Band-bending in Dirac Semi-metal/Semiconductor Interfaces

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Cd_3As_2 provides an excellent platform for studying the properties Dirac semi-metals. Electrically, it has a single band crossing well isolated from trivial bands, with an Fermi level that is intrinsically close to the Dirac point. Additionally, its similarity structurally and chemically with III-V and II-VI compounds allow for straightforward combination with semiconductors, creating pathways for high-quality epitaxial integration to utilize the unique properties of topological semimetals. Beyond their stand-alone properties, due to their vanishing density of states near Dirac points, large shifts in the Fermi level may occur from band-bending, creating possibilities for unique charge control at interfaces with implications for devices and even contact layers.

Here, Cd_3As_2/n-GaAs interfaces are first explored. Using molecular beam epitaxy, Cd_3As_2 layers are grown directly on GaAs. Depending on the doping, these Cd_3As_2 layers have a Fermi level 30-100 meV above the Dirac point. Using capacitance-voltage measurements, band alignments are calculated, suggesting a mid-gap alignment of the Dirac point. Due to the large dielectric constant of Cd_3As_2, most of the built-in voltage drop occurs in the n-GaAs layer, giving rise to a Schottky barrier. Attempts at forming rectifying barriers on p-GaAs have resulted in Ohmic junctions, suggesting band-bending in the Cd_3As_2 layer results in the near-interface region becoming p-type. Results with p-CdTe will also be discussed.

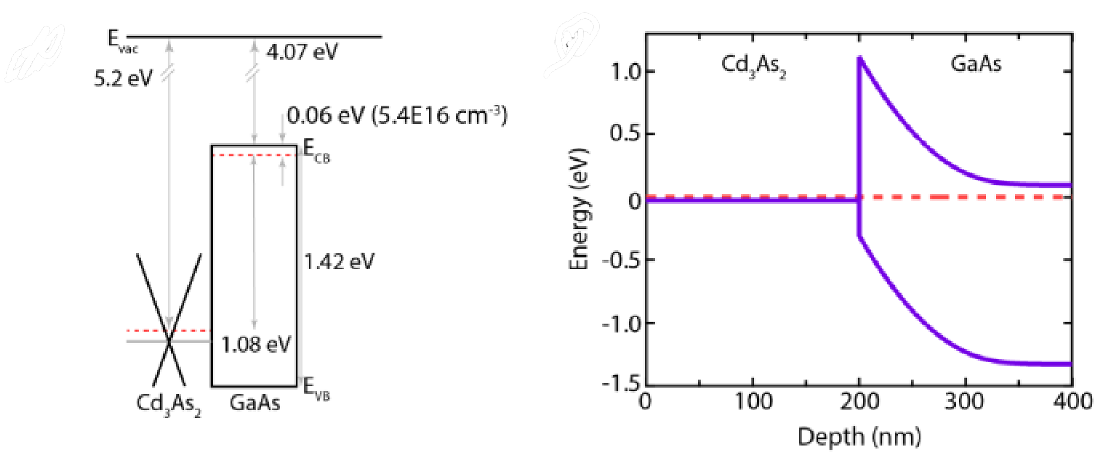

Figure 1. Measured band offset and calculated band bending in a Cd_3As_2/GaAs interface [1]

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