Soft x-ray angle-resolved photoemission spectroscopy of Nickel

We study the bulk band structure and Fermi surface of nickel metal by soft x-ray angle-resolved photoemission spectroscopy (SX-ARPES). SX-ARPES, using tunable photons from $h\nu$~300 to 800 eV, facilitates depth sensitive in-plane band mapping of Ni(100). Horizontal- and vertical-polarization-dependent studies are used to selectively enhance dipole-allowed transitions. While low-temperature (50 K) results provide band dispersions consistent with the direct transition model, room-temperature (300 K) studies confirm and quantify significant intensity loss due to non-direct transitions. The band maps provide band dispersions and identify all the bands in the Γ-X-W-W-X-Γ quadrant in momentum space.[1] In particular, the results show that a hole pocket derived from the $X2\downarrow$ down-spin band exists in bulk Ni. This is in contrast to results of surface-sensitive ultraviolet ARPES studies but consistent with other bulk-sensitive measurements. The $Z1\downarrow$ band is also shown to have depth-sensitive band dispersion and Fermi surface crossings. In addition, the magnetically active $Z2\downarrow$ down-spin band shows nearly flat band behavior. The Fermi surface and band dispersions determined by the present ARPES measurements are in good agreement with local density approximation band structure calculations. SX-ARPES is thus a valuable probe of the intrinsic momentum-resolved electronic structure of solids.

[1] N. Kamakura et al., Physical Review B 74, 045127 (2006) ; Europhysics Letters 67, 240 (2004).