MBE Growth of $MoSe_2$/ MoS_2 Hetero Tri layer for Resonant Tunneling Device Applications

Kajal Sharma[1]

Abir Mukherjee[1], Manoj Kumar Kumawat[2], Rajendra Singh[2] and Samaresh Das[1]

[1] Centre for Applied Research in Electronics, Indian Institute of Technology Delhi,110016, India

[2] Dept. of Physics, Indian Institute of Technology Delhi, 110016, India

*** Contact Email: crz238145@care.iitd.ac.in**

Abstract: We report the molecular beam epitaxy (MBE) growth of bilayer $MoSe_2$ on wafer-scale monolayer MoS_2, forming a well-defined $MoSe_2$/MoS_2 van der Waals hetero trilayer. The monolayer MoS_2 film was synthesized via chemical vapor deposition (CVD), ensuring uniform large-area coverage for subsequent epitaxial growth. Optimisation of MBE growth parameters enables controlled bilayer $MoSe_2$ formation with high crystallinity and atomically sharp interfaces. The growth process was monitored in situ using reflection high-energy electron diffraction (RHEED), where intensity oscillations and diffraction patterns confirm a layer-by-layer growth mode and improved surface ordering. Post-growth characterisation using Raman spectroscopy reveals distinct vibrational modes corresponding to $MoSe_2$ and MoS_2, indicating successful heterostructure formation. X-ray photoelectron spectroscopy (XPS) confirms the chemical composition and stoichiometry, while atomic force microscopy (AFM) demonstrates uniform surface morphology with low roughness.The resulting $MoSe_2$/MoS_2 heterotrilayer provides a controlled platform for interlayer coupling and band engineering. A resonant tunnelling device fabricated using this heterostructure exhibits promising characteristics, highlighting its potential for quantum transport and next-generation nano electronic applications.

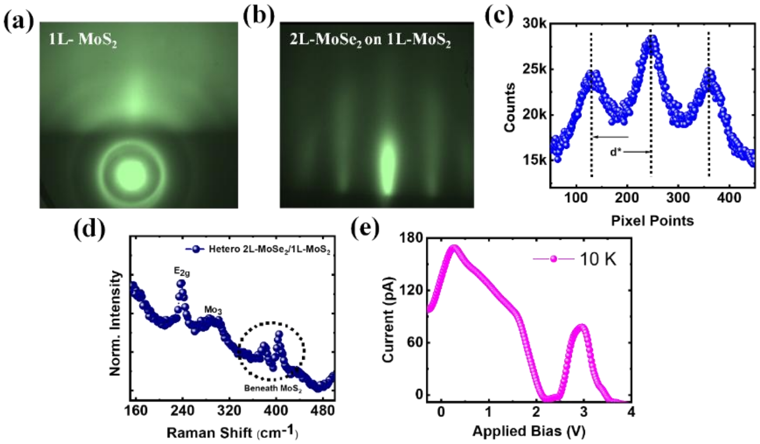

Figure.1: RHEED Spectra of (a) MoS_2 (b, c) Grown $MoSe_2$, (d) Raman (e) Electrical Characterization

References

[1] Mukherjee, A.; Sharma, K.; Bhatt, K.; Kandar, S.; Singh, R.; Das, S. MBE Grown Tri-Layer 2H-MoTe2 Quantum Wells Coupled with WSe2 Carrier Reservoir for Resonant Tunneling Device Applications. APL Quantum 2025, 2 (4), 046112. https://doi.org/10.1063/5.0296597.