Tuneable Hybridization between Rashba-split Surface States in BiAg$_2$/Ag/Au(111) Trilayer Systems

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Long-range ordered metallic surface alloys are known to feature surface states with a very large Rashba-type spin-orbit splitting.° The particular alloys BiAg$_2$/Ag(111), PbAg$_2$/Ag(111) and BiCu$_2$/Cu(111) feature a qualitatively similar electronic structure characterized by two spin-split surface states of mainly $sp_z$ and $p_xp_y$ orbital character.° Important quantities characterizing the details of the surface electronic structure are the size of the spin-splitting, the position of the Fermi level as well as the orbital composition and the hybridization strength of the two states. Besides the specific substrate and adsorbate atomic species these properties sensitively depend on the individual geometry of the alloy, namely on the height the Bi (Pb) atom protrudes out of the first substrate layer.°

Employing angle-resolved photoelectron spectroscopy we have studied the surface states of a BiAg$_2$ alloy grown on thin Ag films on Au(111) with thicknesses in between 1 ML and 16 ML. In contrast to the case of the bulk Ag(111) substrate we find the $sp_z$-type and the $p_xp_y$-type surface state to be separated by a hybridization gap that is accompanied by a pronounced kink in the dispersion of the $p_xp_y$-type state. The size of the gap can be tuned by the Ag film thickness. These observations are attributed to slight variations in the protrusion height of the Bi atom. We propose that these variations are induced by different partial charge densities of the Ag quantum well states in the topmost layers. As predicted by previous calculations an unconventional sign change of the spin polarization occurs at the hybridization kink of the $p_xp_y$-type state.° The system presented here is perfectly suited to probe this interesting effect that goes beyond the standard Rashba-model by spin-resolved ARPES.

References