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Tuning the hexagonal warping of topological surface states in Rare-Earth surface doped magnetic topological insulators

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Topological insulators (TIs) are materials of particular interest because of their exceptional features stemming from their conducting, topologically protected surface states. The combination of topological properties and magnetic order can lead to new quantum states of matter as the quantum anomalous Hall effect (QAHE) [1]. Recent discoveries as the first antiferromagnetic topological insulator MnBi2Te4 [2] have opened a new perspective for realising these quantized topological effects in intrinsically magnetic stoichiometric compounds. However, such system has a complex seven-layer structure that heavily depends on sophisticated and complex growth methods, resulting in variations in the density of structural defects that can lead to drastic changes, as the opening or not of an intrinsic magnetic gap at the Dirac point [3]. As an alternative strategy, ***we explore the effects of Rare Earth (RE) elements as surface dopants on TI substrates***, investigating their magnetic properties and their influence on the topological surface state (TSS). In principle, RE large magnetic moments could be relevant in order to maximize an eventually magnetically induced gap which would host the spin-polarized currents. Additionally, RE magnetic moments large size can also inhibit substitutional sites, reducing the multiplicity of adsorption configurations. Particularly, we report a study on, in the first place, the magnetic anisotropy of RE (Er and Dy) single atoms on Bi2Te3, which has been investigated by X-Ray Magnetic Circular Dichroism (XMCD). Then, by means of Angle Resolved Photoemission Spectroscopy (ARPES) measurements the effects of the RE surface dopants on the TSS have been explored. More precisely, the deposition of Er and Dy on Bi2Te3 and Bi2Se2Te substrates has been analyzed, reflecting how it is directly affecting the TSS of these TIs. Especially relevant are the changes induced in the Fermi surface (FS) of the different systems investigated, noticeably affecting the hexagonal warping (see attached Figure), which is an indirect indication that RE magnetic impurities can significantly act on the spin texture of the TSS, reducing out-of-plane spin component and possible scattering channels derived from the hexagonal warping [4]. This study has been carried out entirely at the ALBA synchrotron, at BOREAS (XMCD measurements) and LOREA (ARPES) beamlines.

Figure: FS evolution of Bi2Te3 single crystal (left) with 10% of Er coverage (right).

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