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## **Advanced Non-classical Field Effect Devices Using 2D Transition Metal Dichalcogenides and InGaZnO channel**

### **Abstract**

Advanced non-classical functions from newly-designed field effect devices are introduced by combining TMD FET and InGaZnO (IGZO) FET on one common gate: multi-value FETs, photo-detecting circuit, and signal frequency doubler. According to individual transfer characteristics of two FET devices, our n-IGZO FET always showed higher drain current and more positive-side threshold voltage than those of n-TMD channel FETs. As a result, a combined transfer characteristics presented two-step drain current levels, so that their load-resistance inverter might demonstrate three value output voltage signals. Those ternary value inverter devices with n-IGZO/n-ReSe<sub>2</sub> or n-IGZO/n-WSe<sub>2</sub> combination also operate as a photodetector, responding to visible/near infrared (IR) photons with a fast photo-dynamics of 30 ms rising/falling time. The most interesting is the ambipolar device achieved from n-IGZO FET/p-MoTe<sub>2</sub> FET combination circuit. The ambipolar device circuit operates as AC signal frequency doubler and demonstrates twice of OLED blinking in one AC period. Our unprecedented technique for the multi-functional and non-classical field effect TMD devices incorporating n-IGZO FET would open the new path toward future electronics.

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## Figures

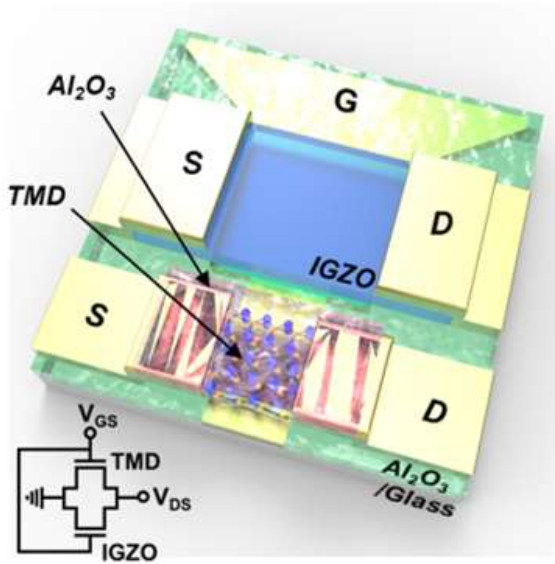


Figure 1: 3D schematic Image and Circuit of IGZO and TMD channel hybrid device

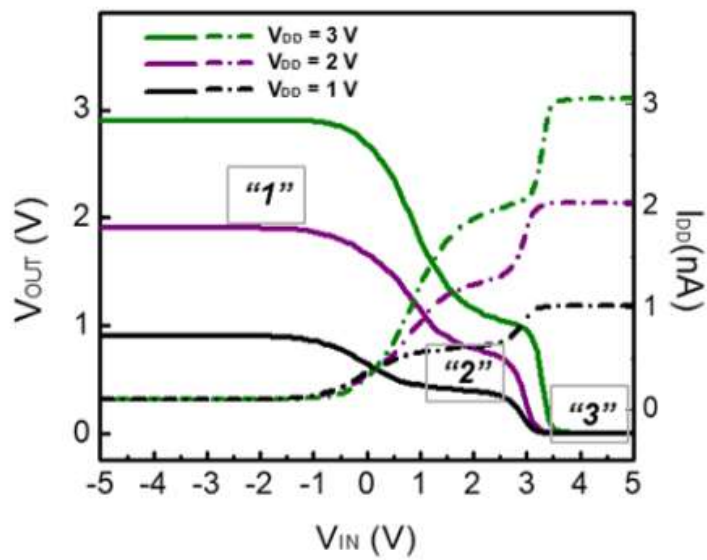


Figure 2: Voltage Transfer Characteristic curves of Multi-value device