ADDING MAGNETISM TO $(Bi_2)(Bi_2Te_3)$ MULTILAYERS

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INTRODUCTION

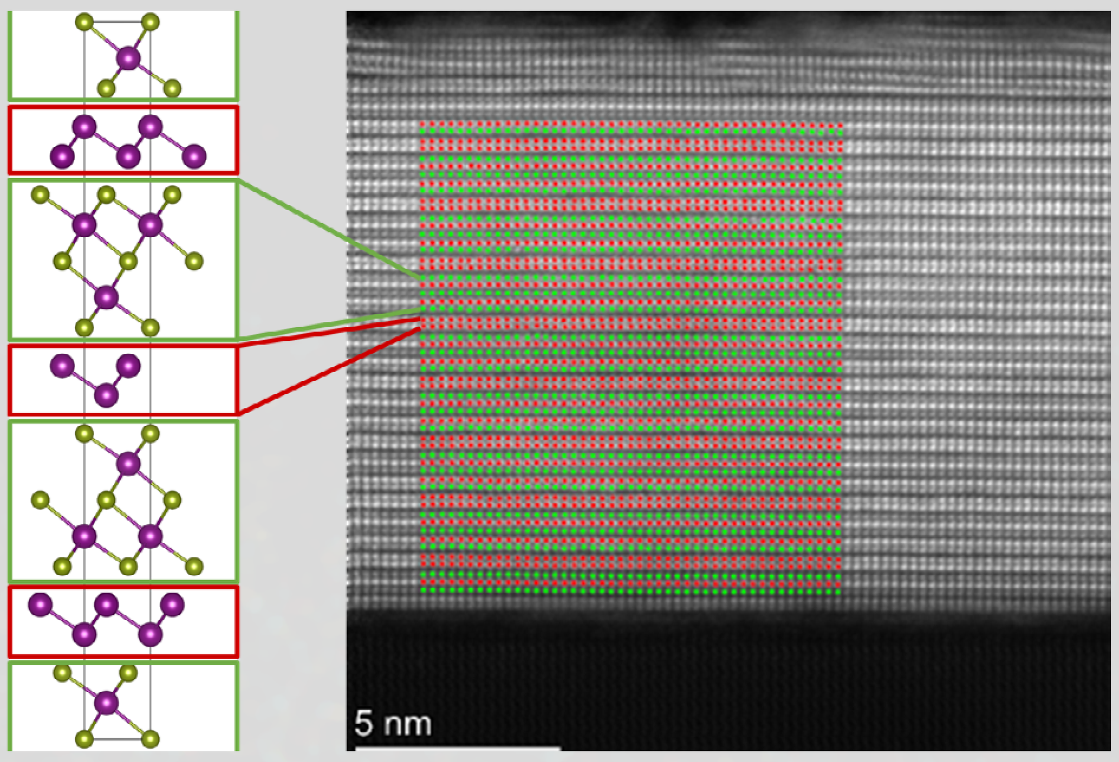
The addition of magnetism to topological insulators (TIs) by means of doping is a proven technique to establish the quantum anomalous Hall effect (QAHE)[1,2]. Magnetism breaks the time-reversal symmetry of a topological insulator resulting in an exchange gap with edge states. For the QAHE intrinsic magnetism within the sample is required instead of an external magnetic field like with the normal quantum Hall effect.

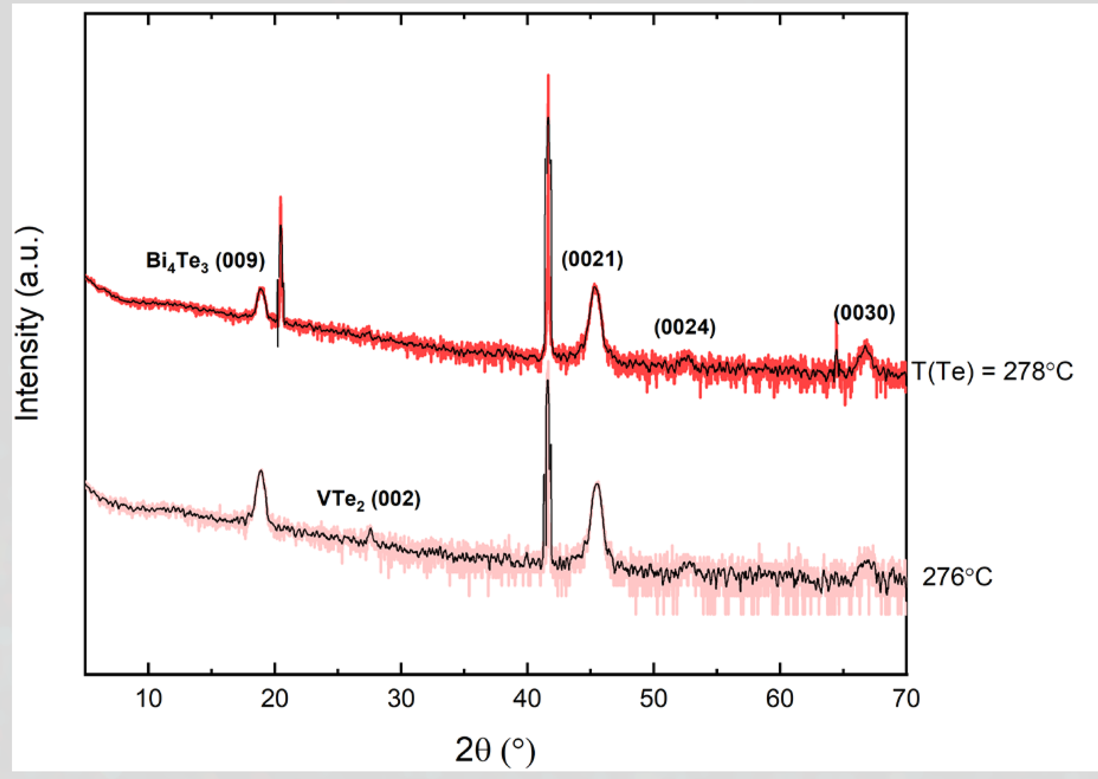
STRUCTURE

$(Bi_2)(Bi_2Te_3)$ multilayers are structured as a periodic stacking of Bi_2Te_3 (QL) and Bi_2 (BL) layers in a 1:1 ratio and is also known as Bi_4Te_3. The layers are separated by a Van der Waals-gap. Here, we present results on Bi_4Te_3 thin films deposited on Al_2O_3 substrates by molecular beam epitaxy (MBE). During the deposition the Bi:Te ratio is of critical importance to synthesise Bi_4Te_3. In addition, vanadium is added as a magnetic dopant during the deposition.

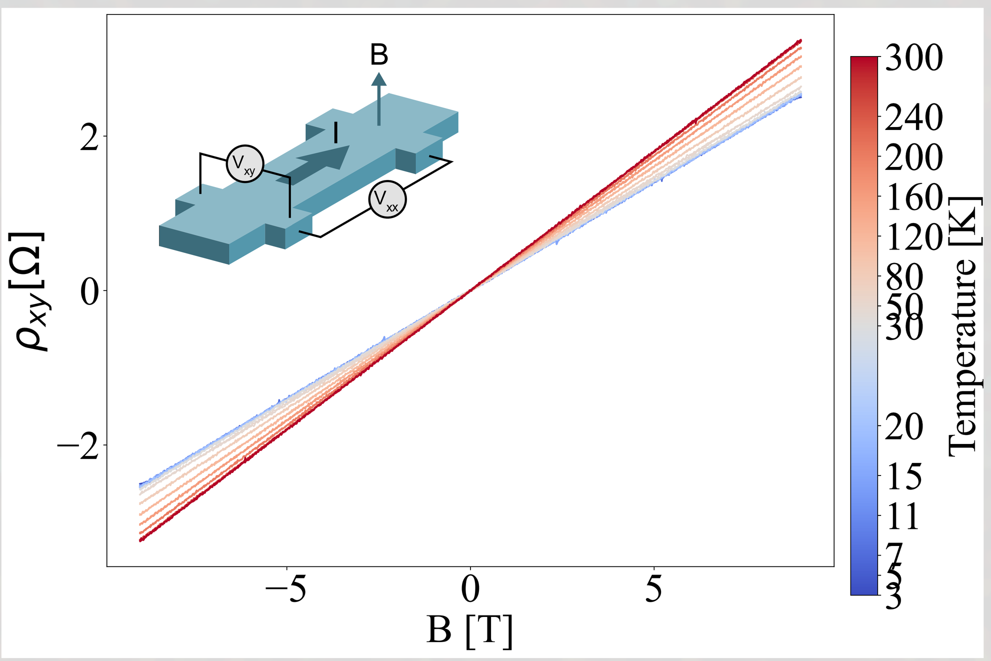
Bi_4Te_3 | $V\text{-}Bi_4Te_3$

CRYSTAL



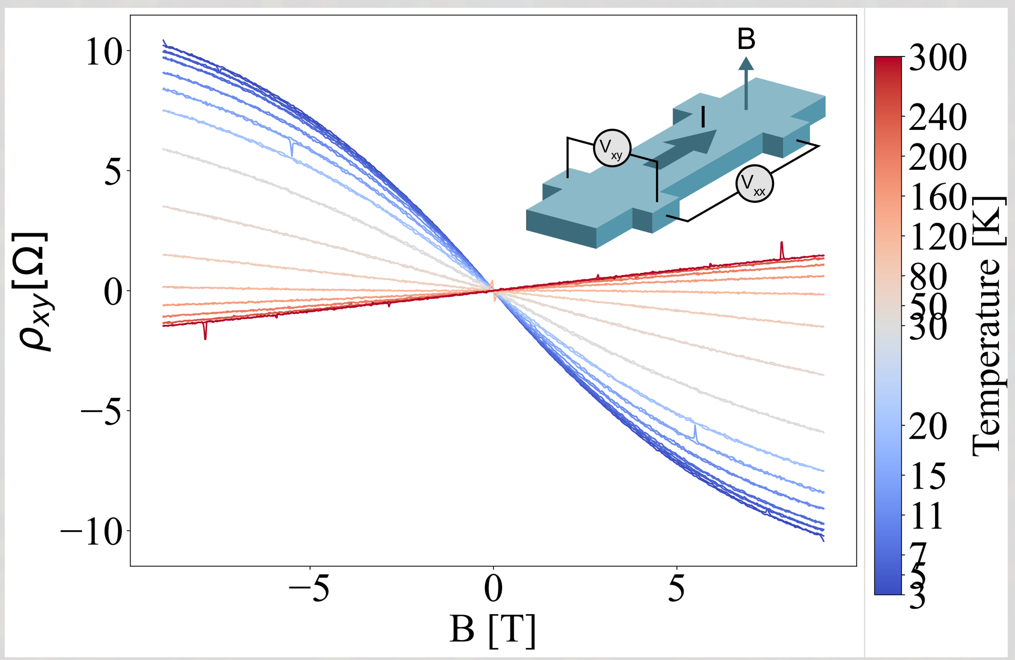


MAGNETOTRANSPORT



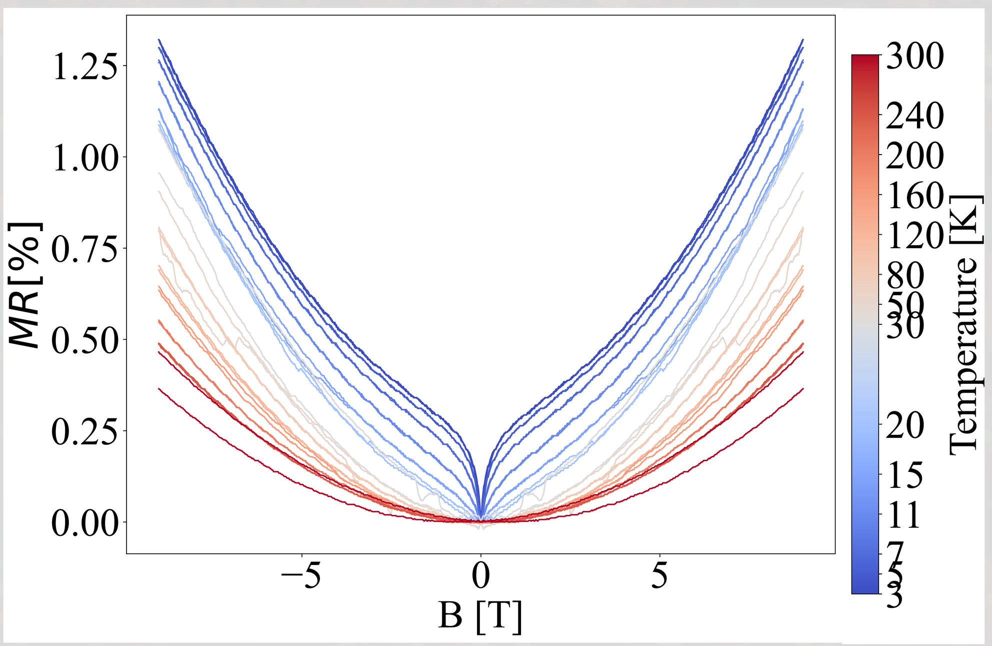
Hall resistivity shows:

- Electron dominated single-band transport.
- Carrier density ~10^{15} cm^{-2} indicating metallic behaviour. Decreases with increasing temperature.



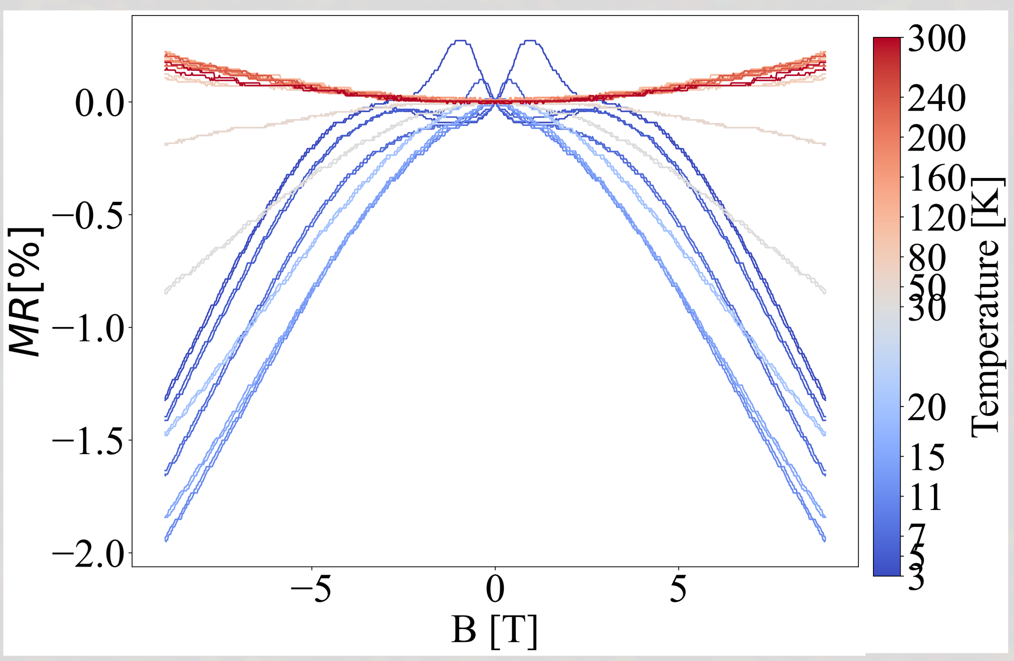
Hall resisitivity shows:

- T < 120 K hole-dominated two-band transport.
- T > 120 K electron-dominated single-band transport.
- Carrier density ~10^{16} cm^{-2} at 300 K.
- No magnetic hysteresis.



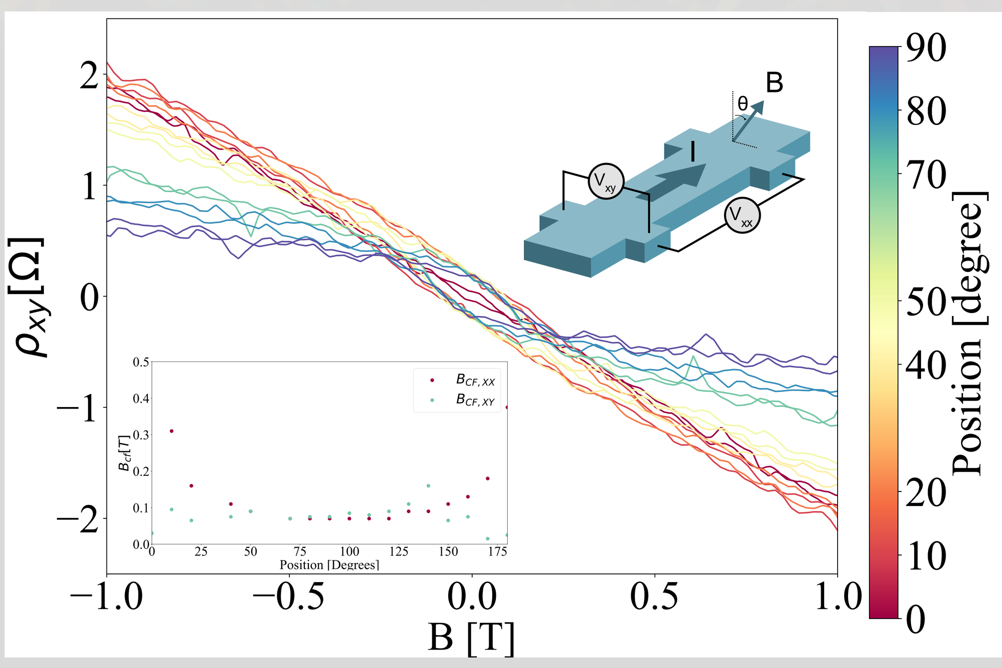
MR shows:

- Weak anti-localization up to 20 K.
- At 3 K, the HLN fit results in α = -0.48 and L_{phi} = 175 nm. α indicates effectively a single-surface channel.

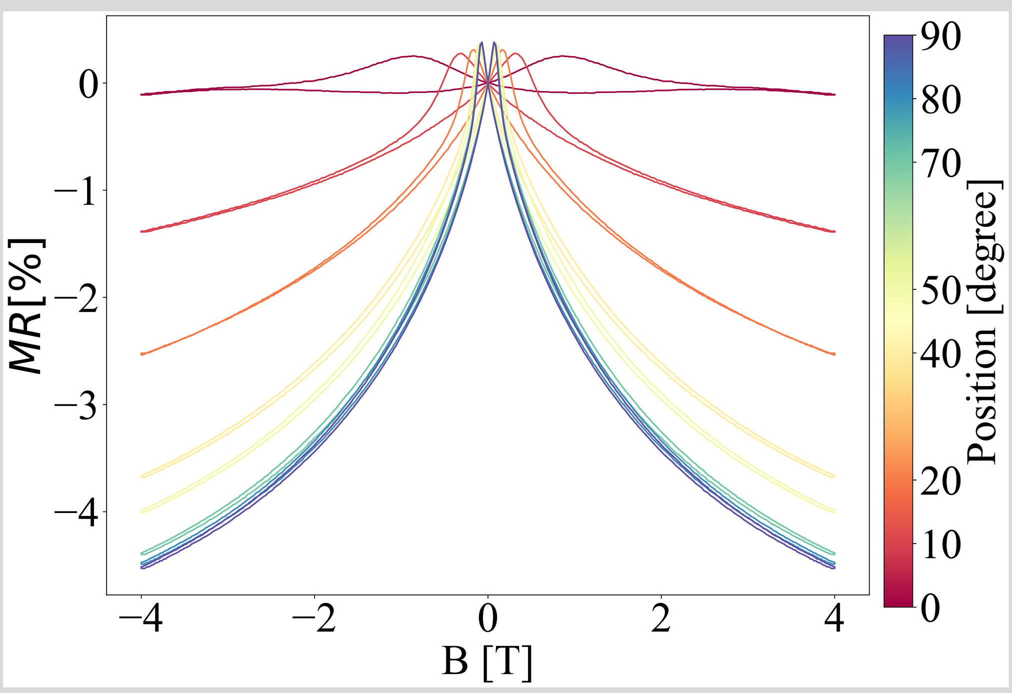


MR shows:

- Hysteresis up to 7 K between up- and downsweep.
- Switch from negative to positive MR between 50 K and 80 K.



For a varying direction of the B-field, an hysteresis appears in the Hall resistivity as well.



Hysteresis is a stong indictaion for succesfully added magnetism!

CONCLUSION

(V-doped) Bi_4Te_3 samples were succesfully deposited by MBE. The WAL in Bi_4Te_3 typically related to topological insulating state, which is consisted with theoretical predications [3]. The high-carrier density indcates a significant bulk contribution in the transport.

Magnetism is accomplished by V-doping in Bi_4Te_3 as indicated by the measured hysteresis between the up- and downsweep. The measured hysteresis as a function of the orientation of the magnetic field has a strong indication for an in-plane easy axis. Further research is needed to understand the observed magnetism.

REFERENCES

[1] C.-Z. Chang *et al.*, Science **340**, 6129 (2013)
[2] C.-Z. Chang *et al.*, Nat. Mater. **14**, 473-477 (2015)
[3] D. Nabok *et al.*, Phys. Rev. Mat. **6**, 034204 (2022)