Recent Research and Development of ARPES Beamlines at HiSOR and Future Plan for Upgrade

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Keywords: Synchrotron radiation, Angle-resolved photoemission spectroscopy

The Research Institute for Synchrotron Radiation Science is a synchrotron radiation facility established at Hiroshima University. A compact 700 MeV electron storage ring provides synchrotron radiation in the vacuum ultraviolet (VUV) and soft x ray regions. Tunable photon energies in this range are indispensable for studying the fine electronic structures of novel materials such as superconductors, topological insulators, and Weyl semimetals using high resolution angle resolved photoemission spectroscopy (ARPES).

Our facility hosts several undulator beamlines dedicated to high-resolution ARPES (BL-1 and BL-9A), enabling measurements with an energy resolution better than 5 meV. At BL-1 (high-resolution ARPES beamline, $h\nu = 23 - 350$ eV), the beam size has recently been reduced by an order of magnitude (to ~70-80 μm in the vertical direction), and a new electron analyzer (A-1, MBS) equipped with a deflector mode has been installed to facilitate detailed measurements. In addition, we have introduced the three-axis goniometer of the focusing mirror for optimization of the focused beam more precisely. A laser source has also been introduced at the endstation to conduct the experiment with synchrotron radiation. These developments allow BL-1 to flexibly switch between synchrotron radiation and laser light depending on the experimental requirements, enabling highly efficient ARPES measurements. A spin-detection system will be introduced in 2026, along with new experimental apparatuses to support a wide range of research fields.

BL-9A provides low-energy-photon ARPES capabilities for solids and thin films, using synchrotron radiation in the ultraviolet region ($h\nu = 6.5$ - 40 eV). This beamline delivers high-brightness radiation with excellent energy resolution. Since October 2022, a hemispherical analyzer (ASTRAIOS 190, SPECS; acquisition angle ±20° to ±30°) and a six-axis manipulator (operational temperature range: ~10 - 300 K) have been installed at the endstation. Operando measurements are also possible.

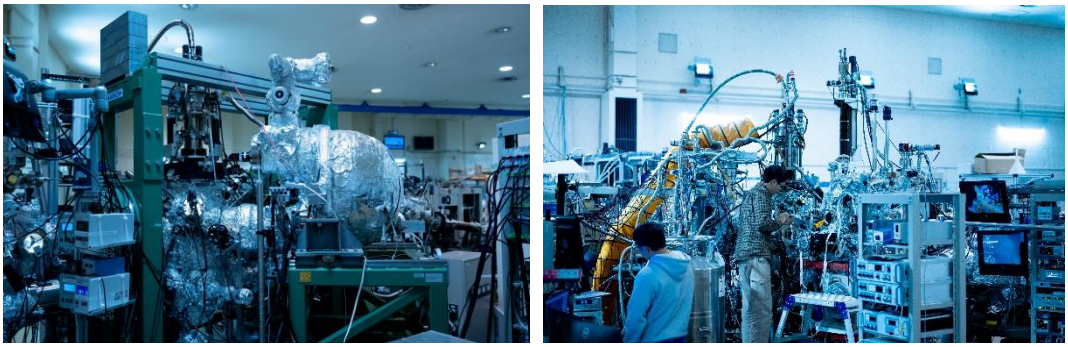

FIGURE 1. Endstations for the high-resolution angle-resolved photoemission spectroscopy. Left and right is BL-1 and BL-9A, respectively.