Quantum Oscillations of the Rashba Spin-splitting Compound BiTeI

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Introduction

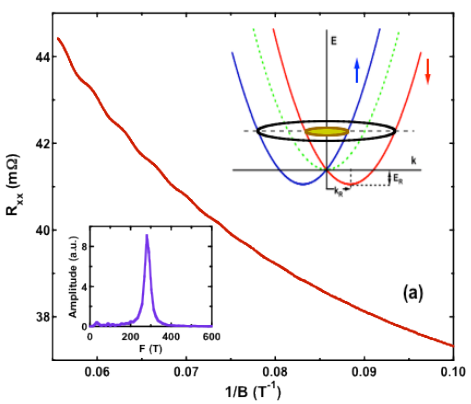
BiTeI has attracted considerable interest over the past year due the observation of a large Rashba spin-splitting of the electronic bands. Another particularity of this compound is that the effect has been, at least initially, proposed to be purely bulk in nature [1]. Recent photoemission (ARPES) experiments indicate possible charge accumulation at the terminated layer that give rise to a surface electron system distinct from the bulk. Given the particular sensitivity of the ARPES technique to the surface, we proposed an investigation of the Fermi surface through Shubnikov-de Haas (SdH) oscillations.

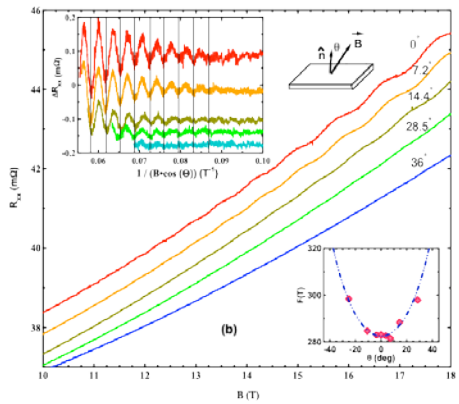
Experimental

Single crystals of BiTeI were grown by chemical vapor transport and Bridgman methods. Two samples were initially screened and both revealed very similar quantum oscillations. Then, a complete study was performed on one sample with approximate dimensions $4\times6\times0.09$ mm^3. Gold wires were attached using silver paint and sample resistance was measured using a commercial resistance bridge. The experiment was performed at the SCM-2 facility of the National High Magnetic Field Laboratory in Tallahassee.

Results and Discussion

Clear quantum oscillations were observed at high magnetic field in both longitudinal and Hall resistance. For a Rashba-split conduction band, two oscillation frequencies are expected, corresponding to the inner (IFS) and outer Fermi surface (OFS), respectively, as illustrated in the upper inset of **Figure 1(a)**. We observed only one frequency (lower inset of **Figure 1(b)**), most likely from the OFS and this suggests that the chemical potential is located below the crossing point for the two bands.





Angle dependence is shown in **Figure 1 (b)**. Oscillations scale very well with the normal component of the field (upper inset of **Figure 1 (b)**), their amplitude is strongly suppressed with tilting magnetic field (main panel **Fig. 1 (b)**) and their frequency follows a cos(θ) function (lower inset of **Figure 1 (b)**). These are strong indications of a highly 2D Fermi surface, very possibly originating from surface carriers.

Conclusions

We successfully resolved quantum oscillations in the Rashba spin-splitting compound BiTeI and found that they are rather indicative of a surface electron system accumulated at the top layer. Combining with optical spectroscopy, we fully resolve the electronic properties of both surface and bulk carriers [2].

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References

[1] Ishizaka, K. *et al*., Nature Materials, 10, 521 (2011).
[2] Martin, C., *et al*., arxiv: 1208.5523 (2012).