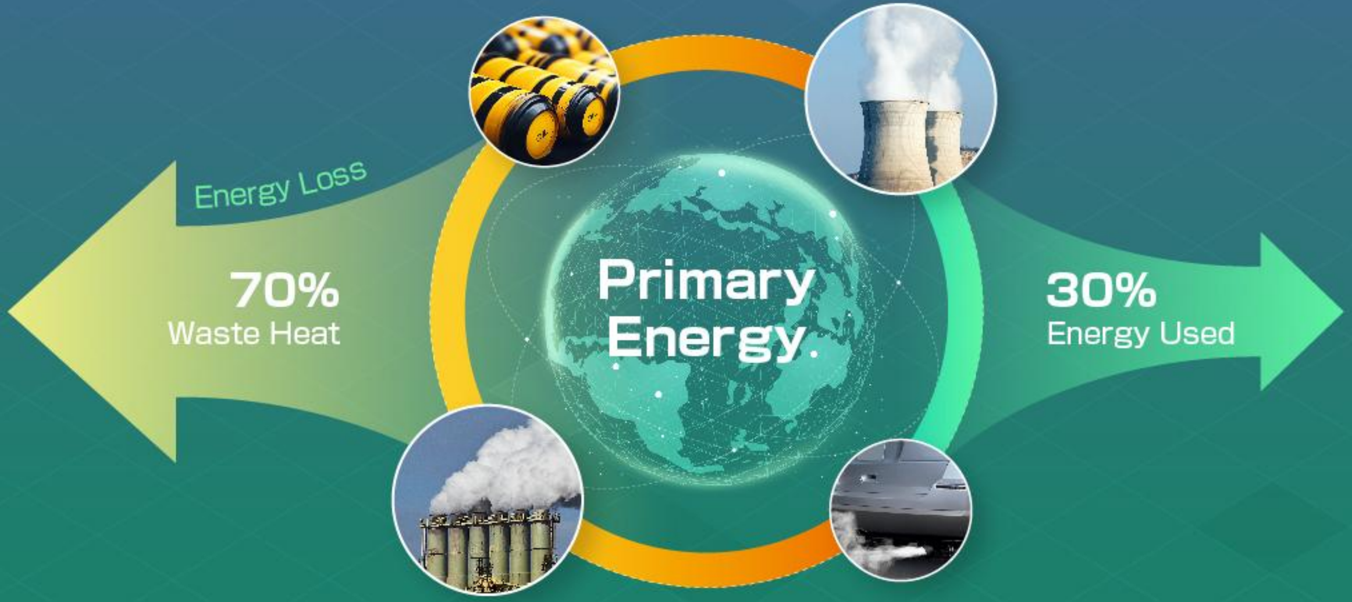


Project: **GE-2776**

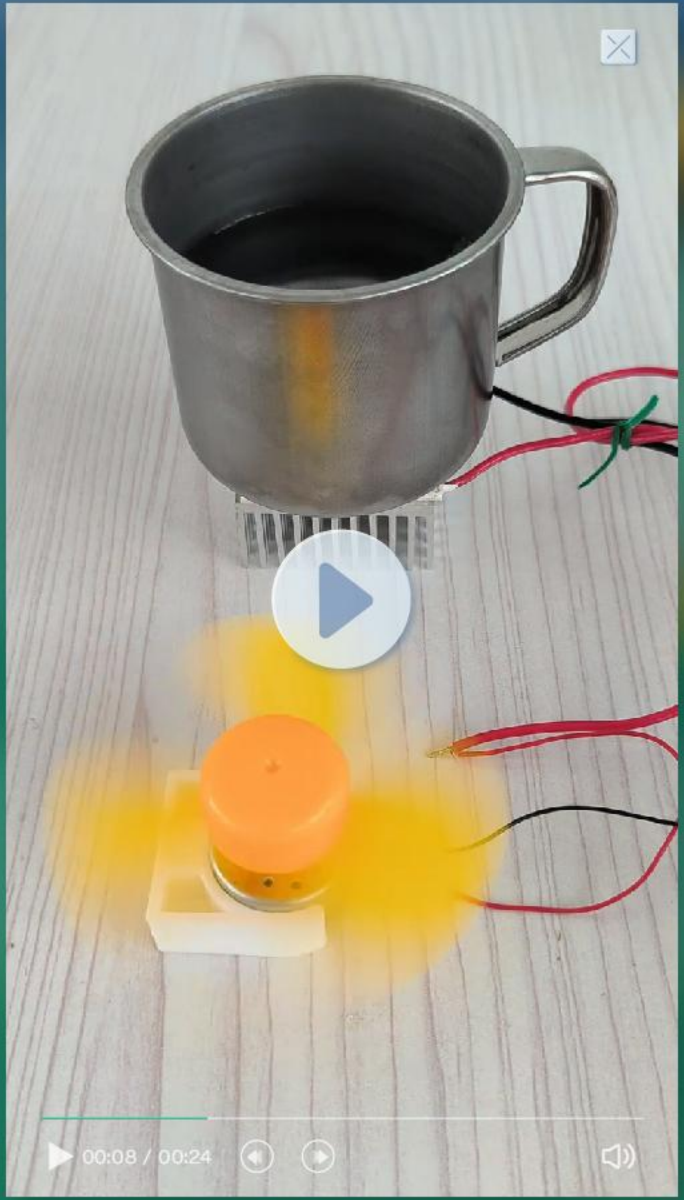
Department of Mechanical Engineering, Nagaoka University of Technology, Japan

What is thermoelectric technology?

- Growing demand for energy consumption and the negative environmental impacts of pollution and global warming has become a major challenge facing the world today. A large amount of the world's energy consumption (about 70% of total energy) is wasted in the environment as heat, which raises global environmental issues. This has led to increased activity in developing alternative eco-friendly energy conversion technologies. Clean energy can be generated by converting waste heat directly into profitable electricity using the thermoelectric phenomenon known as the Seebeck effect.



- This phenomenon converts the temperature difference between two dissimilar electrical conductors or semiconductors into electrical voltage. The development of efficient thermoelectric materials is expected to provide a breakthrough in the widespread application of thermoelectric generators for electricity generation from waste heat discharged from various systems (industrial furnaces, incinerators, automotive exhaust, etc). Thermoelectric generators are noise-free, without emission of toxic gases, with no moving components, and reliable, making them ideal for eco--friendly power generation. So, thermoelectricity is an alternative and unique Green Technology for converting waste heat to electricity using thermoelectric generators.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Improvement of the Energy Conversion Performance of the Thermoelectric Cobaltite for Waste Heat Recovery Applications

- Currently, commercially available thermoelectric materials are unsuitable for large-scale applications due to their limited operating temperature range, high cost, toxicity, and thermal degradation.

- The discovery of cobalt-based thermoelectric materials (cobaltites) by Japanese scientists opened the way toward the development of these materials for possible applications. Cobaltites have a great potential for use in thermoelectric devices due to their environmental friendliness, high thermal and chemical stability, abundance, and low cost of raw materials. However, their disadvantage is low heat-to-electricity conversion efficiency, compared to traditional ones, such as silicon-germanium alloys, intermetallic compounds, etc. Thus, efforts to improve the efficiency of cobaltites are in high demand. The project team's purpose is to enhance the heat-to-electricity conversion efficiency of thermoelectric cobaltites by incorporating appropriate additives into these materials.

The ISTC's financial support facilitated the establishment and successful functionality of the first laboratory of thermoelectric cobaltites in Georgia and the entire Caucasus region.

Introduction | Purpose | Scope Of Activities | Outcome
ENG | 日本語

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Collaboration with a Japanese Scientist for Advancing Research on Thermoelectrics

- Thermoelectric technology is an interdisciplinary field covering physics, chemistry, materials science, nanotechnology, and engineering. So, international collaboration is vital to the project's success.

- The Georgian team has long-standing collaboration experience with respected Japanese colleague, Prof. Masatoshi Takeda (Nagaoka University of Technology). He has internationally-recognized research expertise in thermoelectric materials. He collaborates with the project team by reviewing and analyzing gathered information, making recommendations for project initiatives, and helping the project team in every step of the research from the beginning to the publication of research results.

- The project team significantly improved the thermoelectric cobaltite materials by adjusting the amount of additives utilized. The fruitful collaboration with Prof. Takeda has resulted in five joint presentations at international conferences and one paper published in a peer-reviewed journal. Another paper is currently undergoing review.

Scientific Visit to Georgia: Prof. Masatoshi Takeda gave an invited presentation at Georgian Technical University and met with Georgian colleagues to strengthen collaboration within the framework of the ISTC project.

What is the application of the research results and how will the new materials benefit society?

Currently, the majority of energy production methods rely on thermal processes, primarily fossil fuel-based energy consumption, which generates vast amounts of residual/waste heat that is released into the environment. This causes uncontrolled environmental pollution and global warming.

As a result, studies on the efficient recycling of heat energy become more important. In this context, a thermoelectric generator stands out as an eco-friendly and renewable energy source that directly generates electric energy by recovering waste heat. However, thermoelectric generators are still less efficient than other energy conversion technologies, such as photovoltaic systems (solar panels) and heat engines; hence, studies are underway to develop high-performance materials to improve the efficiency of thermoelectric generators.

The project results show that incorporating suitable additives into thermoelectric cobaltites enhances thermoelectric efficiency. Prof. Masatoshi Takeda will help the project team in developing a laboratory model of a thermoelectric generator using the optimized materials. A thermoelectric generator can transform heat from a variety of sources (including solar, geothermal, and exhaust from vehicles or other industrial processes) directly into green electricity. In particular, Georgia possesses great solar and geothermal energy potential. Thermal-concentrated solar and geothermal thermoelectric generators are capable of realizing this potential for electricity generation from renewable energy sources. The project will contribute to the implementation of thermoelectric power generation technology in Georgia by developing the high-performance thermoelectric materials.

GE-2776 research group

Project Manager

Dr. Giorgi Mumladze

Project Scientific Leader

Dr. Nikoloz Margiani

Key Personnel

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Key Personnel

Dr. Iamze Kvartskhava

The project research team includes

4 Dr., **1** Msc., **1** PhD Student

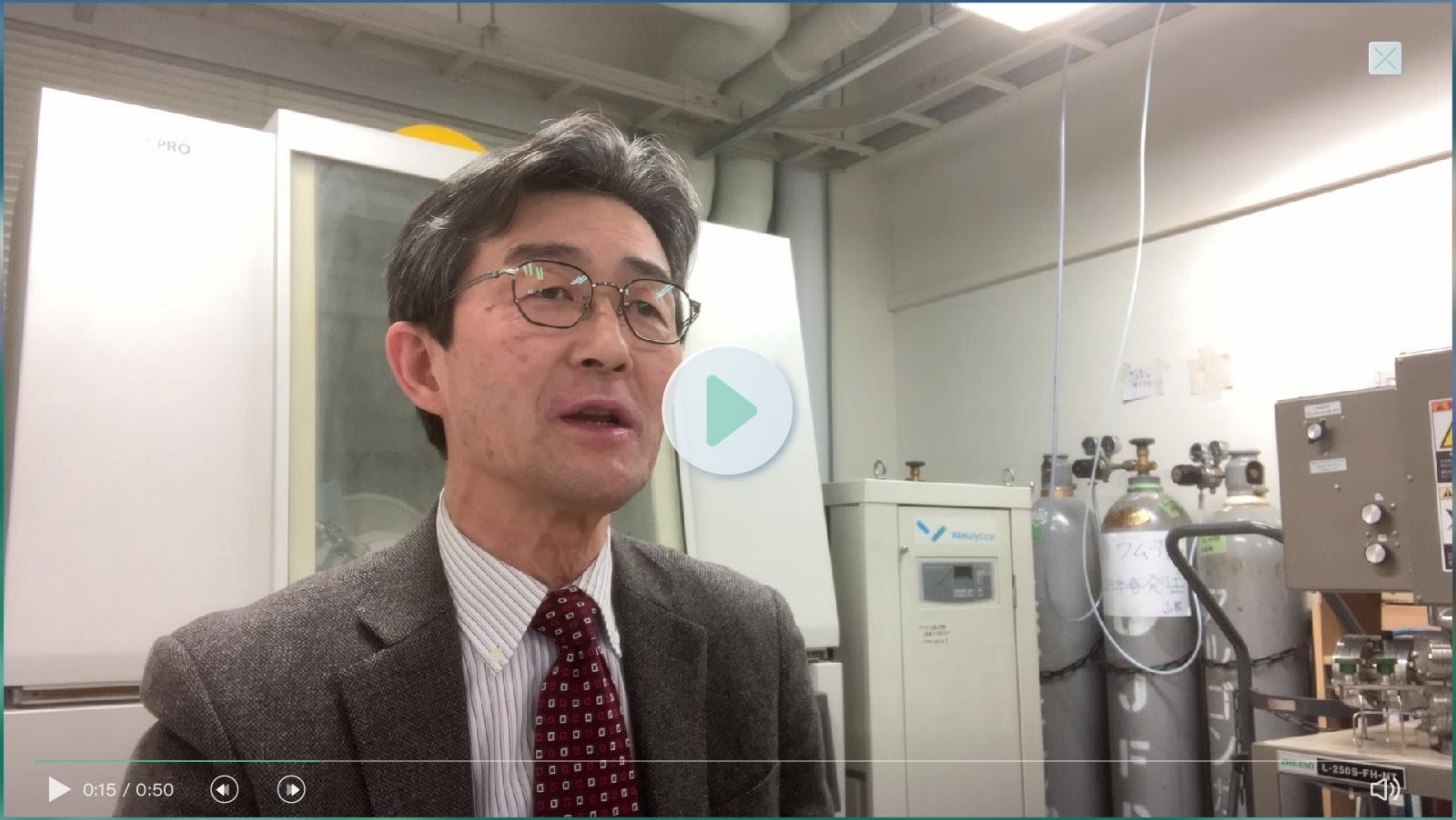
Supporting Personnel

PHD Student Natia Margiani

Key Personnel

Dr. Maia Balakhashvili

Scientific activities of Research group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