7 Projects

The Photon Factory is conducting a wide variety of national projects. This section outlines some of the currently running projects.

7-1 Elements Strategy Initiative to Form Core Research Center

The national project “Elements Strategy Initiative to Form Core Research Center” was started in 2012. The Photon Factory has especially been committed to two research fields of the Elements Strategy Initiative: electronic and magnetic materials. The project aims to develop entirely new materials that use ubiquitous elements. In the Elements Strategy Initiative for Electronic Materials, the aims are to develop materials based on successful experience though it is sometimes far away from conventional development policy, and to pioneer electronic materials to create new guidelines for material design using harmless elements to open up new fields of material science. The project members research the crystal, local, electronic, and magnetic structures of new functional materials using synchrotron radiation, muon and neutron sources. Meanwhile, the goals of the Elements Strategy Initiative Center for Magnetic Materials are: (1) laboratory-scale synthesis of mass-producible high-performance permanent magnets without using critical rare-earth elements for the next generation and (2) framework-building and provision of basic science and technology for industrial R&D. To achieve these goals, the project members focus on theoretical research and mining of new permanent magnet materials, and simultaneously pursue various processing technologies to improve the existing high-performance permanent magnet materials through cooperative activities in the three research fields of computer physics, structural and property characterization, and material processing.

7-2 Platform for Drug Discovery, Informatics, and Structural Life Science (PDIS)

Crystallography with synchrotron X-ray has been the most successful method for determining the high-resolution structures of proteins and their complexes. In Japan, the Photon Factory (PF) and Structural Biology Research Center (SBRC) have played leading roles in structural life science and have supported a number of scientific achievements, including two structural genomics projects since 2002. The SBRC has now been leading the third national project in the field.

The Platform for Drug Discovery, Informatics, and Structural Life Science (PDIS) has been supported by the Ministry of Education, Culture, Sports, Science & Technology (MEXT) and then the supporting organization was taken over by the Japan Agency for Medical Research and Development (AMED) in April 2015 (http://www.pford.jp/). In the project, all life scientists, both in academia and industry, have a chance to be supported by leading scientists with a variety of expertise through a single proposal if it is approved. They can also use facilities such as the PF and SPring-8. The plan is for the PDIS to become a critical research hub for all researchers who are interested in using structural information in their own research projects.

The platform is composed of three cores: structural analysis (Kaiseki), control (Seigyo), and information (Joho). The structural analysis core covers bioinformatics, protein production, and structural analysis. The core office has been located in the SBRC since April 2015 and the Center has also organized the structural analysis core. The Center has supported users through a pipeline with a high throughput crystallization system, synchrotron X-ray beamlines for structure determination as well as consulting for users’ structural biology projects. It has also been developing a state-of-the-art environment for optimal data collection and data processing in protein crystallography and in small-angle X-ray scattering.

The Center is actively utilizing other structural biology techniques such as NMR and electron microscopy to collect as much structural and dynamic information as possible. The Center will work together in order to establish and support a better research environment for structural life science in Japan.

7-3 Cross-Ministerial Strategic Innovation Promotion Program (SIP)

The Cross-ministerial Strategic Innovation Promotion Program (SIP) [1] was established by the Council for Science, Technology and Innovation (CSTI) of the Cabinet Office in order to realize scientific and technological innovation strategically under its initiative in 2014. SM^4I (Structural Materials for Innovation) [2] is one of the 10 R&D subjects of the SIP that is planned for the period from October 2014 to March 2019, with the participation of 72 major research groups in the field (industry: 27, university: 35, public (non-profit) institutions: 10 in FY2014). The TIA-nano consortium of AIST, NIMS, Univ. of Tsukuba and KEK joined the SM^{4}I project as Unit D66 - Innovative measurement and analysis for structural materials (SIP-IMASM), in which advanced analytical techniques are being researched and developed for structural materials for aerospace in the following four areas: (1) stress and cracks, (2) light and additional elements, (3) interfaces and microstructures, and (4) defects.

Members of IMSS of KEK take advantage of analytical techniques using synchrotron radiation and positron beams to characterize structural materials for aerospace such as ceramic coating, steel, nickel-alloy, and fiber-reinforced polymer (FRP). We focus on revealing the heterogeneity in microstructures and chemical states simultaneously using various techniques such as X-ray absorption fine structures (XAFS), X-ray diffraction (XRD), scanning transmission X-ray microscopy (STXM), and computed tomography (CT), and nano-scale defects using positron annihilation. We also plan to install an X-ray transmission microscope (XTM) in the PF-AR for 3D observation of microstructures and chemical states simultaneously with a special resolution as small as 50 nm. We aim to establish a new approach to enable detection of the initiation and propagation of degradation of structural materials for aerospace three-dimensionally using these advanced analytical techniques, through collaboration of the members of SM^{4}I (Fig. 1).

REFERENCES

[1] SIP: http://www.jst.go.jp/sip/index.html
[2] SM^{4}I: http://www.jst.go.jp/sip/k03.html

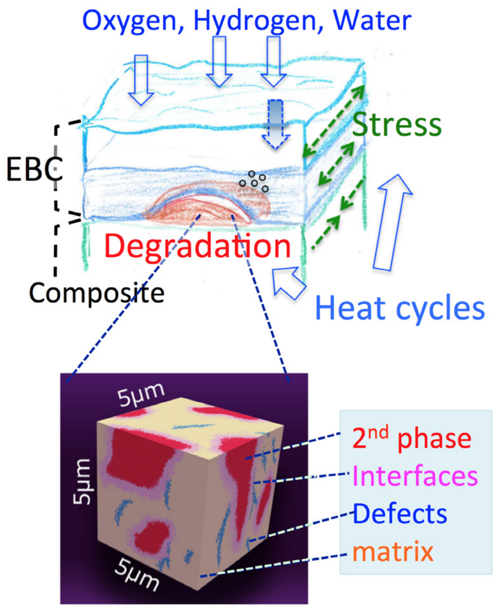

Figure 1: 3D characterization of degradation in structural materials in semi-nano scale.

7-4 Accelerated Innovation Research Initiative Turning Top Science and Ideas into High-Impact Values (ACCEL)

The Photon Factory has taken part in one of the projects of the Accelerated Innovation Research Initiative Turning Top Science and Ideas into High-Impact Values (ACCEL) of the Japan Science and Technology Agency (JST): "Materials Science and Application of Electrides", which is led by Prof. Hideo Hosono (Tokyo Inst. Tech., JST-ACCEL) and managed by Prof. Toshiharu Yokoyama (JST-ACCEL, Tokyo Inst. Tech.). New electrides have been synthesized by Prof. Hosono's group, and show low work functions together with thermal and chemical stabilities. The project seeks to apply the functions to develop new electronic and catalytic materials. As for catalysts, the main target is to develop a new process of ammonia synthesis, which works in a relatively mild atmosphere. The Photon Factory staff involved in this project have carried out experiments to characterize the catalysts and to provide feedback to the members synthesizing the catalysts.

7-5 Photon Beam Platform

This program aims to accelerate industrial innovation and enhance the academic activities of Japan through the shared use of advanced research facilities. MEXT has promoted this program since 2005, and deployed two platforms as a part of it since 2013, i.e., the Photon Beam Platform [1] and the NMR Platform.

In this program, the Photon Factory has been actively engaged in two tasks: one is the Trial Use that offers free-of-charge use of the beamlines to introduce new industrial users to the PF, and the other is to chair the Photon Beam Platform as a representative institute. Under the Photon Beam Platform, six synchrotron facilities and two large-scale laser facilities collaborate with each other to offer better services to users, set up general coordinators, conduct public relations campaigns, improve the ease of using the service, and investigate new technologies through the collaboration (Fig. 2).

REFERENCE

[1] http://photonbeam.jp/

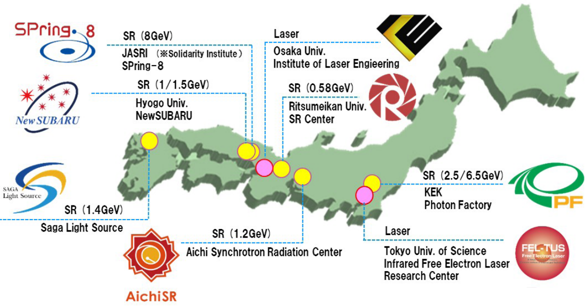

Figure 2: Framework of Photonebeam Platform.

7-6 Nanotech Career-Up Alliance (Nanotech CUPAL)

One of the most crucial missions of the synchrotron facility is to enhance the development of human resources actively involved in the synchrotron radiation community, especially the younger generation. In this context, the Photon Factory has joined the Nanotech Career-up Alliance (Nanotech CUPAL), which was established based on the MEXT projects in 2014.

The Nanotech CUPAL project was originally launched as a ten-year project in collaboration with the Tsukuba Innovation Arena for nanotechnology (TIA-nano) and Kyoto University's Nanotechnology Hub (KUNH) for enhancing the careers of young researchers in the nanotechnology field and improving the mobility of human resources. The alliance comprises “A Institutions”, which are responsible for the training of human resources (KUNH and four organizations constituting TIA-nano in the Tsukuba area (National Institute of Advanced Industrial Science and Technology (AIST), National Institute for Materials Science (NIMS), KEK, and University of Tsukuba)) and “B Institutions”, ten universities dispatching young researchers to the “A Institutions”. The targets are mainly postdoctoral fellows, fixed-term assistant professors, and PhD students who belong to the alliance organizations. Researchers outside the alliance can also join the program by covering part of the costs by themselves.

The “A Institutions” provide various types of training courses related to state-of-the-art nanotechnologies such as ultrafine fabrication processes, micro/nano electro-mechanical systems (MEMS), electron microscope techniques. As a member of TIA-nano, the PF offers opportunities for training on basic synchrotron radiation techniques (X-ray absorption fine structure, small-angle X-ray scattering, powder diffraction and phase-contrast imaging) through on-the-job training at the beamlines. In 2014, four researchers joined the first course, and more participants are expected in the next term (Fig. 3).

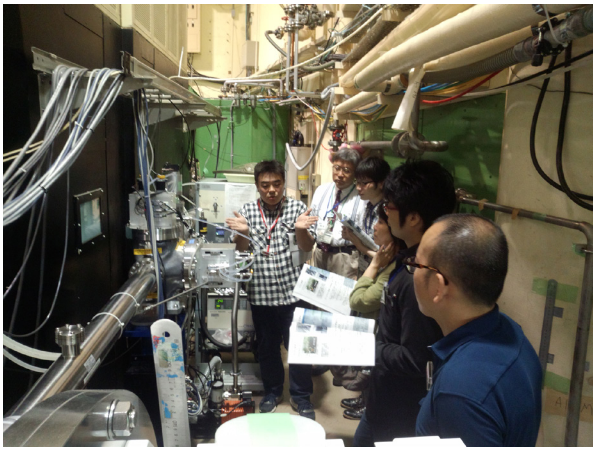

Figure 3: Practice scene of SAXS at BL-10C.