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Demonstration of High-performance Transistors with Narrow Bandgap High-Mobility Ultrathin 2D Films GANG QIU, YIXIU WANG, YUCHEN DU, LINGMING YANG, WENZHUO WU, PEIDE YE, Purdue University — The scaling trend of transistors has triggered a thirst of seeking for ultrathin 2D semiconductors with excellent electrical transport properties. Here we present a promising solution of high-performance transistors on ultrathin 2D semiconducting films with unprecedented transport properties and stability. Similar to black phosphorus or phosphorene, it is a p-type semiconductor with a direct band gap ranging from 0.35eV (bulk) to >1.2eV (monolayer). Large scale (>100μm) atomic-flat 2D films with controllable thickness were achieved by hydrothermal method. Great scaling potential was demonstrated by aggressively shrinking the device dimensions, including film thickness (from over 30nm to 4nm), channel length (from 5 μm to sub-100nm), and gate dielectric (EOT from 300nm to 5nm). Other methods such as buried gate and contact engineering were also applied to optimize the device performance. Transistors display high performance with on/off ratio over 106, maximum on-current over 500 mA/mm, field-effect mobility over 700cm2/Vs, contact resistance 0.6kΩ*mm and great air stability.

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