

Giant Rashba spin splitting of monolayer Pb adsorbed Ge(111) surface

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Introduction

Rashba spin splitting of a surface state band on a semiconductor surface allows us to open a novel physics such as a spin transport at the surface. The Rashba spin-split bands on the semiconductor surfaces have been identified on Si(111) and Ge(111) surfaces so far [1-4]. Among them, monolayer lead (Pb) adsorbed Ge(111) surface (Pb/Ge(111)- β) is remarkable because one of the surface state bands crosses Fermi level with the Rashba spin splitting. In the present study, we report on the giant Rashba spin-split band of Pb/Ge(111)- β studied by spin- and angle-resolved photoelectron spectroscopy (SARPES).

Experiment

Experiments were performed at KEK-PF BL18A and 19A. A Ge(111) substrate was prepared by several cycles of Ar⁺ bombardment with 0.5 kV and annealing up to 900 K for a few seconds. Pb was deposited onto the surface at room temperature, which was then annealed at 570 K for three minutes to prepare a well-ordered wide terrace of Pb/Ge(111)-($\sqrt{3}\times\sqrt{3}$)R30°.

Results and discussion

Figure (b) shows the ARPES image taken along $\bar{\Gamma}\bar{M}\bar{\Gamma}$ of ($\sqrt{3}\times\sqrt{3}$)R30° surface Brillouin zone (SBZ) shown in Fig. (a). We found three Pb-induced bands named S_1 , S_2 and S_3 . The spin structures were investigated by SARPES. Hereafter, we focus on the S_2 band. First, it is found that the spin-up and spin-down branches of S_2 are degenerate at the \bar{M} point. Also, the peaks of S_2 show clear energy splitting and the peak positions of the spin-up and spin-down branches are inverted around \bar{M} . We therefore concluded that the S_2 band splits into two due to the surface Rashba effect. The Rashba parameter is roughly evaluated to be 1.9 eV Å, which is comparable with the other giant Rashba systems [1-3].

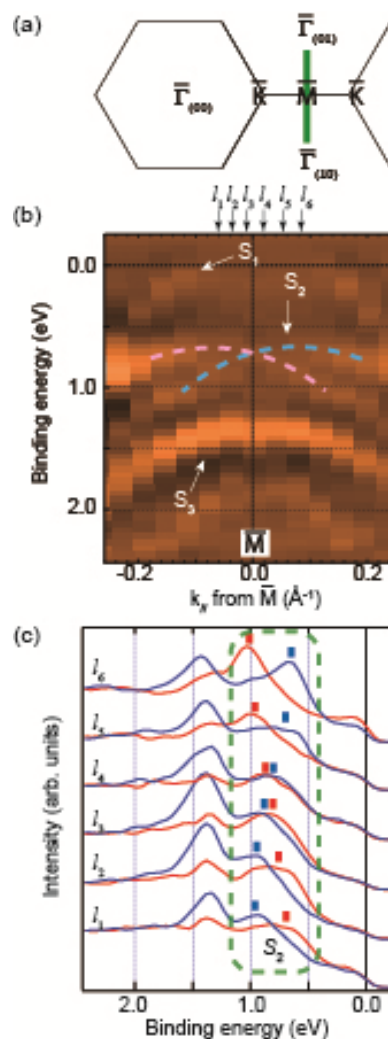


Figure (a) SBZ of Pb/Ge(111)- β . (b) ARPES image taken along green line in the SBZ shown in (a). Dashed curves represent two branches of S_2 . (c) SARPES spectra taken with the arrows shown in (b). Red and blue lines represent the up and down spin states, respectively.

References

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