Quasi Van der Waals Epitaxy of Magnetic Topological Insulators on a GaAs (111) Substrate

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Magnetic topological insulator could achieve quantum anomalous Hall (QAH) effect and spin-orbit torque (SOT) switching in the same structure. This is promising for its future applications in memory or switching with its robust surface properties by topological protection. Considering the van der Waals nature of the epitaxial layers, it has very weak van der Waals bonding with the substrate. This gives rise to a novel quasi Van der Waals epitaxial growth mode at the interface of GaAs (111) substrates and the epitaxial layers, which has the advantages of both good crystallinity from substrate confinement, and a less influence from defects and roughness on the substrate surfaces. This is very crucial for achieving the quantization regime.

In this work we have done hetero-epitaxy of Cr:$(Bi_xSb_{1-x})_2Te_3$ and other magnetic topological insulators on GaAs (111) substrates by MBE (Molecular Beam Epitaxy). Unlike the pure Van der Waals epitaxy which has more freedom at the interfaces epitaxial layer and substrates, we found out that in this quasi Van der Waals growth mode, strain exist and relaxes quickly within the 1st epitaxial layer. While the surface defects quickly get screened within the 1st layer, the surface confinement also gives the epitaxial layer a uniform in-plane orientation which is important for achieving a single crystalline structure. Growth mechanism and the influence on its transport properties are also discussed.

Figure 1. qvdWE of Cr: $(Bi_xSb_{1-x})_2Te_3$ (CBST) on GaAs (111)

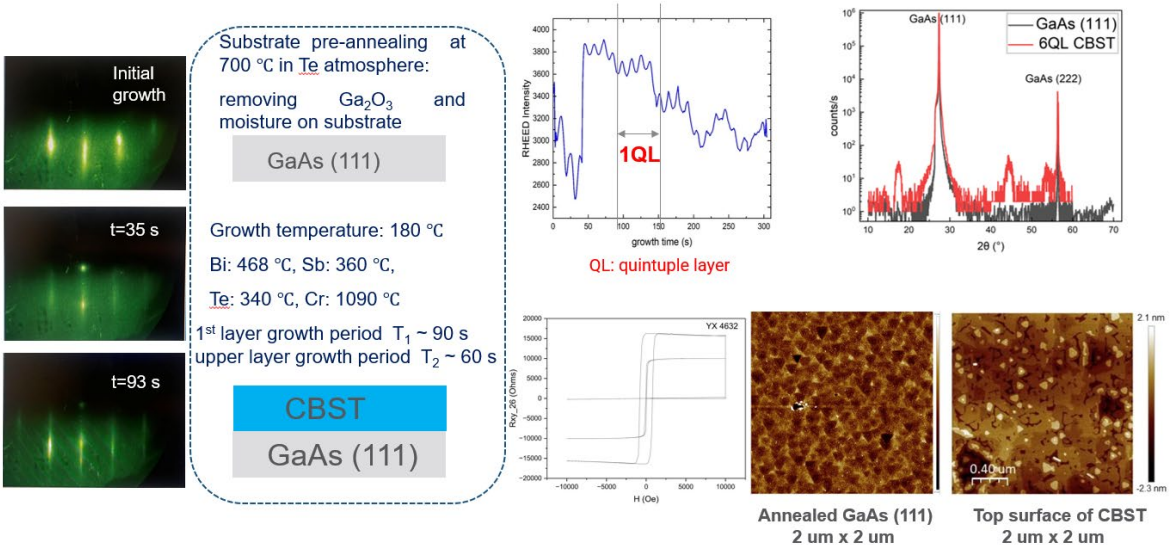
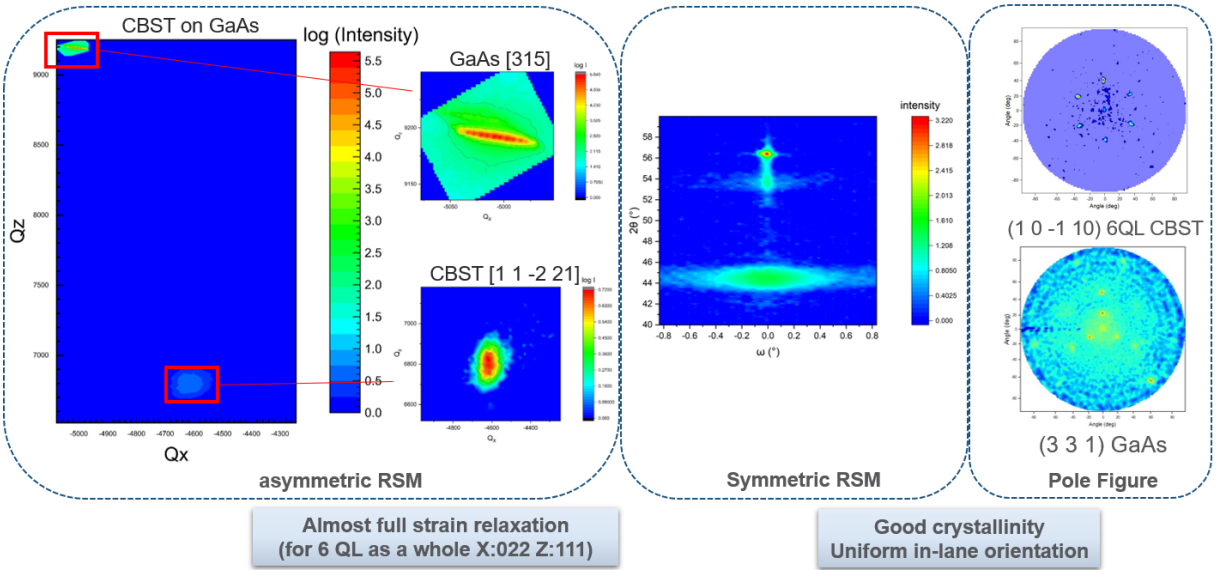


Figure 2. Reciprocal Space Mapping (RSM) for 6 QL CBST on GaAs (111)



[1] Alaskar Y, Arafin S, Martinez-Velis I, Wang KL. Heteroepitaxial growth of III–V semiconductors on 2D materials. Two-dimensional Materials-Synthesis, Characterization and Potential Applications. 2016 Aug 31

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