Split-gate Ferroelectric Field-effect Transistor based on $WSe_2/CuInP_2S_6$ Heterostructures for memory and photovoltaic applications

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Abstract

The development of two-dimensional (2D) materials have opened up new possibilities for designing and implementing innovative devices. Recently, 2D ferroelectric van der Waals materials (vdW) have attracted interest[1] due to their intrinsic ultrathin ferroelectric behavior. The Ferroelectric Field Effect Transistor (FeFETs)[2] is a key building-block for non-volatile memory and neuromorphic computing. In this study, we present a novel split-gate architecture for a 2D FeFET based on WSe_2/hBN/$CuInP_2S_6$ heterostructures (**Figure 1a**). The two $CuInP_2S_6$ ferroelectric gates provide switchable and non-volatile polarizations, used to alleviate the doping profile along the WSe_2 semiconducting channel. The strong polarization of $CuInP_2S_6$ enables to exhibit the ambipolar behavior of WSe_2 (**Figure 1b**). The FeFET demonstrates excellent performance as nonvolatile memory, including a high on/off ratio (>10^5) and long data retention (>10^4 s). The split-gate architecture enables to encode remanent and reconfigurable p-n junction with an excellent rectification ratio. This allows us to achieve the implementation of non-volatile XNOR logic gates through a single-active channel, which is key building-block of next generation neuromorphic computing. Finally, we address the optoelectronic properties of our device and showcase its versatility to function in both phototransistor and photovoltaic modes. While forming the p-n junction, we take advantage of the built-in electric field to assist charge dissociation. This unlocks photovoltaic functionality, that demonstrates large open circuit voltage and close-circuit photovoltaic current (**Figure 1c**).

References

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Figures

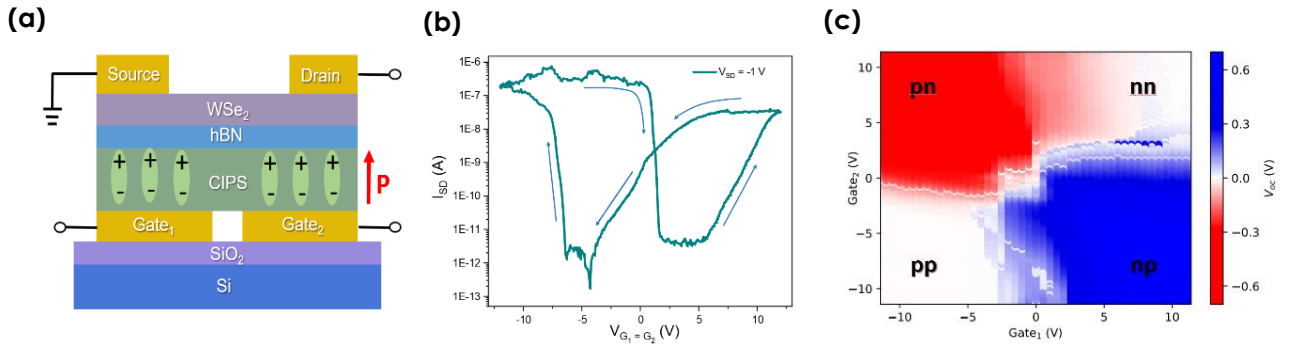

Figure 1: (a) Schematic of a split-gate FeFET based on a WSe_2/hBN/$CuInP_2S_6$ heterostructure. (b) I_{SD}-V_G transfer charecteristics. (c) photovoltaic map representation of reconfigurable transistor.