Tuning the Curie Temperature of a 2D Magnet/Topological Insulator Heterostructure to Above Room Temperature by Epitaxial Growth

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Heterostructures of two-dimensional (2D) van der Waals (vdW) magnets and topological insulators (TI) are of substantial interest as candidate materials for efficient spin-torque switching, quantum anomalous Hall effect, and chiral spin textures. However, since many of the vdW magnets have Curie temperatures below room temperature, we want to understand how materials can be modified to stabilize their magnetic ordering to higher temperatures. In this work, we utilize molecular beam epitaxy to systematically tune the Curie temperature (T_C) in thin film Fe_3GeTe_2/Bi_2Te_3 from bulk-like values (~220 K) to above room temperature by increasing the growth temperature from 300 °C to 375 °C (Figure 1). For samples grown at 375 °C, cross-sectional scanning transmission electron microscopy (STEM) reveals the spontaneous formation of different $Fe_mGe_nTe_2$ compositions (e.g. $Fe_5Ge_2Te_2$ and $Fe_7Ge_6Te_2$) as well as intercalation in the vdW gaps, which are possible origins of the enhanced Curie temperature. This observation paves the way for developing various $Fe_mGe_nTe_2$/TI heterostructures with novel properties.

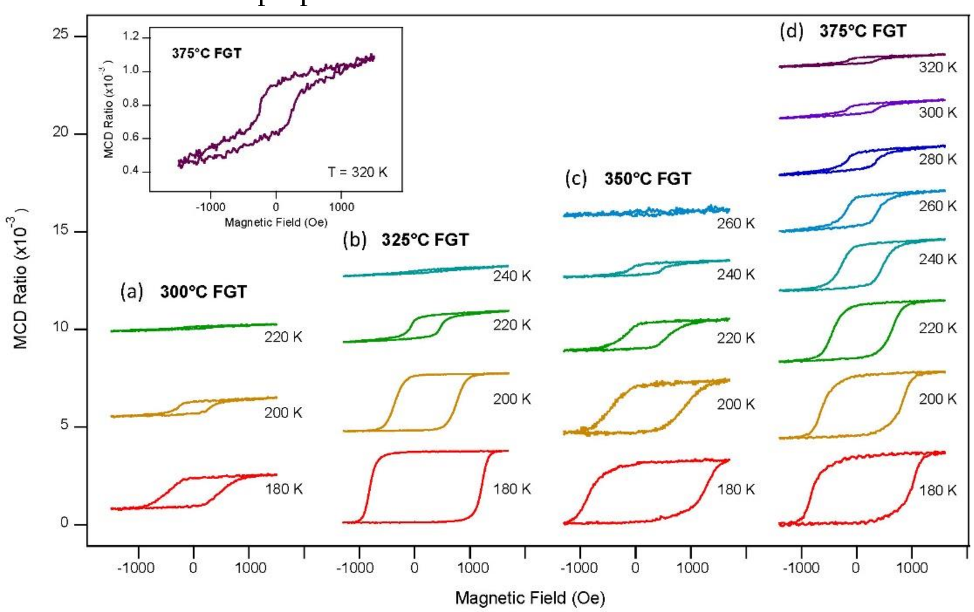
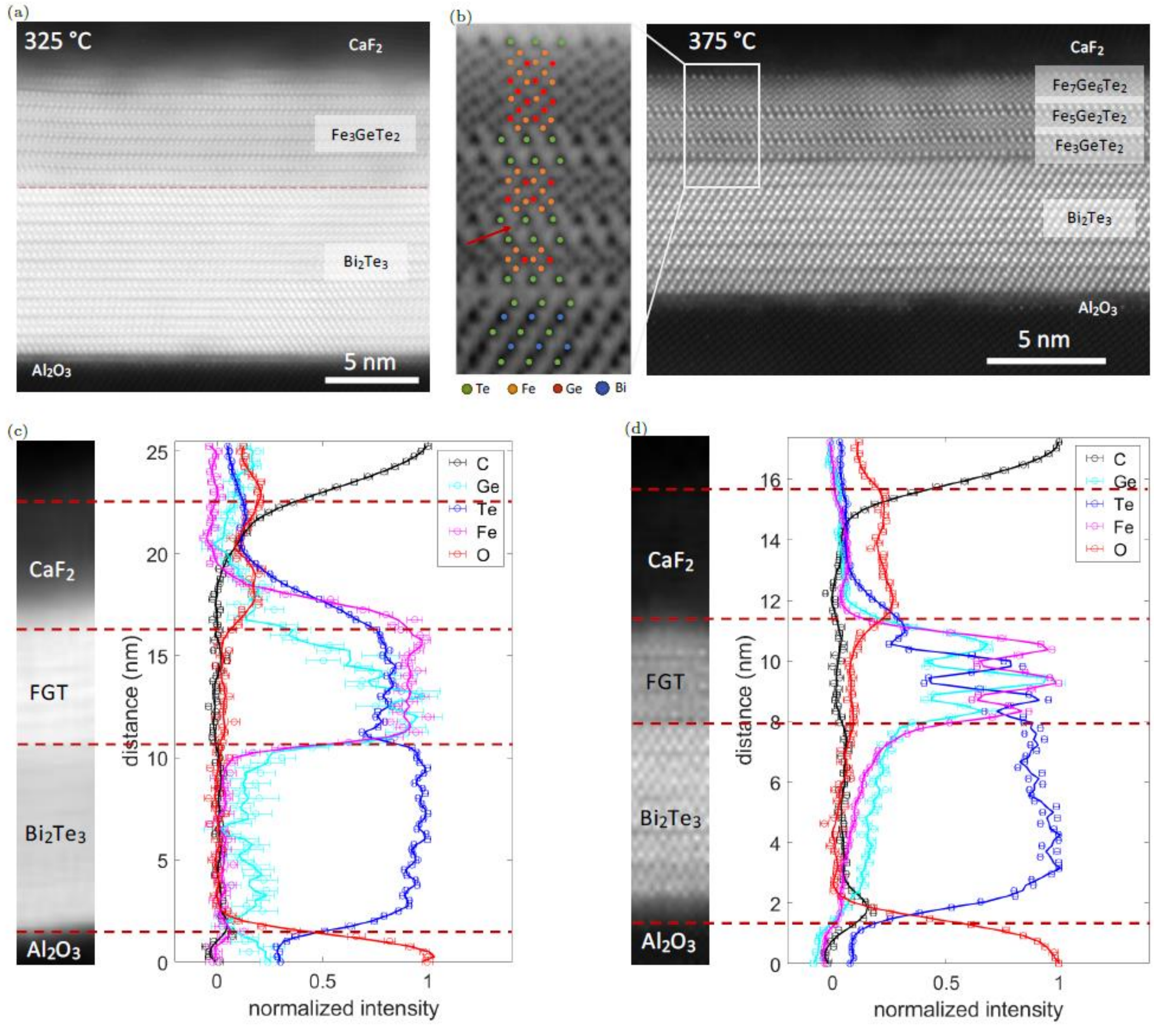


Figure 1. Temperature dependence of MCD loops for FGT samples (~ 4 nm) grown at 300 °C, 325 °C, 350 °C, and 375 °C on Bi_2Te_3.

Supplementary Pages



Supplementary Figure. STEM investigations. (a) HAADF STEM image of an FGT(6.4nm)/Bi_2Te_3(10 nm) heterostructure grown at 325 °C (for FGT). (b) HAADF STEM image of an FGT(4 nm)/Bi_2Te_3(8 nm) heterostructure grown at 375 °C (for FGT) and a zoomed in BF STEM image with different atoms marked out in the left. The red arrow indicates the position of an intercalant atom. (c) EELS line profile of the FGT(6.4 nm)/Bi_2Te_3(10 nm) heterostructure grown at 325 °C (for FGT) with the corresponding HAADF image on the left. (d) EELS line profile of the FGT(4 nm)/Bi_2Te_3(8 nm) heterostructure grown at 375 °C (for FGT) with the corresponding HAADF image on the left.