Research area in Strategic Objective:

・*Innovation in measurement and analysis processes aimed at solving social issues*

・*Precision control of bonding and decomposition for resource recycling*

・*Opening up of unexplored exploration space of materials with multi-element, composite, and metastable phases based on elements strategy*

・*Precise arrangement toward functionality*

・*Information carriers and innovative devices*

・*Elucidation of mechanical properties based on an understanding of nanoscale dynamics*

・*The creation of innovative materials and devices based on the creation of topological materials science*

Trans-scale approach toward materials innovation

Research supervisor: Masayuki Takeuchi (Director, Research Center for Macromolecules and Biomaterials, National Institute for Materials Science)

Overview

The purpose of this Research Area is to develop a trans-scale approach toward materials innovation, with the goal of building a better society. Materials innovation, a highlight of industry-academia cooperation in Japan, constitutes vital core technology that can contribute to all aspects of the national growth strategy under the Japanese government's agenda to forge a New Form of Capitalism. The key to materials innovation is to transcend scale—to straddle the nano, meso, and macro scales. Crucially, such a trans-scale approach can address a critical problem in functionalizing materials: understanding at the nanoscale is not always directly related to understanding at the macroscale. In this Research Area, we will promote approaches that transcend spatiotemporal scales, while remaining rooted in basic research, to realize materials innovation that creates truly functional and innovative materials in various research fields such as structure, computation, measurement, and data.

In this Research Area, "materials" include, besides substances and raw materials, processes, nanotechnology, and devices. The "nano-scale" covered in this Research Area include atoms, molecules, crystals, supramolecules, particles, transmission electron microscopes, atomic force microscopes, X-rays, ab initio calculations, molecular dynamics, and materials informatics. The "macro-scale" covered in this Research Area include polymers, metallography, composite materials, optical microscopes, the finite element method, materials informatics, and process informatics.

In facilitating such research, we will prioritize talent development. In other words, we will provide opportunities for young researchers in disparate fields to engage with one another with a view to cultivating a body of researchers who contribute to advanced technology and to building a researcher network that will enable collaborative research in the future.

Research Supervisor's Policy on Call for Application, Selection, and Management of the Research Area

1. Background

As stated in Integrated Innovation Strategy 2022, materials constitute an important feature of industry-academia cooperation in Japan and a vital core technology that can contribute to all aspects of the national growth strategy under the Japanese government's agenda to forge a New Form of Capitalism (these aspects are Science, Technology and Innovation; The Vision for Digital Garden City Nation; Carbon Neutrality; and Economic Security). As stated in the Materials Innovation Strategy, since Japan's materials sector boasts a plethora of researchers and companies along with exceptional R&D infrastructure, the nation should facilitate efforts to create value by exploring the essential properties of materials and to ensure talent sustainability.

It was to such an end that this Research Area was established by ACT-X, a program in which young researchers hone their academic individuality by engaging in original and enterprising research. In line with this program, the Research Area will promote original and enterprising research on materials under the keyword of "trans-scale" and support young researchers with ideas for generating new value from materials innovation.

We welcome applications from young researchers in this Research Area. We define "young researchers" as individuals who have earned a doctoral degree less than eight years ago (not considering prenatal/postnatal/childcare leave) or, if not a doctoral degree, earned a Bachelor's degree less than 13 years ago (not considering prenatal/postnatal/childcare leave). Young researchers can include postgraduate students.

2. Principle of invitation project and selection

In this Research Area, we call for enthusiastic and enterprising research proposals aimed at pioneering a trans-scale approach toward materials innovation. We welcome a wide spectrum of research, including research on materials in general (such as substances, raw materials, processes,

nanotechnology, and devices) and research in fields that are indispensable to materials science (materials synthesis/assembly, computational science, advanced measurement and analysis, and data science).

Materials innovation can only occur with collaboration between researchers from each approach: those who approach materials from the nano scale, working from an understanding of atomic and molecular behavior, and those who adopt a macro-scale approach, in which they glean the principles of materials from the materials' functional properties in macro-scale. In other words, both sets of researchers must communicate with each other to gain an understanding of how problems, issues, and research perspectives differ between these scales. Therefore, this Research Area values a trans-scale, rather than scale-specific, understanding of the principles expressed in substances and in material properties.

We do not require you to specialize in or have research experience in both the nano and macro scale at the time of application submission. However, we do seek proposals for research in which the researchers go beyond the scale they generally focus on in their research. We would appreciate, for example, research that includes a discussion on what occurs at the nano scale and analysis of how that might affect meso-scale and macro-scale properties—or conversely, a discussion on how to transcend a spatial or temporal scale when creating or analyzing materials.

The interdisciplinary research perspective gained at the young age of ACT-X will give more freedom in the direction of research in the future. While it would be ideal if, during the research period, the selected Research Projects lead to the creation of innovative materials that contribute to a better society, we do recognize the difficulty of creating innovative materials in such a short time period depending on the nature of the researcher's area of interest. However, it is essential that you consider how your research is going to contribute to materials innovation that creates truly functional and innovative materials. Rather than being risk-averse, research proposals should offer originality and creativity.

3. Research periods and research funds

The Research Period will last two years and six months. During that period, 6 million JPY will be provided as Research Funds. Please note that this amount excludes any Indirect Funds (overhead Funds). If your total Research Funds exceed 6 million JPY, we may increase the provision (to a maximum of 10 million JPY) if you submit a written statement outlining the circumstances. If your research proposal is accepted, you will undergo a follow-up evaluation two years after commencement of your research. If the evaluation determines that your Research Project would deliver even greater outcomes if continued, then you will receive an additional year's worth of funding. Actual funding will depend on the Research Budget for a selected Research Project and other budgetary factors.

If you are a graduate student, then you may apply for Research Assistant expenses of your own in addition to the abovementioned Research Funds.

4. Principle of research-area management

This Research Area will facilitate interactions between young researchers with a view to cultivating an interdisciplinary researcher network that will play a vital role in the future.

ACT-X is designed to empower young researchers (including graduate students) to pursue enterprising research ideas. The program takes into account the risk that such enterprising research could end in failure. As the Research Budget for each Research Project is limited, you should consider using common research facilities in your Research Institution or using existing research equipment.

We recognize that novice researchers may struggle to draft and implement a Research Plan concerning materials research. Nonetheless, we welcome graduate students on the basis that they can conduct Research Projects while developing fresh ideas and independent perspectives in the course of their academic activities.

In this Research Area, we will assign to each researcher a Research Area Advisor who is a researcher at the frontlines of their field as part of a research advice framework tailored to your requirements.

We will also organize a Research Area Meeting in which you meet with your Research Supervisor and Research Area Advisor. The purpose of this meeting is to facilitate interactions between researchers as part of an effort to build a network of young researchers that will enable cross-disciplinary group Research Projects. Instead of being overly concerned with short-term outcomes or academic outreach, we prefer to offer young researchers the space to devote themselves to their research. We also want to provide an environment that accommodates graduate students and researchers at all life stages.