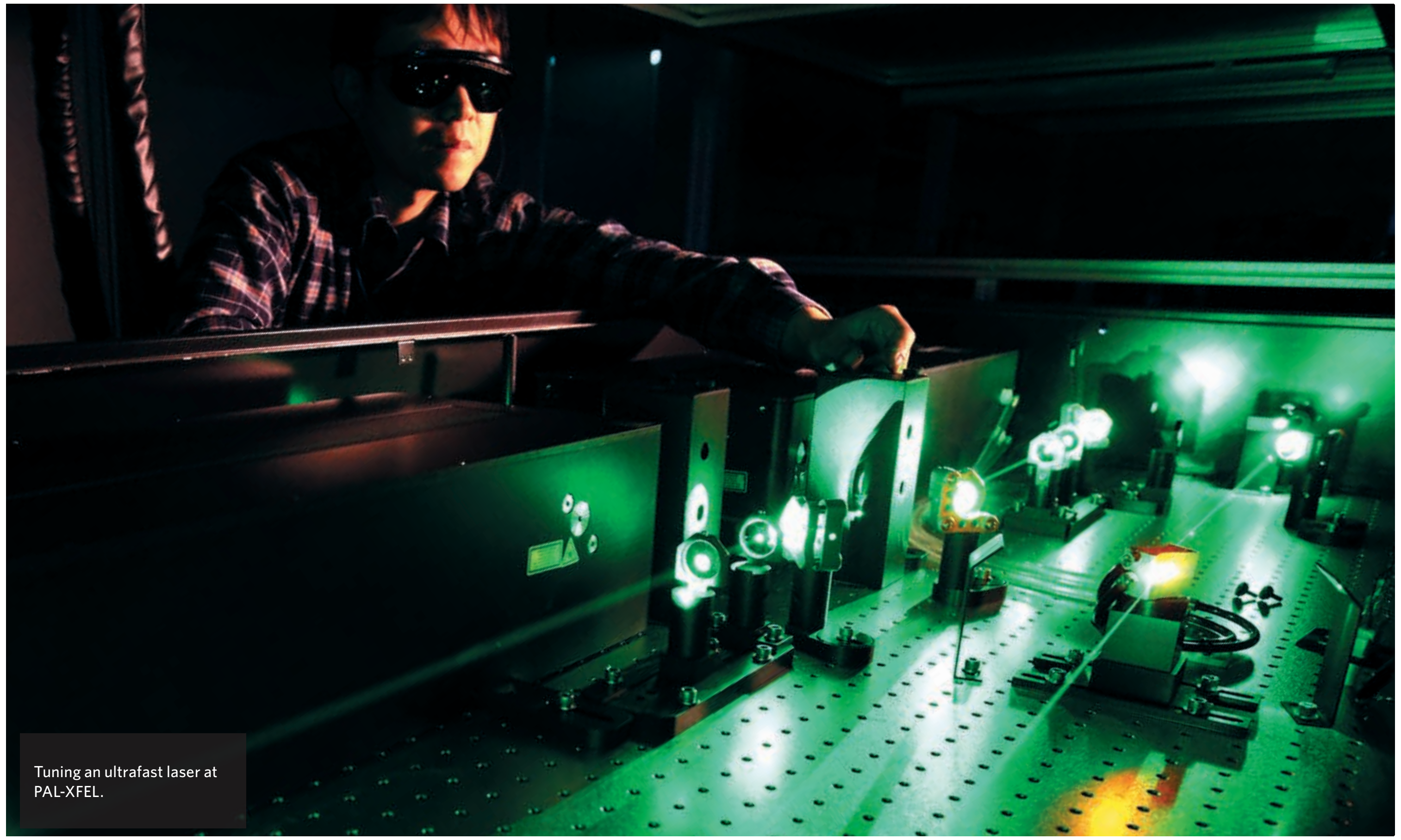
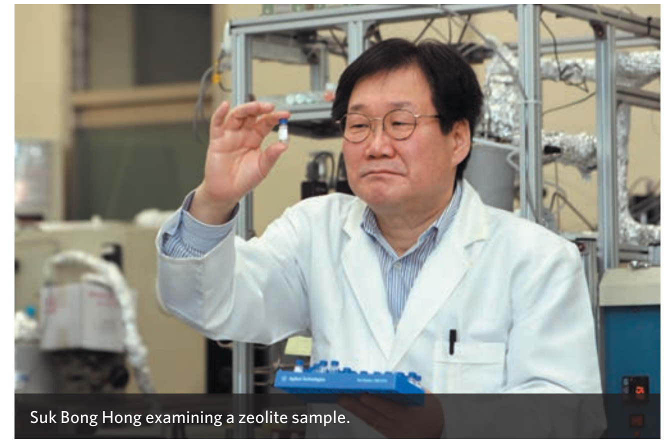
Accelerating the pace of innovation

POSTECH'S IMPRESSIVE RESEARCH INFRASTRUCTURE, which includes two synchrotron radiation accelerators, is spawning breakthroughs in fields as diverse as drug development and materials science.



Tuning an ultrafast laser at PAL-XFEL.



Suk Bong Hong examining a zeolite sample.

Yunje Cho (right) and Jaehyun Park (left) at the PAL-XFEL Beamline.

Founded in 1986, Pohang University of Science and Technology, commonly known as POSTECH, has quickly risen to become one of the world's most innovative universities, placing 12th in the Reuters 2019 innovative university rankings, ahead of the University of California, Johns Hopkins University and Caltech.

The jewel in the crown of the young research university's infrastructure are its two accelerators. One of only two universities to house a synchrotron radiation accelerator, POSTECH boasts a third-generation accelerator, the Pohang Light Source-II (PLS-II), and a fourth-generation one, the Pohang Accelerator Laboratory X-ray Free Electron Laser (PAL-XFEL).

"PAL-XFEL CAN HELP US UNDERSTAND PHENOMENA THAT TRANSPIRE ON VERY SHORT TIMESCALES."

Opened to users in 2017, PAL-XFEL is now the world's most stable XFEL in terms of beam position and energy. It can be used to investigate ultrafast processes. "PAL-XFEL can help us understand phenomena that transpire on incredibly short time-scales like photosynthesis and chemical reactions," says POSTECH's president, Moo Hwan Kim. "We look forward to developing cutting-edge technologies using the facility."

Prospecting for new materials

One researcher who has particularly benefited from PLS-II is zeolite expert, Suk Bong Hong, a professor of Environmental Science and Engineering at POSTECH. Zeolites are crystalline microporous materials that are of major importance as industrial catalysts and adsorbents.

"There are several million theoretical possible structures, but only about 250 different structure types of zeolites have been recorded to date, and only about 10 have been commercialized as catalysts or adsorbents," says Hong. His research is focused on developing new synthesis strategies and creating new zeolite frameworks and compositions.

X-ray diffraction data obtained from PLS-II enabled Hong and colleagues to solve more than 10 new zeolite structures (for example, *Nature* **524,** 74–78; 2015). "Without PLS-II, I wouldn't have been able to expand my research area," says Hong.

He believes that PAL-XFEL's ability to do dynamic experiments will make it invaluable for looking into more fundamental aspects of materials science, such as the mechanism of crystallization.

Intensifying the search for new drugs

"I'm trying to understand, from a structural viewpoint, how cells maintain their genomic stability by regulating the DNA replication and repair mechanism," says Yunje Cho, a professor at POSTECH's Department of Life Science. He is working on the structures of the various protein complexes, which are involved in signalling and repairing the DNA damages, such as double-strand breaks and interstrand crosslinks.

Cho is excited about PAL-XFEL's potential to transform his work, particularly in eliciting the structures and mechanisms of membrane proteins and how they regulate cell metabolism and signalling. "The intensity of the XFEL is more than 10 billion times stronger than third-generation synchrotron," he explains. With XFEL it is possible to capture ultrafast movement at the level of femtoseconds, which includes processes like electron movement and changes in protein structures.

Because diffraction analysis is destructive, it is vital to generate significant amounts of nanocrystals of proteins, a strength of Cho's team. "With this intense beam, if we hit crystals in the time-resolved manner, they burn — but at the same time the beam diffracts. By obtaining this information we can see the dynamic structure of the protein at the atomic level."

A vision for a better society

POSTECH has also established two dedicated research centres: the Bio Open Innovation Center (BOIC), and the Institute of Membrane Proteins (IMP).

To facilitate collaboration in the creation of new drugs across academic, government, and industrial sectors, POSTECH, Pohang city, and biotechnology venture company, Genexine, jointly invested in BOIC. As well as POSTECH researchers, the institute will be home to more than 20 domestic and international companies, research institutes, and a drug-development pilot plant, which will support the testing and production of new drug candidates.

"We will provide a ground-breaking industry–academic cooperative support system so that researchers can actively collaborate with industries rather than being trapped in ivory towers," says Kim.

"BOIC is dedicated to developing biomedicines such as small molecule drugs or antibodies, based on protein structures," says Cho. Researchers will use PAL-XFEL and cryo-electron microscopy to uncover and design new drug candidates, as well as use stem cells and 3D printing technology for artificial organ research.

The Institute of Membrane Proteins, which will be located within BOIC, will focus on investigating high-resolution stereoscopic structures of novel drug-target cell membrane proteins. While cell membrane proteins account for more than 60% of disease causes, their complexity has made analysis of their structures formidable. This will change with access to PAL-XFEL. IMP researchers will use the facility to develop antibodies and new drug candidates through structural analysis and functional and application research of the cell membrane protein of six major types of disease: cancer, infectious diseases, metabolic disorders, brain diseases, cardiovascular disorders, and rare diseases.

"Through the state-of-the-art research infrastructure consisting of BOIC and IMP, we wish to fulfil our role as a university that contributes to the betterment of the nation and society, our founding tenet." says Kim. "We strive to nurture bioengineering experts and cultivate the highly valued pharmaceutical sector, and ultimately to generate value that will lead to the progress of our nation and mankind."■

POSTECH
POHANG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Website postech.ac.kr/eng
Facebook www.facebook.com/postech.global
Instagram www.instagram.com/postech.global
Linkedin www.linkedin.com/school/pohang-university-of-science-and-technology
Email press-release@postech.ac.kr
Address 77 Cheongam-Ro. Nam-Gu. Pohang. Gyeongbuk. Korea 37673