Growth of Cd_3As_2 on GaAs[110] Substrates

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Cd_3As_2, a prototypical Dirac Semi-metal, provides an excellent platform for studying physics of topological materials. With a single band crossing that is well isolated from trivial bands and is near the intrinsic Ferm level, straightforward methods such as electrical measurements are viable options for studying these states in this material. Additionally, thin film growth methods have been extremely successful, including growth on III-V and II-VI substrates in [112] and [001] orientations. No effort to date has been reported on attempts at [110] oriented films, which could place the c-axis in-plane, allowing for measurements along it via lateral electrical measurements, and also introduce a new orientation for measurements such as ARPES to probe.

Here, Cd_3As_2 films are grown with MBE on GaAs[110] substrates using similar II-VI buffer structures as other reports on [111] and [001] oriented GaAs substrates. A thin layer of Zn_3As_2 is inserted between III-V and II-VI layers to remove tilting of layers which was observed in X-ray diffraction. Unlike previous efforts [1], no substrate miscut or lattice-matched layers are required to obtain mobilities above 10,000 cm^2/V-s. While out of plane lattice constants are consistent with [110] oriented films, transmission electron microscopy reveal 2 domains of c-axis orientation, consistent with either a-axis orienting in-plane. Despite these domains, no difference is observed in electron mobility parallel or perpendicular to these domains, however a large difference in the fractional magnetoresistance is observed. This difference can be explained by differences in defect spacings along these directions and using the guiding center of diffusion model. Possible routes toward single domain films will also be discussed.

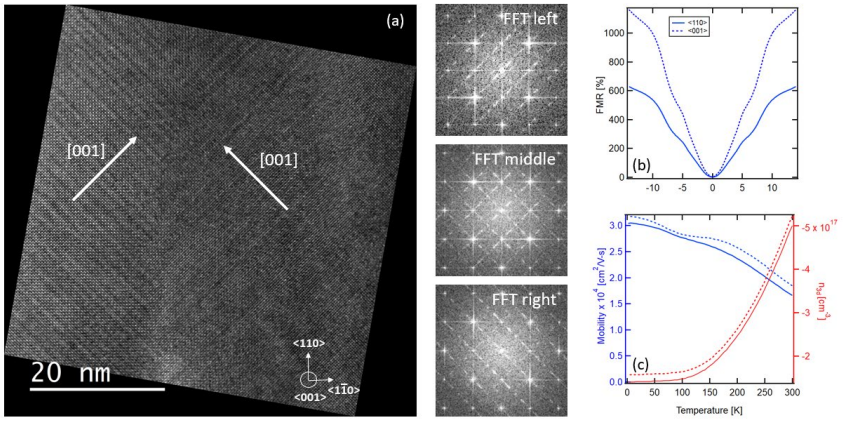

Figure 1. (a) TEM of Cd_3As_2 taken along GaAs[001] zone axis , along with fast Fourier transforms taken in different domains (b) Fractional magnetoresistance of films taken along [001] and [110] substrate directions (c) low field electron mobility and concernation taken along these directions

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[1] A. D. Rice, K. Park, E. T. Hughes, K. Mukherjee, and K. Alberi. *Phys. Rev. Materials* **3**, 121201(R)