# School of Physical Sciences

## Indian Institute of Technology Mandi (HP)


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# Van der Waals Hetero-structures for Orbital Gating in Photo-transistors and Electronic Spectroscopies


**Abstract:** Each atomic layer in van der Waals hetero-structures possesses a distinct electronic band structure that can be manipulated for unique device operations. The subtle but critical band coupling between the atomic layers, varied by the momentum (valley) of electrons and external electric fields in device operation, has not yet been presented or applied to designing original devices with the full potential of van der Waals hetero-structures. In this talk, I will introduce interlayer coupling spectroscopy at the device-scale based on the negligible quantum capacitance of two-dimensional semiconductors in lattice-orientation- tuned, resonant tunneling transistors (Figure 1.). The effective band structures of the mono-, bi-, and quadri-layer of $MoS_2$ and $WSe_2$ , modulated by the orientation- and external electric field-dependent interlayer coupling in device operations, could be demonstrated by the new conceptual spectroscopy overcoming the limitations of the former optical, photoemission, and tunneling spectroscopy [1]. Based on the vertical hetero-junction, single-defect resonant transistors [2], and novel orbital-gating phototransistors [3] could be developed.


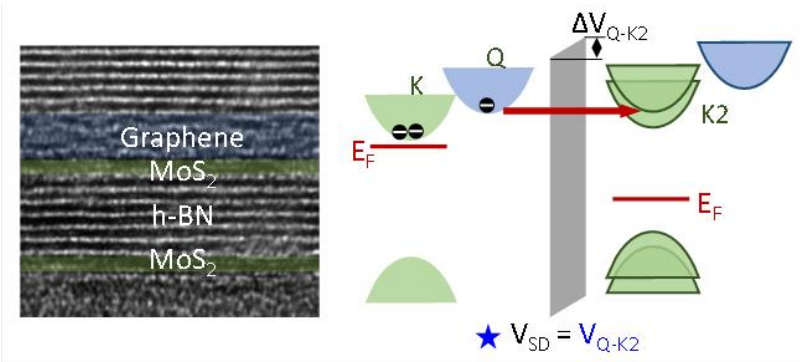


**Figure 1**. Resonant tunneling spectroscopy via orientation-tuned van der Waals layers


1. Advanced Materials 32, 1906942 (2020)
2. ACS Nano 15, 20013 (2021)
3. Advanced Materials 34, 2106625 (2022)


**About the speaker:** Prof. Yang is professor at the Korea Advanced Institute of Science and Technology. He was awarded the IUPAP Young Scientist Prize in Semiconductor Physics 2018 for his outstanding contribution to novel interface devices based on structural, electronic, and quantum-state control with van der Waals layered materials. He is a member in the Korea Academy of Science and Technology. He received his PhD in physics on the spectroscopy of graphene by scanning tunneling microscopy and spectroscopy (STM/STS) from Seoul National University (Korea) and University Paris-Sud XI (France, a joint degree) in 2010, and experienced industrial device studies in Samsung Electronics from 2010 to 2012. He worked on graphene spintronics in Albert Fert's (2007 Novel laureate) group in CNRS/Thales as a postdoc from 2012 to 2014.With his research background on molecular and nanometer-scale studies (in Seoul and Paris) and electric and spintronic device physics (in Samsung and CNRS/Thales), he moved to Sungkyunkwan University (2014 ~ 2021) and KAIST (2021~) and started original device studies with phase engineering of low-dimensional materials. He has proposed novel and conceptual interface devices such as 'Graphene Barristor' (Science 2012) and 'Ohmic homojunction contact between semiconductor channel and metal electrodes' (Science 2015).