Advances and possibilities of the Materials Innovation Platform with examples from Spin-ARPES

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The quest for device applications based on quantum materials, such as topological insulators, density wave systems, or superconductors, requires strict control of the environments these materials are exposed to during production and also while under investigation. It is most straightforward to gather all parts of the experiment, from sample growth to state-of-the-art analysis, in one connected UHV system. This approach in creating a so-called Materials Innovation Platform (MIP) has proven to be extraordinarily valuable in recent years.

In this presentation, I will focus on one such configuration; a combination Molecular Beam Epitaxy (MBE) system and Angle Resolved PhotoEmission Spectroscopy with spin detection capability (Spin-ARPES). The advantages of this set-up will be explored, as well as highlighting some of the very recent electronic band structure research performed with such a system. Two specific examples will be reviewed: Yang *et al.*[1] investigation of the impact of photogenerated carriers on the superconducting transition temperature; and advances high efficiency spin-ARPES[2]. The work by Yang *et al.*, enabled by the *in-situ* growth and analysis possibility, shows rapid, reliable, reproducible switching between normal and superconducting states, which demonstrates the possibility of making energy-efficient quantum optoelectronics devices. Future possibilities of Spin-ARPES and laser-ARPES in combination with MIP will also be discussed in relation to how this approach can allow more complete and precise studies of quantum materials.

[1] Yang et al., Nature Communications (2019)10:85, https://doi.org/10.1038/s41467-018-08024-w

[2] Data courtesy: Prof. Dengsung Lin, Dept. of Physics, NTHU, Taiwan

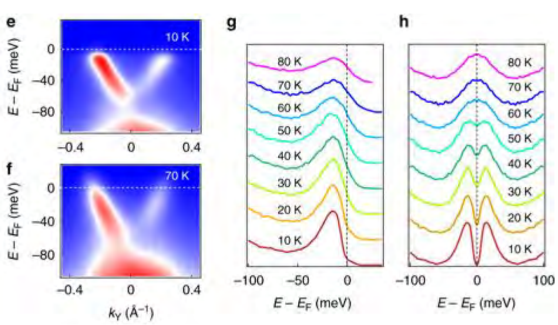

Figure 1: Taken from Yang et al., ARPES Lab spectra across M-point measured at 10K (e) and 70K (f). Temperature-dependent energy distribution curves (EDCs) (g) and symmetrized EDCs (h) at the Fermi crossing, showing the superconducting gap opening between 50 K and 60 K.

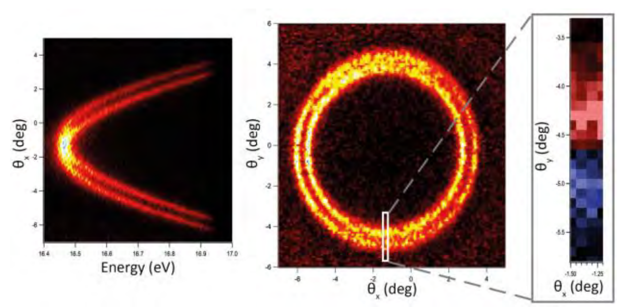

Figure 2: Overview ARPES and spin-ARPES data from [2] exemplifying high quality, high efficiency spin resolved measurements with the DA30L and VUV5k He lamp.

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