Optical characterisation of MBE grown TMD heterostructures transferred to silicon wafers

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Abstract

Current preparation of 2D materials for use in devices mostly focuses on Chemical Vapor Deposition and exfoliation from bulk crystals. Molecular Beam Epitaxy (MBE) for synthesis in ultra-high vacuum (UHV) conditions offers unparalleled control of growth parameters. [1] One of the limitations of current growth procedures is the reliance on metallic Ir(111) or Au(111) substrates, which quench the optical response of grown materials, making them unsuitable for optoelectronic devices. We present a method to transfer MBE grown transition metal dichalcogenide (TMD) heterostructures (HS) to a SiO_2/Si wafer, where we can investigate optical properties and use the sample for device fabrication.
We grew a quasi-freestanding HS WS_2/MoS_2/Graphene/Mo on Ir(111), consisting of TMD islands of lateral size below 100nm [2]. The large, continuous graphene surface beneath the TMD HSs allows the transfer to a SiO_2/Si wafer. The transferred HS is then characterised with AFM for roughness and height. Micro-Raman spectroscopy confirms the presence of the HSs and shows fluorescence with characteristic excitonic peaks, which blue-shift upon lowering the temperature to 4 K. Wide-field hyperspectral microscopy yields spatially and spectrally resolved images of the sample, see Figure 1., revealing the homogenous spectral signature of the sample over hundreds of microns.

References

[1] Joshua Hall et al 2018 2D Mater. 5 025005
[2] B. Pielić et al 2021 "Electronic structure of quasi-freestanding WS2/MoS2 heterostructures" submitted

Figures

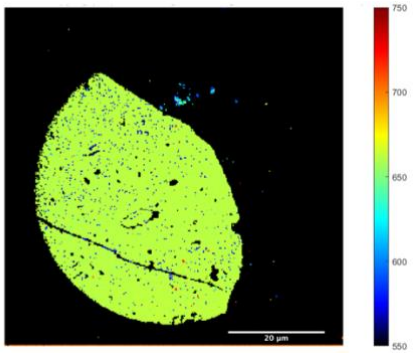

Figure 1: Spectral peak mapping from 550 to 750 nm with hyperspectral microscope of WS_2/MoS_2/Graphene.