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Control Carrier Trapping-Detrapping Events: Pioneering Memory-Transistor Functionalities in van der Waals Electronics

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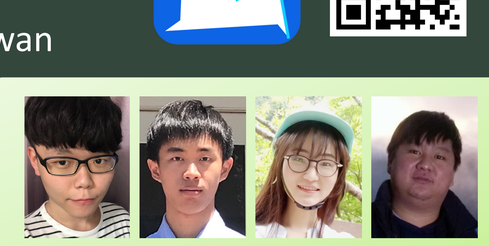
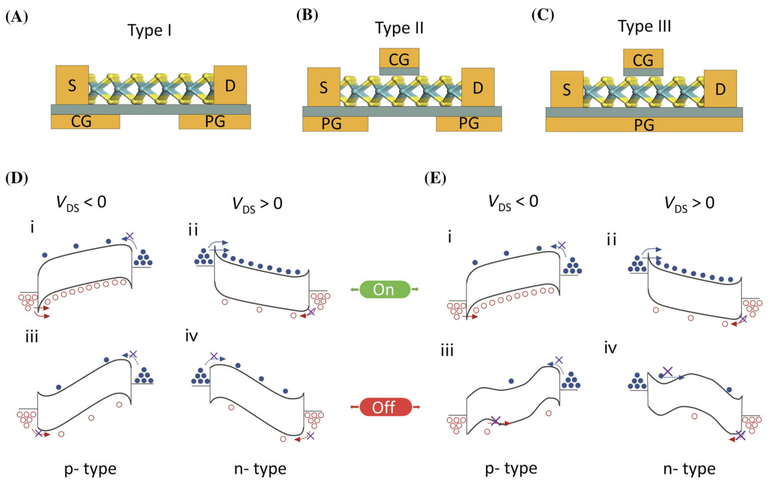


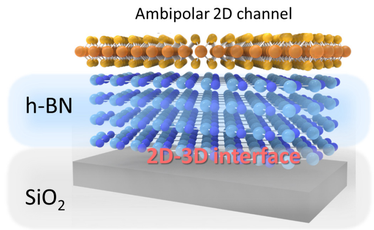
Nat. Electron. **6**, 755 (2023); *Sci. Adv.* **9**, eadk1597 (2023)

• Motivation and operation concepts

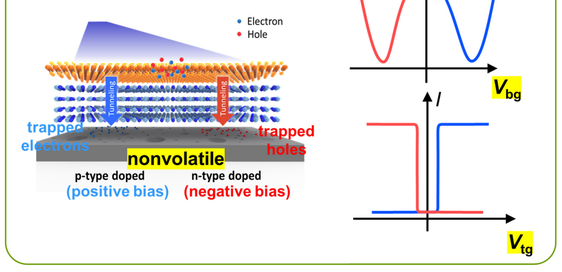
◆ Reconfigurable field-effect transistors (RFETs)

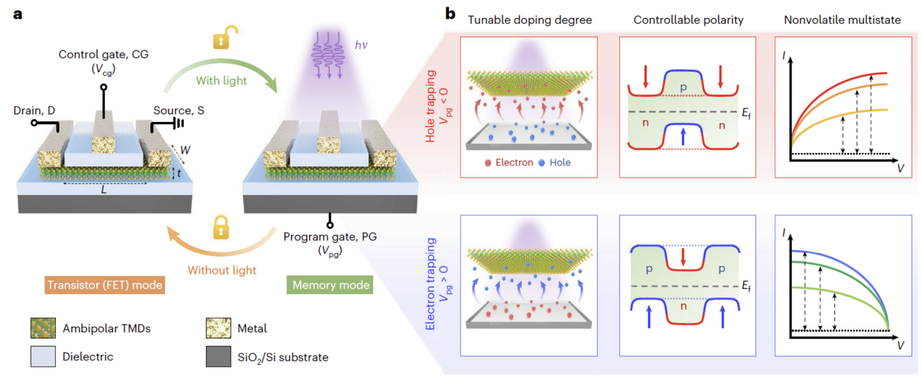


Fei, W., et al. (2022). "Emerging reconfigurable electronic devices based on two-dimensional materials: A review." *InfoMat.* **4**, e12355



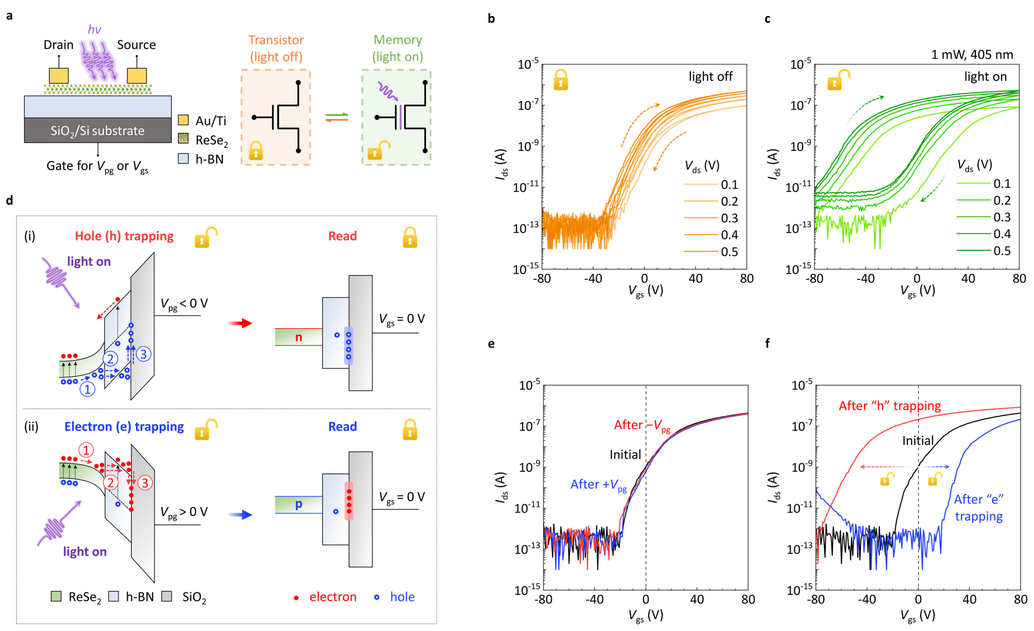
◆ Light illuminations+ bias:

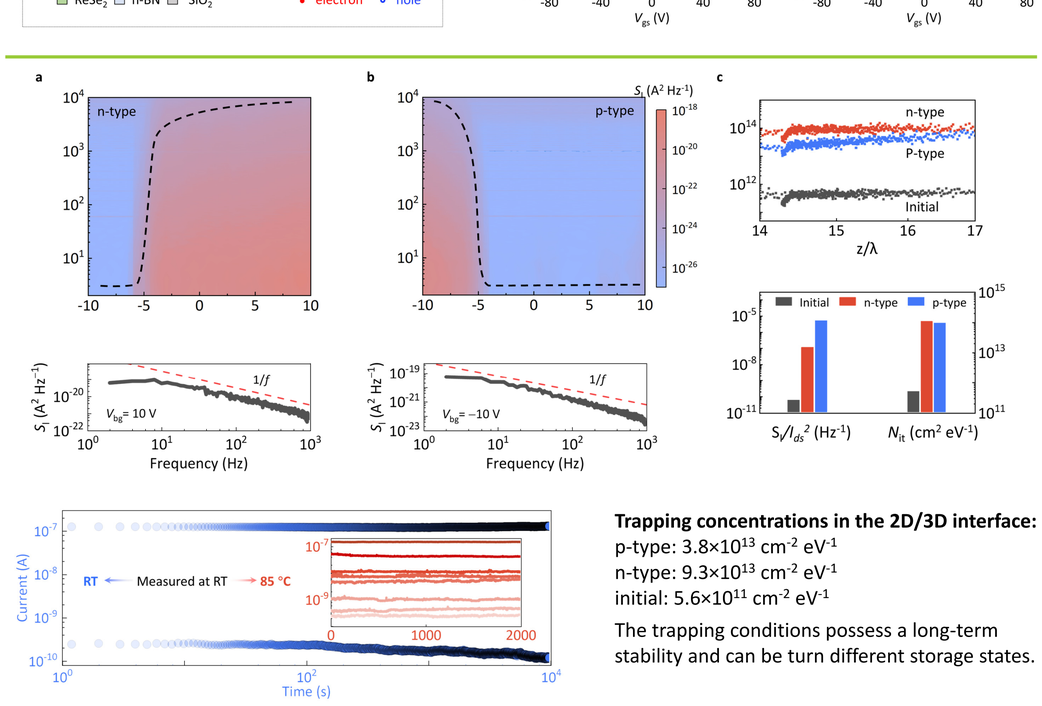




a, Schematic illustrations of the proposed PT-RFET heterostructure device. Light illumination acts as a switching key between the transistor mode and the memory mode. **b**, Illustrations of the tunable doping degree, n/p polarity control, and the nonvolatile multistate characteristics that can be realized in the proposed photoinduced trapping RFETs. Here, E_f represents the Fermi level.

• Nonvolatile photoinduced trapping

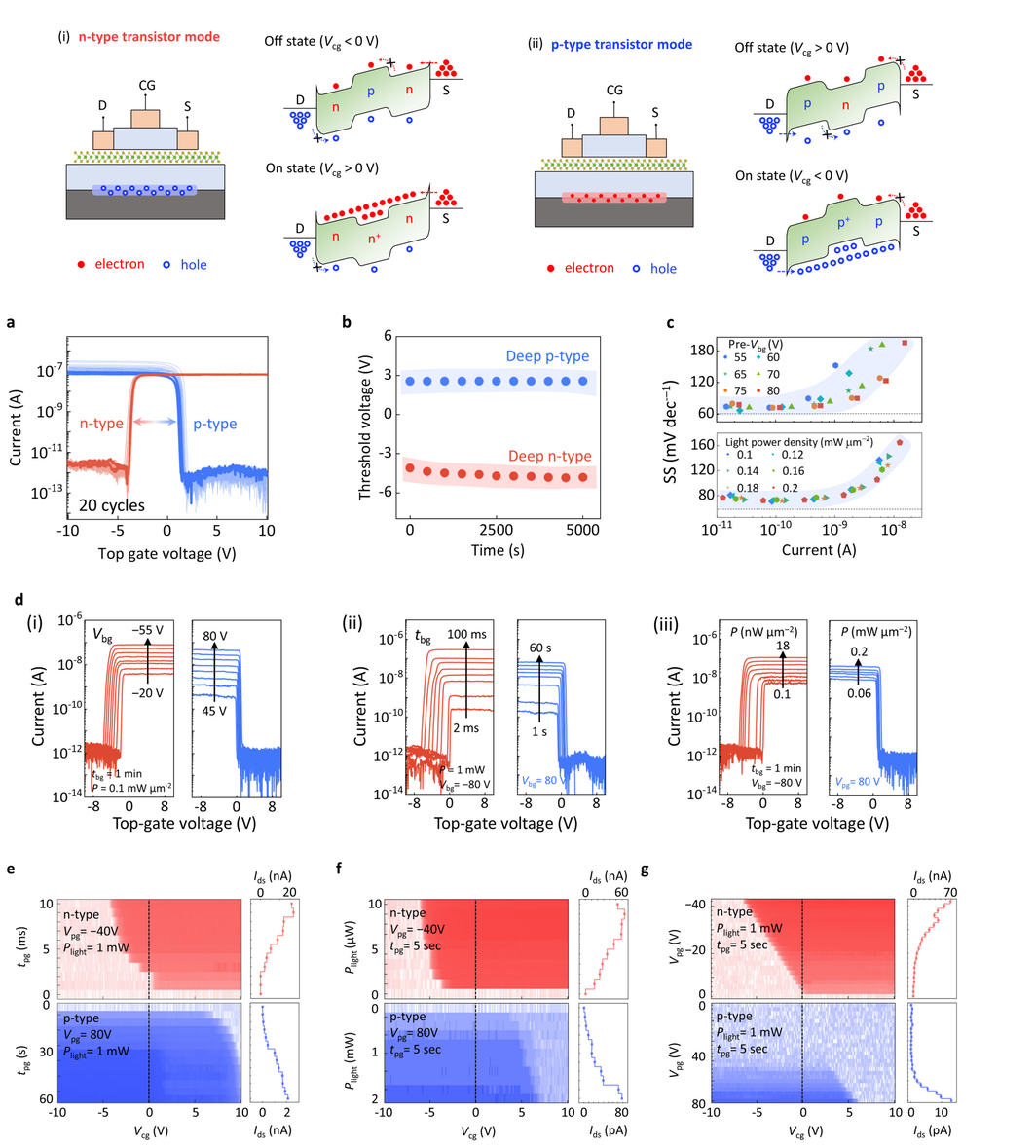




Trapping concentrations in the 2D/3D interface:
p-type: 3.8×10^{13} cm^{-2} eV^{-1}
n-type: 9.3×10^{13} cm^{-2} eV^{-1}
initial: 5.6×10^{11} cm^{-2} eV^{-1}

The trapping conditions possess a long-term stability and can be turn different storage states.

• Demonstration of device operations

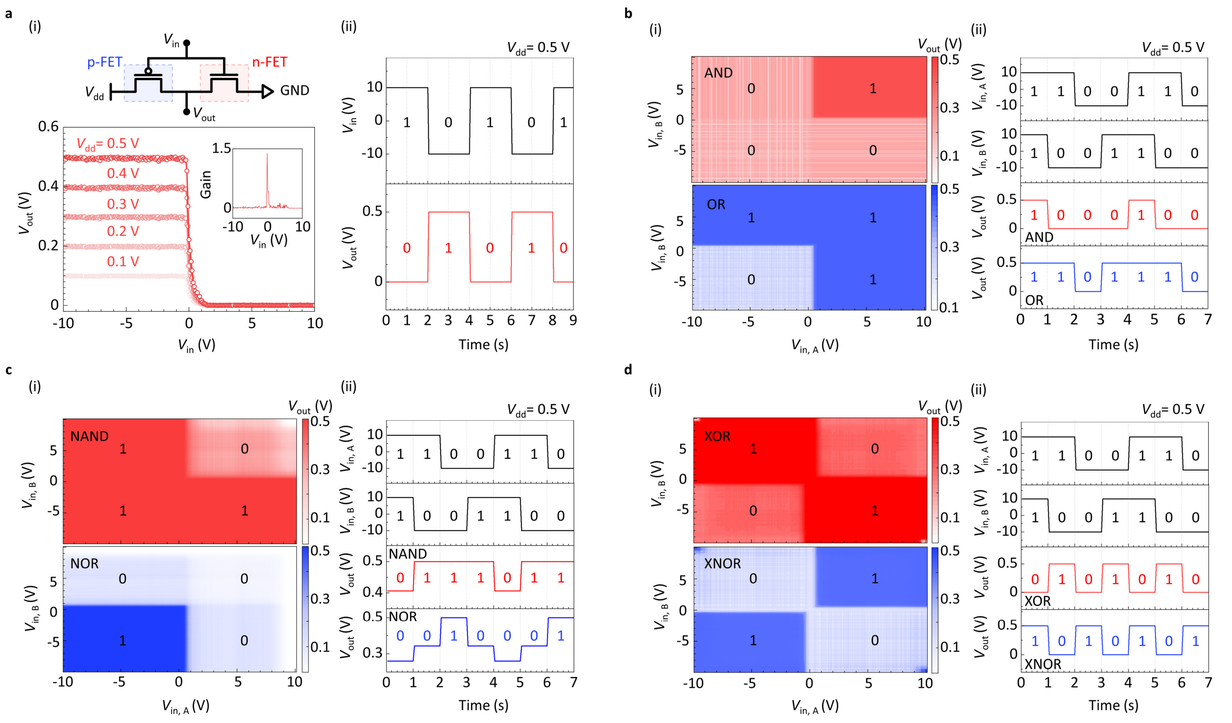


◆ **Excellent FET performances** can be achieved in the transistor mode, while in the memory mode the multistate functions can be done.

◆ **Larger t_{pg}, P_{light}, and V_{pg} values** result in higher light absorption and carrier trapping characteristics.

• Demonstration of reconfigurable transistor-memory functions

◆ Transistor modes: logic circuits



◆ Memory modes: artificial synapses