Element- and Momentum-Resolved Electronic Structure from Standing-Wave Hard X-ray Angle-Resolved Photoemission

Ján Minár[1, a)], Slavomír Nemšák[2], Ivan A. Vartaniants, Charles S. Fadley[3]

[1]New Technologies-Research Center, University of West Bohemia, 306 14 Plzen, Czech Republic;
[2]Materials Sciences Division, Lawrence Berkeley National Laboratory, 1 Cyclotron Rd, Berkeley, CA-94720, USA;
[3] Photon Science, DESY, Hamburg

Corresponding author: [a)]jminar@ntc.zcu.cz

Abstract. We have studied the electronic structure of the dilute magnetic semiconductor $Ga_{1-x}Mn_xAs$ and undoped GaAs with standing-wave (SW) hard X-ray angle-resolved photoemission (HARPES). The standing wave is produced by Bragg reflection of X-rays at a few keV from the {111} planes of (001)-oriented epitaxial films of $Ga_{0.95}Mn_{0.05}As$ and single-crystal GaAs, and is moved through the unit cell by scanning photon energy over the Bragg condition. By partitioning the energy-scan HARPES intensities into element-resolved components using analogous energy scans of Ga 3d, Mn 2p, and As 3d core levels, we are able to conclude that Mn is substitutional, and that a decomposition of the data into element- and momentum resolved intensities is possible. Comparison with element-projected Bloch spectral functions yields excellent agreement with experiment. This novel SW-HARPES technique should be broadly applicable to other multi-element materials [1]. In addition we present first one-step model of photoemission implementation of X-ray standing waves in order to describe these kind of experiments.

References

[1] S. Nemsak et al., Nature Communications, in consideration (2018)