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Termination dependent band structure of ScV6Sn6

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1 Introduction

The intertwining between strong electronic correlation and nontrivial band topology in quantum materials can give rise to exotic topological correlated physics, such as topologically protected Majorana fermions[1,2]. The kagome lattice, with its 2D network of corner-sharing triangles, can generate a unique electronic structure including Dirac cones, flat bands, and van Hove singularities, making it a promising system for exploring the interplay among orbital, charge, and spin degrees of freedom[3,4]. Recently, the observations of superconductivity, nontrivial band topology and chiral charge density wave (CDW) orders in AV_3Sb_5 (A = K, Rb, Cs) family of materials[5-8] have provoked intensive research interest. A cascade of symmetry-breaking electronic orders have been discovered, such as charge order[6,7], chiral flux phase[9], stripe order[10], nematic order[11,12], superconductivity[6,13,14]. Understanding and revealing the nature of these orders and their interactions is currently a top priority in condensed matter physics in the community. The RV_6Sn_6 structure, specifically the bilayer kagome metals in the "166" family with *R* representing a rare earth element, provides a promising platform to explore Fermi surface instabilities of the kagome lattice. The electronic structure of RV_6Sn_6, akin to that of the sister compounds AV_3Sb_5, exhibits a complex phase diagram characterized by the coexistence of itinerant Dirac fermions, nontrivial flat bands, and van-Hove singularities in the vicinity of the Fermi level[15-17]. While the vanadium atoms that make up the kagome layers in RV_6Sn_6 are non-magnetic, the choosing rare earth element *R* allows for selective tuning of magnetism. ScV_6Sn_6 stands out from other kagome metals in the RV_6Sn_6 family due to its manifestation of a three-dimensional CDW state with a different wave vector Q*=(1/3, 1/3, 1/3) below $T_{CDW} \approx$ 92 K, similar to the bulk CDW phase observed in AV_3Sb_5 [18]. However, little is currently known about the origin and spectroscopic characteristics of the charge order in ScV_6Sn_6, making it an area of high interest for researchers. Here, we plan to utilize ARPES to examine the alterations in electronic structure that arise due to the presence of the CDW order in ScV_6Sn_6, e.g., the observations of CDW gap and band reconstruction.

2 Experiment

Using the small-spot ARPES system at PF BL-28A, we successfully distinguished two different cleavage planes of ScV_6Sn_6 through core-level analysis. We systematically tested their electronic structures using 80 eV photon energy. As shown in Fig. 1, the band quality is very high, providing a solid foundation for our subsequent tests and analysis.

3 Results and Discussion

We performed ARPES measurements on ScV_6Sn_6 at 20K. As shown in Fig. 1, we can distinguish different cleavage planes and kagome band features. However, it is noteworthy that our ARPES experiments did not observe band folding due to CDW, similar to what is seen in CsV_3Sb_5. This prompts us to reconsider the CDW mechanism in ScV_6Sn_6.

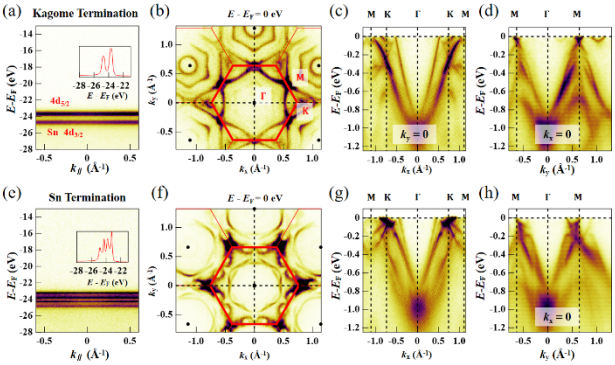

Fig. 1: The ARPES spectra of ScV_6Sn_6. (a-d) Kagome termination. (e-h) Sn termination.

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