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Topologically entangled Rashba-split Shockley states on the surface of grey arsenic PENG ZHANG, YUKIAKI ISHIDA, Institute for Solid State Physics, University of Tokyo, JUNZHANG MA, LINGXIAO ZHAO, QIUNAN XU, BAIQING LV, GENFU CHEN, HONGMING WENG, XI DAI, ZHONG FANG, Institute of Physics, Chinese Academy of Sciences, KOICHIRO YAJI, Institute for Solid State Physics, University of Tokyo, XINGQIU CHEN, Institute of Metal Research, Chinese Academy of Sciences, LIANG FU, Department of Physics, Massachusetts Institute of Technology, TIAN QIAN, HONG DING, Institute of Physics, Chinese Academy of Sciences, SHIK SHIN, Institute for Solid State Physics, University of Tokyo — Topological surface states (SSs) and Shockley SSs are two kinds of typical SSs. The relationship between them has been theoretically proposed while convincing experimental evidence is still absent. Here we discover a pair of spin-polarized surface bands on the (111) face of grey arsenic by using angle-resolved photoemission spectroscopy (ARPES). In the occupied side, the pair resembles typical nearly-free-electron Shockley states observed on noble-metal surfaces. However, pump-probe ARPES reveals that the spin-polarized pair traverses the bulk band gap and that the crossing of the pair at Γ is topologically unavoidable. First-principles calculations well reproduce the bands and their non-trivial topology; it also supports that the surface states are of Shockley type because they arise from a band inversion caused by crystal field. The results provide compelling evidence that topological Shockley states are realized on As(111).

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