A new all-2-D light-emitting field-effect transistor

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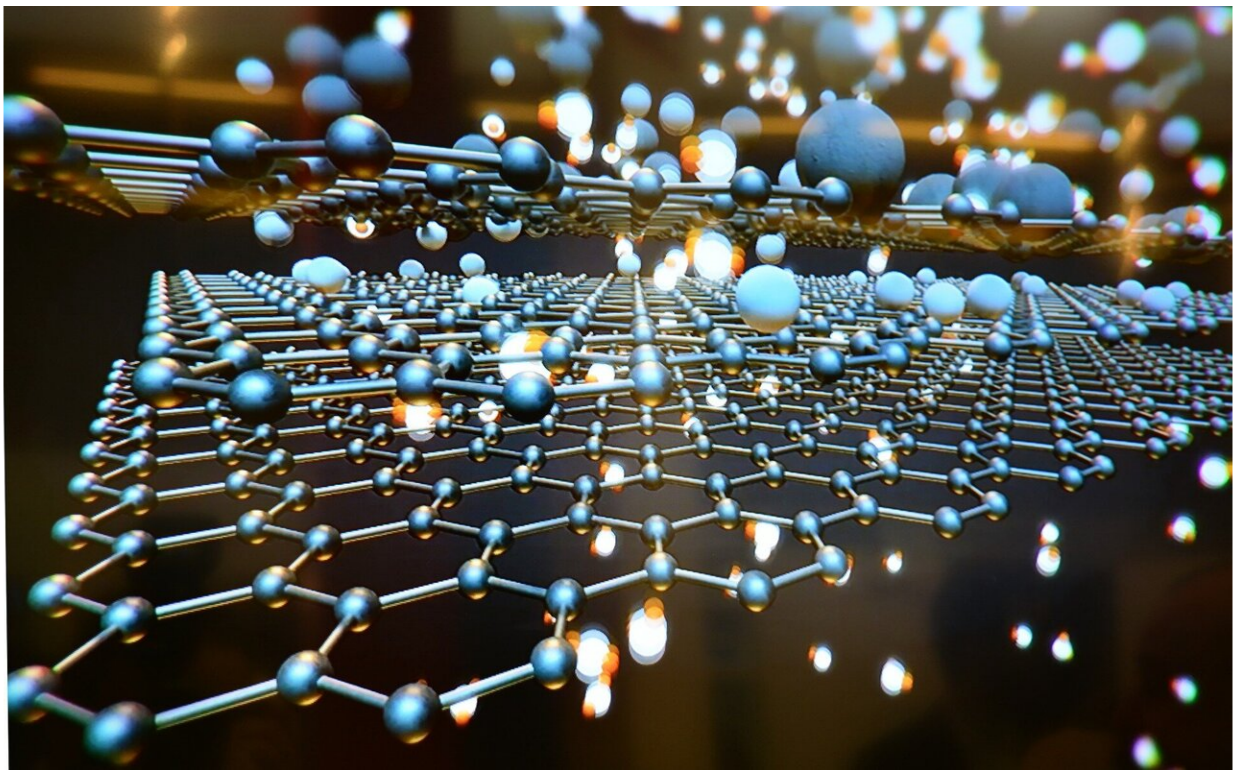

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Transition metal dichalcogenides (TMDs), a two-dimensional (2-D) semiconductor, are promising materials for next-generation optoelectronic devices. They can emit strong light due to the large binding energies of excitons, quasiparticles composed of electron-hole pair, as well as an atomically thin nature. In existing 2-D light emitting devices, however, the simultaneous injection of electrons and holes into 2-D materials has been challenging, which results in low light emission efficiency.

To overcome these problems, Prof. Gwan-Hyoung Lee's group in Seoul National University and Prof. Chul-Ho Lee's group in Korea University demonstrated all-2-D light-emitting field-effect transistors (LEFETs) by staking 2-D materials. They chose graphene and monolayer WSe_2 as contact electrode and an ambipolar channel, respectively. Typically, a junction between metal and semiconductor has a large energy barrier. It is the same at a junction of graphene and WSe_2.

However, Lee's group utilized the barrier-tunable graphene electrode as a key for the selective injection of electrons and holes. Since the work function of graphene can be tuned by an external electric field, the contact barrier height can be modulated in the graphene-contacted WSe_2 transistor, enabling selective injection of electrons and holes at each graphene contact. By controlling the densities of injected electrons and holes, high efficiency of electroluminescence as high as 6% was achieved at room temperature.

In addition, it was demonstrated that, by modulating the contacts and channel with separate three gates, the polarity and light emission of LEFETs can be controlled, showing great promises of the all-2-D LEFETs in multi-digit logic devices and highly integrated optoelectronic circuitry.

This research is published as a paper entitled "Multi-operation mode light-emitting field-effect transistors based on van der Waals heterostructure" in *Advanced Materials*.

More information: Junyoung Kwon et al. Multioperation-Mode

Light-Emitting Field-Effect Transistors Based on van der Waals Heterostructure, *Advanced Materials* (2020). DOI: 10.1002/adma.202003567

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