Large area MOCVD growth of Bi_2Te_3 on top of Sb_2Te_3 to shift the Fermi level close to the Dirac point

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Topological insulators (TIs) are attracting high interest for applications based on spin-charge interconversion mechanisms [1]. We have recently demonstrated the topological character of Sb_2Te_3 and Bi_2Te_3 TIs, as grown on top of 4'' Si(111) by Metal Organic Chemical Vapour Deposition (MOCVD) [2]. In particular, the existence of topological surface states (TSS) has been demonstrated on the basis of angle-resolved photoemission spectroscopy (ARPES) and magnetoelectrical measurements [2]. On the other hand, especially in the case of Bi_2Te_3, a relevant contribution from bulk states (BS) is still present at the Fermi level, which largely affects the overall electrical conduction of the TI. As reported in Refs. [3,4], the position of the Fermi level could be manipulated by growing heterostructures made of Sb_2Te_3 and Bi_2Te_3. With the aim of exploring such a possibility, we performed the MOCVD growth of Bi_2Te_3 on top of Sb_2Te_3, and the comparison of the surface band structures in Si/Bi_2Te_3 and Si/Sb_2Te_3/Bi_2Te_3, as imaged by ARPES, is displayed in Figure 1. Clearly, the Fermi level in the Sb_2Te_3/Bi_2Te_3 heterostructures shifts towards the valence band, Figure 1(b), thus not showing the relevant contribution from the BS, as in the single Bi_2Te_3 layer, Figure 1(a). In this work, we will report how such a Fermi-level engineering is reflected in the (magneto)transport properties of the Sb_2Te_3/Bi_2Te_3 heterostructure, by following the same methodology previously employed to analyze single TI layers, within the Hikami-Larkin-Nagaoka model [2]. In particular, we measured an $\alpha = -0.5$, which indicates the existence of an "ideal" TSS completely decoupled from the BS. We will also report on the first attempts in integrating ferromagnetic layers on top of Sb_2Te_3/Bi_2Te_3 heterostructures, with the aim of exploiting their TSS for spin-charge interconversion.

References

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Figures

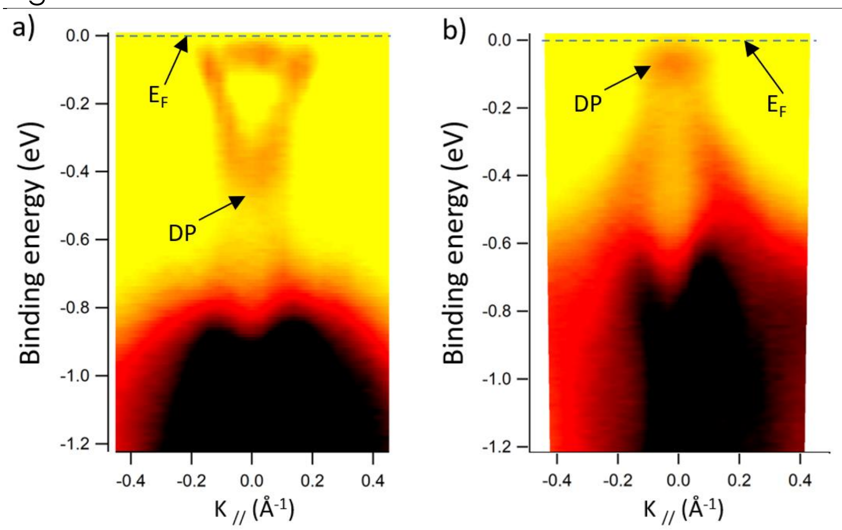

Figure 1: Comparison of the band structures observed by ARPES at the surface of (a) Si/Bi_2Te_3 and (b) Si/Sb_2Te_3/Bi_2Te_3.