

Research area in Strategic Objective “*Creating Ultra-Long Life Materials for a Sustainable Society*”, “*Towards discontinuous technological innovation through quantum materials research*”, “*Creating novel materials by controlling and utilizing fluctuations*”, “*Materials Science for desirable Selection*” – *Constructing new principles toward a sustainable development society*”

Frontier Materials for Green Transformation (GX)

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Overview

This Research Area aims to create frontier materials for energy-efficient use and material conversion in order to realize Green Transformation (GX). The creation of materials that challenge the limits of material performance and functionality, as well as the development of materials that lead to new value creation, is indispensable for the realization of next-generation energy utilization, high-efficiency energy processes, and resource-circulating systems. In this Research Area, we promote the collaboration and interdisciplinary interaction among young researchers who tackle materials, processes, and device research with innovative ideas and methods without being bound by existing methods or conventional frameworks. We foster challenging research that seeks to overcome issues previously regarded as difficult or impossible, thereby transforming the impossible into the possible.

The scope of research includes not only materials creation but also material design, development of measurement and characterization methods, and elucidation of fundamental principles. Ultimately, this Research Area promotes frontier materials research that contributes to the realization of GX. Specifically, research targets include next-generation semiconductors, quantum materials, materials for computing based on new principles, soft materials, extreme-environment materials, and ionics. While advanced methods such as AI, materials informatics, and computational science are also utilized, functional design aspects such as thermal transport, thermal radiation control, external field control, and control of reaction rates are incorporated. This Research Area also emphasizes interaction and close linkage between fundamental and basic research and research aimed at social implementation.

In promoting research, this Research Area places importance on creating opportunities for young researchers from different fields to interact and inspire each other, fostering human resources who

advance cutting-edge research contributing to the future, and building researcher networks that facilitate future collaboration.

Research Supervisor’s Policy on Call for Proposal, Selection, and Management of the Research Area

1. Background

As stated in the “Integrated Innovation Strategy 2025” and the “Materials Innovation Strategy”, materials technology forms the foundation of Japan’s scientific, technological, and industrial competitiveness, and is an important research area for the realization of Green Transformation (GX), the creation of sustainable value, and human resource development. In particular, the creation of frontier materials related to energy-efficient use and material conversion has been recognized as a challenging task that leads to innovation and creation in new materials science fields, and has been positioned as a priority area in national strategy.

Within this Research Area, under the ACT-X program framework, which enables young researchers to establish their individual research capabilities through research based on original and challenging ideas, we focus on the creation of frontier materials that contribute to the realization of GX. We support young researchers who are committed to pursuing innovative ideas and generating new values through the innovation and creation of their respective fields.

The “young researchers” eligible to apply in this Research Area are defined as those within eight years of receiving their doctoral degree, or, for those without a doctoral degree, within thirteen years of obtaining a bachelor’s degree (including graduate students), excluding any periods of maternity or parental leave in either case.

2. Principle of invitation project and selection

This Research Area seeks challenging research proposals aimed at the creation of frontier materials for energy-efficient use and material conversion, contributing to the realization of GX. Proposals targeting energy storage materials with high social demand, hydrogen- and ammonia-related materials, heat-resistant materials, and materials required for extreme environments such as space are encouraged. In addition, research exploring or developing novel substances or materials beyond these examples is also welcomed.

Applicants are expected to conduct research based on original and challenging approaches, grounded in their own expertise, free from constraints imposed by existing methods or conventional frameworks. Rather than the mere application of established technologies, priority is given to material design and evaluation methods that are innovative and directly linked to the advancement of energy-

efficient use and material conversion. Examples include, but are not limited to, the development of materials that enable reduced energy consumption and materials designed to achieve decarbonization or resource circulation. Even if the materials under study are not entirely new, proposals suggesting new principles or technologies that can contribute to GX are welcomed. Proposals should aim to address technical or theoretical challenges previously considered difficult or impossible.

In the selection process, priority will be given to originality, challenge, interdisciplinarity, and potential contribution to GX. Collaboration and integration across disciplines and processes—including material design, elucidation of fundamental principles, characterization, measurement, and material creation—will also be considered positively. While the Research Area emphasizes fundamental and basic research, it actively supports ambitious research aimed at the realization of GX.

Applications from both doctoral degree holders and graduate students are welcome. However, proposals that are judged to be mere extensions of research already conducted in the applicant's laboratory will not be considered for selection. Applicants should clearly highlight their originality and strengths in their proposals. Furthermore, having at least two first-author publications and oral presentation experience at international conferences will be used as reference points to demonstrate the applicant's ability to independently carry out research.

3. Research periods and research funds

The research period is set at 2 years and 6 months. The standard research budget is 6 million yen in total (excluding indirect costs) and does not need to be allocated evenly across fiscal years. If a total research budget exceeding 6 million yen is required, the reason must be clearly stated in the proposal (up to a maximum of 12 million yen).

The number of projects to be accepted is approximately 20, although this may vary depending on the budget situation and the research budgets of the accepted proposals. Awardees will undergo a progress evaluation approximately two years after the start of their research. Projects that are expected to yield significantly greater outcomes with continued support may receive an additional one-year extension of funding as an “acceleration phase” (up to approximately 10 million yen).

Furthermore, if a graduate student is selected, they may apply for additional expenses such as their own Research Assistantship (RA) on top of the aforementioned research budget.

4. Principle of research-area management

This Research Area places importance on the formation of researcher networks across different disciplines that will be crucial in the future, and supports interactions among young researchers. ACT-X is designed on the premise that young researchers, including graduate students, will undertake challenging research, with the associated risks fully acknowledged. At the same time, as the budget for individual research projects is not large, planning that considers the use of shared facilities at each

research institution or existing laboratory equipment is recommended.

Each researcher will be assigned a Research Area Advisor who is an active expert at the forefront of their respective field. Advisors provide guidance and discussion on research plans according to the needs of the awardees. Shortly after selection, awardees will receive support from the Research Supervisor and Advisors to clarify their research concepts, aiming to achieve more effective outcomes.

Furthermore, a Research Area Meeting will be organized, bringing together the Research Supervisor, Advisors, and awardees to promote interaction among researchers. This is expected to facilitate network formation among young researchers and the development of cross-disciplinary group research.

This Research Area provides an environment where researchers can focus on research without being constrained by short-term outcomes or outreach requirements, making it accessible to graduate students and researchers at various life stages.

Furthermore, we encourage short-term international research stays or similar activities that lay the foundation for international joint research. We recommend applying to “PRESTO” if a suitable Research Area can be proposed even during the research implementation period; if selected, your ACT-X research period will conclude early and you will transition to PRESTO.