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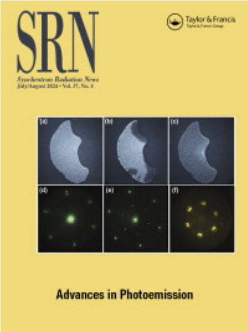

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Advances in Angle-Resolved Photoemission Spectroscopy

Angle-resolved photoemission spectroscopy (ARPES) has become a premier tool for investigating the electronic structures of quantum materials by directly visualizing the momentum-resolved single-particle spectral function [1]. The technique has been enjoying its prevalence in synchrotrons around the world and continues to improve with innovations in beamline optics, detector technology, analysis tools, and sample environments.

This special issue of *SRN* highlights some of the recent developments in synchrotron-based ARPES and the science examples enabled by new capabilities. Readers may notice a few common themes in the technical advances shared by modern ARPES beamlines in addition to the high resolution, high flux, and full polarization control of the photon beam: (i) better focusing of synchrotron radiation at the sample position, down to 5–10 µm or even to a few hundred nanometers, provides spatial resolution required to investigate small domains and nanoflakes of samples; (ii) advanced electron detectors, such as hemispherical analyzers with electron deflectors and momentum microscope with photoemission electron microscopy (PEEM)-type lens elements, allow more efficient data collection; (iii) combining sample growth and preparation capability and integrating other experimental tools enable *in situ*, multimodal measurements for a more precise and complete measurement; (iv) more user-friendly control and analysis software are now available by adopting fast developments in computer science and information technology.

In particular, the article by Makoto Hashimoto, Yong Zhong, and Donghui Lu from Stanford Synchrotron Radiation Lightsource describes how the oxide molecular beam epitaxy (MBE) system connected to the ARPES endstation makes it possible to perform a systematic study on high T_c cuprates to reveal the essential ingredients of the mechanism behind the superconductivity. Cheng Chen and his collaborators from Shanghai Synchrotron Radiation Facility report the successful inclusion of a two-dimensional (2D) materials heterostructure assembly system to their nano-ARPES beamline to make in situ, in operando ARPES measurement on 2D devices.

Visualizing the spin textures is crucial for understanding topological materials, magnetic materials, and materials with strong spin-orbit interaction, as emphasized in the article by Craig Polley and the team from MAX IV Laboratory. They show that the combination of micro-ARPES and spin-ARPES with a VLEED-type detector is a powerful tool for investigating 2D materials with strong spin-orbit coupling. The commissioning of momentum microscopes at synchrotron beamlines would facilitate a more efficient detection of the electron spin degree of freedom. Vitaliy Feyer and the team from Jülich/Elettra showcase the high-resolution spin-resolved data from Fe surface and graphene/metal heterostructures.

A multimodal approach integrating ARPES with other synchrotron-based techniques provides a more comprehensive understanding of materials, as exemplified by the article by Elio Vescovo and his collaborators from NSLS-II. They present that the ARPES combined with XPEEM/LEEM can provide a clearer view of the structure-property relation.

By extending the incident photon energy to the soft x-ray regime, one may expect a more clear separation of bulk and surface, elemental specificity through resonance, and access to the buried interface. The article by Jessica L. McChesney and Fanny Rodolakis from Advanced Photon Source presents clear examples in this regard from 2D electron gas on oxide surfaces and heavy fermion systems. Fumihiko Matsui and his collaborators from UVSOR introduce a unique beamline design that can utilize both VUV and soft x-ray beams on a single endstation equipped with a momentum microscope.

With ongoing and projected upgrades of synchrotron radiation facilities in the next decades [2], it is an exciting time to witness rapid advances in synchrotron-based science. I hope this special issue helps readers get a glimpse of the ongoing developments in ARPES. My sincerest gratitude goes to all the authors for sharing their valuable time and expertise with us.

Disclosure Statement

No potential conflict of interest was reported by the author(s). ■

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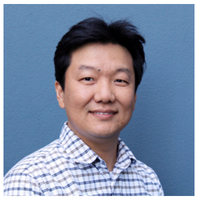

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