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Colloquium

Recent advances on photoelectron momentum spectro-microscopy at the Taiwan Photon Source

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Abstract

The Photoelectron Related Image and Nano-Spectroscopy (PRINS) end-station at the Taiwan Photon Source (TPS) 27A2 is now hosting a momentum microscope that aims to work on photoelectron-related imaging and nano-scale spectroscopy through the combination of an imaging-type electron column integrated with a hemispherical electron energy analyzer and an imaging spin filter [1]. The microscope is able to conduct full-field imaging in either real-space or momentum-space. The main microscope system was delivered at the TPS at the end of 2021, and its on-site testing has been initiated in the first half of 2022. Although the beamline will not be ready until mid-2024, the offline commissioning by He-I radiation and a Hg lamp has demonstrated its capabilities in real-space and momentum-space imaging.

In this talk, I will first give a brief introduction to photoelectron-based spectromicroscopy using soft X-rays and followed by demonstrating how the momentumspace and real-space images can be obtained. The performance of this microscope will also be demonstrated using two in-house photon sources, an Hg lamp and He(I) radiation, on a standard checkerboard-patterned specimen and an Au(111) single crystal, respectively. By analyzing the intensity profile of the edge of the Au patterns, the Rashba-splitting of Au(111) Shockley surface state at 300 K, and the photoelectron intensity across the Fermi-edge at 80 K, the spatial, momentum, and energy resolution were estimated to be 50 nm, 0.0172 Å!" and 26 meV, respectively [2]. Additionally, we show that the band structures acquired in either constant energy contour mode or momentum-resolved photoemission spectroscopy mode were in close agreement, and both modes can be performed in the same instrument.

In future, the capability of the microscope using soft X-rays delivered by the TPS 27A Soft X-ray Nanoscopy beamline will be explored. Perspectives on the future capabilities, including imaging based on X-ray photoelectron spectroscopy (XPS), Xray absorption spectroscopy (XAS), and X-ray magnetic circular dichroism (XMCD) will be also presented.

References

[1] Shiu, Chuang, et. al. J. Electron Spectrosc. Relat. Phenom. 266, 147363 (2023).

[2] Chuang, et. al. J. Synchrotron Rad. 31, 195 (2024).