Institute of Materials Structure Science

High Energy Accelerator Research Organization
The Institute of Materials Structure Science (IMSS) was founded in 1997, as one of 19 Inter-University Research Institutes belonging to the Ministry of Education, Culture, Sports, Science and Technology, Japan. The Inter-University Research Institute is leading academic research in national universities and specialized research organizations, by performing collaborative research among its member groups and international collaborators. The IMSS is pioneering a new field called materials structure science.

In materials structure science, we can determine atomic-level and electronic structures of any material, including living systems, natural and artificial materials, and even materials from outer space. Knowledge of these material structures makes it possible to synthesize new materials for technological development.

In the 20th century, the science of materials was based on the extraction of components contained within the materials themselves. However, the characterization of each component is not sufficient to fully understand the properties of materials, because they have multi-functionalities, and the interactions of components govern this phenomenon. A key concept in materials structure science, starting around the turn of the 21st century, is the multi-characterization of the multi-functionality of materials. The IMSS leads materials structure science by combining scientific skills and knowledge via our unique research environment, which utilizes multi-quantum beams, such as photons, neutrons, muons, and positrons in the study of materials.
Magnetism and spin
Magnetic structure is examined using polarized X-rays, spin of neutrons, and muons. Magnetic moment, momentum, and temporal and spatial fluctuations are widely studied.

The development of rare-metal-free magnets and heat resistant magnets has led to better performance and more energy-saving motors in electric and hybrid vehicles.

High-speed reaction
The time scale of chemical reactions ranges from a long period of time to a femtosecond (10^-15 seconds). Using a pulsed light source, reactions can be captured and displayed as single frames like the images of a high-speed camera.

Accelerators are huge microscopes
Light and particle beams generated by accelerators enable us to observe materials in atomic scale. Complementary use of synchrotron radiation, neutrons, muons, and slow positrons is effective for materials structure science.

Surface and interface
The surface and the interface, where materials meet each other, are important sites for chemical reactions. Surface diffraction and reflection can examine the layer-by-layer atomic structure at the surface, the electronic behavior at the surface and interface, and the structural changes during the reactions.

Elemental imaging
The distribution of trace elements can be examined non-destructively using a micro/sub-micro beam.
Inter-University Research Institute

The IMSS operates large accelerators and associated facilities, as an Inter-University Research Institute, which are difficult for individual universities to run. The Photon Factory (PF), the Slow Positron Facility (SPF) in Tsukuba Campus, and the Materials and Life Science Experimental Facility (MLF) of the Japan Proton Accelerator Research Complex (J-PARC) in Tokai Campus are open to users at universities and public research institutions, including those outside Japan, at no charge.

Graduate education

The IMSS is a partner of SOKENDAI (the Graduate University for Advanced Studies) and co-manages the Department of Materials Structure Science in the School of High Energy Accelerator Science. In addition to accepting students from SOKENDAI, the IMSS also enrolls graduate students from universities throughout Japan and all over the world. Students receive the highest level of training, and learn state-of-the-art scientific techniques preparing them for a future career in science.

International collaboration

At the PF, the Indian Beamline has been preferentially used by researchers from India since 2009. The IMSS has been working on synchrotron research collaboration in the Asia-Oceania region, and has been contributing to the construction of the SESAME accelerator in the Middle East.

The Japan-UK agreement, since 1986, resulted in the construction of the neutron chopper spectrometer, MARI, at ISIS in the UK with long-term visiting researchers thereafter. This formed the foundation of neutron science technology at MLF, J-PARC.

The IMSS sponsors the exchange of researchers with the Paul Scherrer Institute (PSI) in Switzerland, and the Tri-University Meson Factory (TRIUMF) in Canada, conducting advanced experiments using muon beams as well as the collaborative development of experimental devices and analytical techniques.

Academic-industrial collaboration

Materials evaluation and characterization are indispensable for manufacturing industries. The PF and the MLF provide materials evaluation and analytical techniques, which lead to the creation of new products and quality improvement.

Contact

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Consultation desk for MLF experiments
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Outreach

The IMSS organizes many events and lectures in science museums and schools, where people can learn about and enjoy materials science.

In 2016, the IMSS’s poster of “Hydrogen” was adopted in the “one for every household” posters project by the Ministry of Education, Culture, Sports, Science and Technology. This poster has been distributed nationwide to elementary, junior, and high schools, and cooperative science museums.

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