北陸先端科学技術大学院大学研究室教育指針
Laboratory Education Guideline

研究室教育指針は、学則第30条の3に基づき、研究指導の方法及び内容並びに修了までの研究指導の計画をあらかじめ明示するものです。
Based on the Article 30-3 of the general academic rules, the Laboratory Education Guideline is intended to clearly outline the methods and content of research guidance, as well as the plan for research guidance until completion.

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1. 研究テーマ / Research Theme

1. Elucidation of nanoscale dynamics in all-solid-state lithium-ion batteries through operando observations
2. Development of AI-based methods to visualize crystal structures and ion conduction in lithium-ion batteries at the nanoscale
3. Development of AI-based atomic-scale methods to analyze defects and strain in materials, including two-dimensional (2D) materials

2. 修得が期待される能力 / Competencies expected to be acquired
研究室教育は必修 A 科目(先端)又は研究支援科目(融合)の一部として単位化されており、この欄はそれら科目のシラバス上の達成目標の一部となります。
Laboratory Education is accredited as a part of the Required courses A (Division of Advanced Science and Technology) or Research Support Courses (Division of Transdisciplinary Sciences), and this section constitutes a part of the course goals stated in the syllabus for such subjects.

In this laboratory, students conduct nanoscale analysis of structure–property relationships in functional materials. Through laboratory education, they build a foundation in solid-state physics, crystallography, electron microscopy, and data science, and learn how to combine these skills to address real research questions.

Students learn to interpret and clearly explain images and diffraction patterns obtained by transmission electron microscopy (TEM) and scanning transmission electron microscopy (STEM), while paying attention to how experimental conditions and sample states influence the results. They also learn to relate acquired data and analysis results to three-dimensional crystal structures, so that microscopy observations can be discussed in terms of realistic structural models.

Another important goal is to develop data analysis skills. Students practice choosing suitable analysis approaches based on the data at hand and the information they aim to extract (*e.g.*, crystal structure, lattice parameters, ion concentration, particle size, and defect types). They evaluate the validity of analysis results and learn to draw well-supported conclusions. By considering problems from the viewpoints of solid-state physics, electrochemistry, and statistical mechanics, students develop the ability to connect TEM/STEM observations to crystal structures and, ultimately, to material properties.

On the practical side, students gain hands-on experience in basic TEM/STEM operation and data acquisition, including sample preparation. They also learn Python-based workflows for image processing and visualization, and use computational tools as needed to compare simulations with experimental results and to interpret their results.

3. 研究指導方針 / Research Guiding Principle

Research topics are set through discussion, reflecting each student's interests. In the early stage, the supervisor takes the lead in defining the research questions and clarifying the project plan. We maintain a relaxed atmosphere while holding one-on-one meetings between the supervisor and each student about once a week. In these meetings, we discuss each stage of the research process (research

planning, literature review, data acquisition, analysis, discussion, and presentation). Students regularly review their goals and progress, evaluate how they are moving the project forward, and identify the next tasks. When necessary, the target goals may be revised or adjusted through consultation with the supervisor.

Experiments are often carried out together with collaborators, which gives students frequent opportunities to discuss their work with other experts. While drawing on advice from the supervisor and collaborators, and on relevant literature (textbooks and papers), we encourage students to think seriously about their research and to communicate new ideas in their own words.

We use laboratory meetings to make reading, summarizing, and presenting scientific literature part of everyday work. Students learn practical skills for research communication, such as writing clear text, preparing figures that convey key messages, leading and participating in discussions, and communicating effectively for collaborative work. Weekly study sessions and paper presentations form the core of our laboratory activities, and we continuously revisit fundamental concepts. In paper presentations, students organize the entire paper based on their own understanding and explain it clearly, sometimes from a critical perspective. Through questions and discussion, students are exposed to others' viewpoints and reasoning processes. They learn to correct gaps in understanding and logical leaps, and to connect the discussion to the next steps.

On the understanding that students are responsible for their final deliverables, and that sources are always cited and primary information is checked, we encourage the use of generative AI as a tool in research. Research outcomes are developed with the expectation that they will be presented at conferences and/or written up as papers. Students are expected to clearly state the validity of results, the consistency between hypotheses and data, and their interpretations, and to improve their work through repeated review and revision. We place strong emphasis on producing outputs that meet external standards, without compromising on quality.

Our guiding principle is to cultivate researchers who pursue results with ambition, work collaboratively with others, and advance their research with independence and a broad perspective. By acquiring advanced expertise that they could not have imagined at the time of admission, students are expected to graduate with solid confidence in their own abilities.

4. 研究室活動の内容及び方法 / Content and Methods of Laboratory Activities

□Daily Activities：

In principle, students are recommended to be in the laboratory between 10:00 and 17:00 to facilitate consultation and collaborative work. Depending on individual circumstances (*e.g.*, experiments, writing, and other research-related tasks), students may adjust their schedules at their own discretion.

□Weekly Activities：

Each member has a one-on-one meeting with the supervisor about once a week, typically for around one hour. In these meetings, we discuss research progress, goals for the week, and a wide range of matters related to conference presentations and paper writing.

As a group, we hold weekly laboratory meetings from April to July and from October to December. Graduate students take turns giving paper presentations and reporting their research progress; at present, each student presents approximately once every three weeks. Depending on the needs of the group, we also conduct lecture-style study sessions (e.g., reading groups) on solid-state physics, electron microscopy, and data science. Part of the laboratory meetings is held jointly with Prof. Yoshifumi Oshima's laboratory.

□Monthly Activities：

N/A

□Occasional Activities：

Depending on research progress, students present their results at annual conferences of the

Japanese Society of Microscopy and the Solid State Ionics of Japan, and other relevant international conferences.

5. 年間スケジュール / Annual Schedule

本学の全学共通の年間スケジュールは「履修案内」の「学位取得に至るスケジュール」を参照してください。(本学HP 参照:ホーム＞教育＞履修関係＞履修案内)

Please refer to the "Degree conferment schedule for the master's program/doctoral program" in the "Degree Completion Guide" for university-wide common schedule (JAIST website: Home >Education>Taking Courses>Degree Completion Guide)

Master's Program, Year 1

- Laboratory orientation for new members (April)
- Research proposal presentation (December)
- Preparation of the research plan document (February)

Master's Program, Year 2

- Microscopy University (organized by the Japanese Society of Microscopy) (November) (participation depending on research progress)
- Annual Meeting of the Japanese Society of Microscopy (June) (presentation depending on research progress)
- Midterm presentation (September) (for M2 students)
- Solid State Ionics of Japan Meeting (December) (presentation depending on research progress)
- Submission of the master's thesis (February)