# 7th International Workshop on 2D Materials

**Title of the Presentation:** Molecular Band Engineering in 2D Semiconductor Heterojunctions


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**Short Biography:**

Prof. Chul-Ho Lee received his B.S. (2005) and Ph.D. (2011) from the Department of Materials Science and Engineering of Pohang University of Science and Technology (POSTECH), Korea. After his Ph. D course, he worked in the Department of Physics (with Prof. Philip Kim) at Columbia University, United States, as a postdoctoral fellow. In 2014, then, he joined the faculty of the KU-KIST Graduate School of Converging Science and Technology at Korea University. His current research focuses on the device physics and applications of 2D semiconductors and their large-scale growth using metal-organic chemical vapor deposition (MOCVD).

**Abstract:**


Energy band engineering of 2D semiconductors is essential for the implementation of various electronic and optoelectronic functions. Molecular materials that can be assembled on the vdW surface have shown great potential for achieving such a purpose by tuning the Fermi level and interface band alignment. In this talk, two examples of molecular band engineering in 2D heterojunction devices will be discussed. First, I will present remote molecular doping in a 2D heterostructure transistor that can diminish doping-induced scattering [1]. In the $WSe_2$/h-BN/$MoS_2$ heterostructure, the underlying $MoS_2$ channel is modulation-doped by charge transfer, where charge-carrying electrons are spatially separated from molecular dopants on the $WSe_2$ surface. The modulation-doped device exhibits the 2D-confined charge transport properties with suppression of impurity scattering, as verified by the increase of mobility with decreasing the temperature. Furthermore, a significant mobility enhancement, by a factor of 10, is achieved in the modulation-doped $MoS_2$ compared with the directly doped counterpart. Second, I will discuss highly tunable rectification in 2D-hybrid molecular heterojunctions. $MoS_2$ and $WSe_2$ are used as a rectifying designer at the alkyl or conjugated molecule/Au interface [2]. From the adjustment of band alignment at 2D/molecule interface that can activate different transport pathways depending on the voltage polarity, the rectifying characteristics can be implemented and controlled. The rectification ratio could be widely tuned from 1.24 to $1.83 \times 10^4$ by changing the molecular species and type and the number of 2D layers.



[1]D. Lee *et al.* Submitted (2020).
[2]J. Shin, S. Yang *et al.*, Nat. Commun. 11, 1412 (2020).