MBE growth of $Zn_xCd_{1-x}Te$ on Cd_3As_2

A.D. Rice,[1+] **K. Alberi**[1]
[1] *National Renewable Energy Lab, Golden, CO, USA.*

The Dirac semimetal Cd_3As_2 has become a scientifically useful material, as it provides access to a variety of interesting phenomena ranging from topological superconductivity to massless Dirac fermions. It is also potentially useful for energy-related applications due to its high electron mobility and large phonon-phonon scattering. While thin film growth has become an increasingly popular route of synthesis, there have been no reports of epitaxial growth on Cd_3As_2, limiting the ability to develop full heterostructures. One barrier to epitaxy on Cd_3As_2 is the high vapor pressure of Cd_3As_2 (1e-7 mbar at only 135° C), which is well below the ideal growth temperature of most semiconductors [1].

The $Zn_xCd_{1-x}Te$ (111) system provides one promising option for overgrowth given that it can be lattice matched to the (112) surface of Cd_3As_2 and has a relatively low optimal growth temperature (240-300° C). Reflective high-energy electron diffraction (RHEED) patterns of epilayers grown on Cd_3As_2 exhibit a (2x1) reconstruction, even with a growth interruption. These patterns are consistent with As-terminated CdTe observed following high temperature annealing under As [2]. CdTe epilayers growth at Cd_3As_2-compatible substrate temperatures (~120° C) are rough, but further growth at 240° C yields smoother surfaces, as seen in atomic force microscopy. X-ray diffraction confirms Cd_3As_2 remains following the higher temperature growth step, suggesting complete coverage is achieved. Higher temperature anneals under As further smooth and passivate this surface, while similar anneals under Te result in disappearance of a RHEED pattern and loss of the Cd_3As_2 layer. Introduction of moderate Zn content into CdTe results in complete surface coverage but also very large features, likely a result of very low Zn adatom mobility at these temperatures. Our results provide a starting point for incorporating Cd_3As_2 into a variety of device structures.

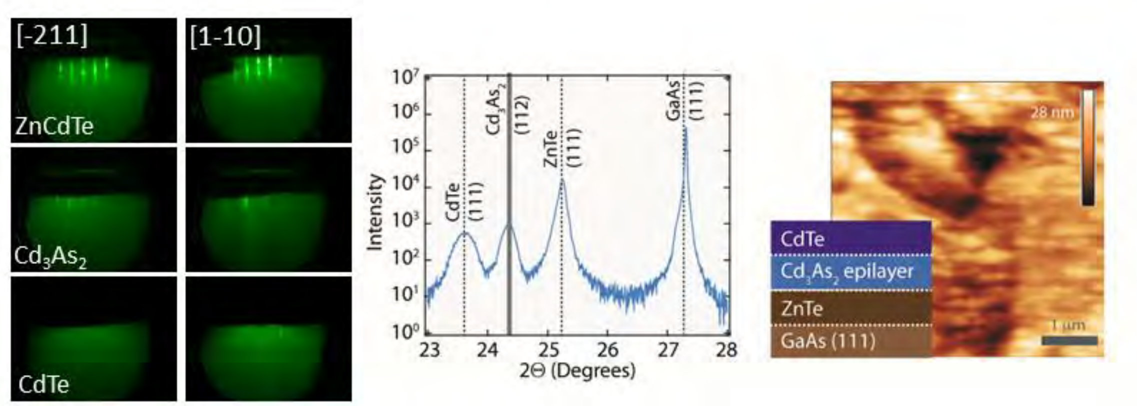

Figure 1. RHEED, XRD, and AFM of CdTe/Cd_3As_2 structures

+ Author for correspondence Anthony.Rice@nrel.gov
[1] V.J. Lyons and V.J. Silvestri, J. Phys. Chem. **64**, 2266 (1960)
[2] Y. Nakazawa, M. Uchida , S. Nishihaya, S. Sato, A. Nakao, J. Matsuno , and M. Kawasaki, APL Mater. **7**, 071109 (2019)