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Controlling Dirac–Rashba and Double Dirac Surface States in Topological Crystalline Insulator via Ultrathin Transition Metal Layers

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The band structure at the topological insulator/magnetic metal (TI/MM) interface is of great significance for realizing exotic spin-dependent phenomena and advanced spin–orbitronic devices. To investigate this interface, we employ a model system consisting of submonolayer transition metal (TM) adsorbates on the surface of a topological crystalline insulator (TCI) and examine it using the angle-resolved photoemission spectroscopy (ARPES). On the polar (111) surface, we observe the coexistence of topological surface states (TSS) and Rashba-split surface states (RSS), the latter induced by the combined effects of inversion-symmetry breaking, potential gradient, and orbital angular momentum. Our investigations demonstrate that the Rashba parameter (α_R) can be tuned over a remarkably wide range of 0 to 3.5 $eV \cdot$
$mathringA$, depending on the type and coverage of the TM adatoms. In contrast, the nonpolar (001) surface preserves inversion symmetry, and hence no Rashba-split states emerge. Instead, surface charge imbalance induces dephasing of the wavefunctions associated with the double Dirac cones, thereby diminishing the momentum-space separation between them. These findings shed light on novel phenomena occurring at the TI/MM interface, offering a versatile platform for future spintronic and quantum devices.

Type of presence

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