Energy Intelligent Computing Devices Based on 2D Materials

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Abstract

Despite the long and crucial role of traditional solid-state physics for current silicon-based technologies, next generation neuromorphic, non-volatile memory, and energy devices that are key components in the era of the internet of things (IOT) require novel working principles with quantum physics emerging in low-dimensional materials1-4. The main research direction for the future devices is to realize ‘ultralow device operation energy’, ‘ultrahigh device operation speed’, and ‘large-scale device integration (up to 1015)’, which calls for exploring diverse quantum phenomena in low dimensional device components5,6. In this talk, I will present some of our recent efforts1-7 to establish new device physics for energy intelligent devices, which could be a milestone for the promising future devices. In particular, charge density wave (CDW), quantum capacitance, bandgap renormalization, structural phase transition, and other intriguing quantum physics in two-dimensional (2D) materials will be discussed along with logic device, neuromorphic computing, and energy device applications.

Reference

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5. L. Sun *et al.* Self-selective van der Waals heterostructures for large-scale memory array. ***Nature Communications*** 10, 3161 (2019)
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Bio

Heejun Yang 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 received his PhD in physics with a subject on 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. Then, he conducted his research 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' and 'Ohmic homojunction contact between semiconductor channel and metal electrodes'.