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Present Status and Future Prospect of Spin-Resolved ARPES at HiSOR

Kazuki Sumida[a], Yuita Fujisawa[a], Takahito Takeda[b], Akio Kimura[b,c,d], Kenta Kuroda[b,c,d], Koji Miyamoto[a], and Taichi Okuda[a,c,d]

[a]*Research Institute for Synchrotron Radiation Science (HiSOR), Hiroshima University, 2-313 Kagamiyama, Higashi-Hiroshima, 739-0046, Japan.*
[b]*Graduate School of Advanced Science and Engineering, Hiroshima University, 1-3-1 Kagamiyama, Higashi-Hiroshima, 739-8526, Japan*
[c]*International Institute for Sustainability with Knotted Chiral Meta Matter (WPI-SKCM^2), 1-3-1 Kagamiyama, Higashi-Hiroshima, 739-8526, Japan*
[d]*Research Institute for Semiconductor Engineering (RISE), Hiroshima University, 1-4-2 Kagamiyama, Higashi-Hiroshima, 739-8527, Japan.*

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Visualization of the electron behaviors in functional materials, such as semiconductors, magnets, and superconductors, is essential because it is closely connected to their numerous functionalities relevant to device applications. The fundamental properties of the electrons in solids are predominantly described by distinct quantum parameters including energy, momentum, and spin. In this context, spin- and angle-resolved photoemission spectroscopy (SARPES) is a very powerful experimental method that can reveal the "complete" electronic structure in energy-, momentum-, and spin-resolved manners [1,2].

Since the discovery of strongly spin-orbit coupled exotic quantum materials such as Rashba systems, topological insulators, and Weyl semimetals, the importance of SARPES experiments has rapidly increased. Nevertheless, SARPES measurements are time-consuming compared to the conventional spin-integrated measurements due to the extremely low efficiency of the spin detector. Thus, we typically sacrifice the energy and momentum resolution for practical experiments to obtain a sufficient signal-to-noise ratio.

To overcome this problem, we have developed a very low energy electron diffraction (VLEED) type high-efficiency spin detector using Fe(001)*p*(1x1)-O target [3,4]. At HiSOR, we constructed two SARPES instruments combined with photon-energy-tunable vacuum ultraviolet synchrotron radiation (16-300 eV) and ultraviolet laser (6 eV) light sources [4-6]. For both instruments, two VLEED spin detectors are installed orthogonally each other after a hemispherical electron analyzer. Since one VLEED spin detector can measure two spin components (P_x & P_z or P_y & P_z) by changing the magnetization direction of the Fe(001)*p*(1x1)-O target, we can perform three-dimensional spin vectorial analysis. In this talk, we will present the recent research highlights utilizing our aforementioned high-efficiency SARPES systems and future prospects, such as developing a multichannel spin polarimeter, time-resolved SARPES, and operand SARPES.

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