 Extended Abstracts of the 2020 International Conference on Solid State Devices and Materials, VIRTUAL conference, 2020, pp649-650

# High performance electronics based on 2D materials and ultrathin ITO

Yanqing Wu[1]

[1] Peking University.
No. 5 Yiheyuan Rd. Beijing China
Phone: +86-10-62750735 E-mail: yqwu@pku.edu.cn

**Abstract**

**Electronic devices based on atomic layered two-dimensional materials and related heterostructures have recently attracted great research attention due to their unique electronic properties and the feasibility of hybrid integration, which provide the unprecedented opportunities for various van der Waals heterojunctions. We have studied the performance improvement based on black phosphorus and molybdenum disulfide from the carrier velocity and operating frequency. High frequency transistor and circuits operating at gigahertz range based on molybdenum disulfide are demonstrated with record high maximum oscillation frequency. High hole velocity of up to 1.5 x $10^7$ cm/s has been demonstrated for short channel BP transistors and transport approaching ballistic limit are predicted for ultimately scaled channel length. High mobility large crystal bilayer $MoS_2$ by CVD growth has been developed with high cut-off frequency and maximum oscillation frequency. Moreover, bandgap engineering using lateral heterojunctions of $MoS_2$/BP has been carried out with multi-value logic and non-volatile logic operations. Vertical heterostructure of BP/$Al_2O_3$/BP with large room temperature negative differential resistance and steep sloop below 60 mV/dec are also demonstrated. In the end, ultrathin indium tin oxide has been also systematically investigated for high performance electronics with high on off rate and radio frequency response.**

**References**

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