UCLA Samueli School of Engineering

Phases Control on Epitaxial MnTe through Buffer Layers

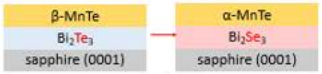
Yuxing Ren[1,3], Hanshen Huang [2,3], Lixuan Tai [2,3], Tao Qu [2,3], Kang L. Wang[1,2,3]

1. Department of Materials Science and Engineering, 2. Department of Electrical and Computer Engineering, 3. Device Research Laboratory. University of California, Los Angeles

Introduction

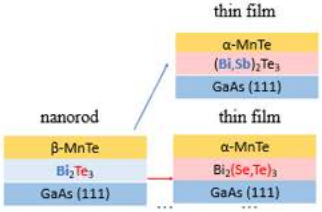
MnTe is one of the 3D semiconductors that can exhibit anomalous Hall effect. The potential edge states correlated with the alter-magnet properties in the α-phase MnTe is also under study these days. The epitaxial growth becomes one method to tune the electronic structure. In this work we have grown both α-phase and β-phase MnTe by Molecular Beam Epitaxy on GaAs (111) and sapphire (0001) substrates with different buffer layers. Meanwhile, both thin film and nanorod MnTe single crystals are grown.

1. By simply replacing Bi_2Te_3 buffer by Bi_2Se_3 we can control different phases of MnTe



Lattice constant from buffer layers influences MnTe phases, and can be used to grow the energy unfavorable one (in bulk) in the form of thin film.

2. By adding more elements into buffer layer we can also control phases grown, despite the species of element added



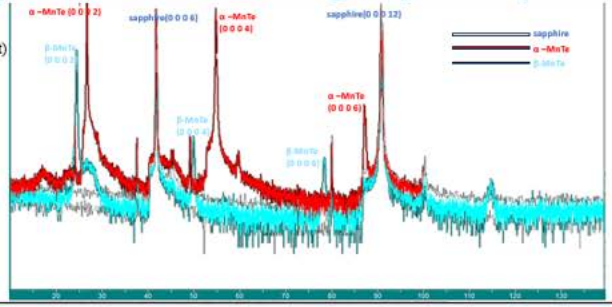
This shows the influence not only from lattice constant in case 1, but also from entropy effect, remote potential, or surface energy.

Summary on buffers & substrates control

buffer	on GaAs	on sapphire
$(Bi,Sb)_2Te_3$	α	/
Bi_2Te_3	β β	β β β
Bi_2Se_3	/	α α
$CrSe_2$ CrSe	/	α α α
$CrSe_2/Bi_2Se_3$	/	α

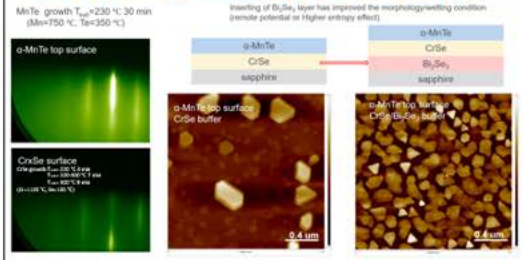
Atomic Force Microscope (AFM) and phases of MnTe samples grown on different buffers and substrates

X-ray Diffractions on MnTe single crystal samples



Result 1:

Improving wetting condition by double buffer layer



Result 2:

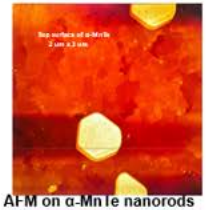
Phases control by changing buffer layer

1) α-phase MnTe is grown on Bi_2Se_3 /sapphire
   β-phase MnTe is grown on Bi_2Te_3/sapphire

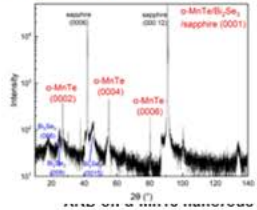
2) α-phase MnTe is grown on $(Bi,Sb)_2Te_3$/GaAs
   β-phase MnTe is grown on Bi_2Te_3/GaAs

Result 3:

Single crystalline α-MnTe nano-rods are grown: potential advantages in measuring MnTe edge states



AFM on α-MnTe nanorods



DRL Device Research Laboratory

UCLA Samueli School of Engineering

Yuxing Ren
Ph.D. candidate
404 Westwood Plaza, 310, Los Angeles, CA
Email: yxren@g.ucla.edu
Tel: 607-262-0094