School of Materials Science and Engineering

Seminar Topic:
Van der Waals Heterostructure Devices for Electronic Spectroscopy and Terabit-scale Memory Integration

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Abstract

Each atomic layer in van der Waals (vdW) heterostructures possesses a distinct electronic band structure that can be manipulated for unique device operations. In the precise device architecture, the subtle but critical band coupling between the atomic layers, varied by the momentum 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 heterostructures. I will introduce the interlayer coupling spectroscopy at the device-scale based on the negligible quantum capacitance of two-dimensional (2D) semiconductors in lattice-orientation-tuned, resonant-tunneling transistors. The effective band structures of the mono-, bi-, and quadrilayer of MoS$_2$ and WSe$_2$, modulated by the orientation- and external electric field-dependent interlayer coupling in device operations, could be demonstrated with the new conceptual spectroscopy by overcoming the limitations of the former optical, photoemission, and tunneling spectroscopy. Another critical and practical issue with the vdW heterostructure device is the large-scale device integration. To overcome the integration issues by 2D materials, I will introduce a self-selective memory cell based on 2D hexagonal boron nitride (h-BN) and graphene in a vertical heterostructure of h-BN/graphene/h-BN. Our self-selective memory cell minimizes sneak currents on a large-scale memory operation, thereby achieving a practical readout margin for terabit-scale and energy-efficient memory integration.

References:

Biography

Dr Heejun Yang received his B.S. from the Korea Advanced Institute of Science and Technology (KAIST) in Korea in 2003. He subsequently obtained a joint PhD from the Seoul National University, Korea and the University of Paris XI, France, in 2009. He is currently an Associate Professor in the Department of Energy Science at Sungkyunkwan University. Prior to this appointment, he also worked as a R&D staff member in Samsung Advance Institute of Technology and scientific researcher in Centre National de la Recherche Scientifique (CNRS)/Thales under Prof Albert Fert (2007 Nobel Laureate in Physics). His recognitions include Young Scientist Awards from Dong-A Ilbo and POSTECH (2016), Korean Graphene and 2D Symposium (2017) and International Union of Pure and Applied Physics (IUPAP, 2018).

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