

NMR evidence for an antisite-induced magnetic moment on Bi in a topological insulator heterostructure $\text{MnBi}_2\text{Te}_4/(\text{Bi}_2\text{Te}_3)_n$

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Intrinsic magnetic topological insulators have recently attracted a tremendous research interest due to the interesting physical phenomena such as quantum anomalous Hall effect. One of the most promising platforms for exploring this elusive quantum effect is the MnBi_2Te_4 (MBT) system, grown in a self-organized layered structure of the van der Waals type $\text{MnBi}_2\text{Te}_4/(\text{Bi}_2\text{Te}_3)_n$ [1]. This compound is composed of seven atomic layers: Te-Bi-Te-Mn-Te-Bi-Te bonded by the van der Waals interaction to the quintuple layers composed of the Bi_2Te_3 (BT) blocks. Neutron diffraction studies report that the Mn atoms within a single Mn layer are ferromagnetically ordered along the axis perpendicular to the Mn plane, but macroscopically the entire system behaves as an A-type antiferromagnet with $T_N=24$ K [2]. A structural compatibility with the nonmagnetic Bi_2Te_3 parent compound gives a possibility to create MBT/BT heterostructures and manipulate their magnetic state in view of optimizing the Quantum Anomalous Hall Effect (QAHE). In this work an extensive NMR study, supported by the bulk magnetization measurements has been performed at 4.2 K on a self-organized single crystal $\text{MnBi}_2\text{Te}_4/(\text{Bi}_2\text{Te}_3)_n$ heterostructure, obtained from the $\text{Mn}_{0.81}\text{Bi}_{2.06}\text{Te}_{4.13}$ melt. ^{55}Mn and ^{209}Bi NMR signals have been recorded as a function of the out-of-plane magnetic field up to 6 T, covering a spin-flop transition (around 3 T) from the antiferromagnetic (AFM) to the canted antiferromagnetic (CAFM) configuration of the Mn layers. Structural defects were shown to contribute a small ferromagnetic component below the spin-flop field. Presence of the AFM-coupled Mn antisites has been evidenced and shown to induce an antiparallel magnetic moment on Bi atoms within the host Bi layer. Detection of the induced magnetic moment on bismuth which contributes a new ferromagnetic component is of utmost importance for understanding the magnetic interactions in the MBT/BT system. Moreover these findings shed new light on local magnetic behaviour of the MBT system beyond spin-flop field in addition to those presented in [3] and have potentially important implications for engineering the QAH devices.

References:

- [1] M. M. Otrokov et al. Nature 576, 416 (2019)
- [2] J.-Q. Yan et al. Phys. Rev. Mater. 3, 064202 (2019)
- [3] M. Sahoo et al. Adv. Sci. 11, 2402753 (2024)