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**High Performance WSe<sub>2</sub> Field-Effect Transistors via Controlled Formation of In-Plane Heterojunctions.** BILU LIU, YUQIANG MA, CHONGWU ZHOU, University of Southern California, UNIVERSITY OF SOUTHERN CALIFORNIA COLLABORATION, TSINGHUA-BERKELEY SHENZHEN INSTITUTE COLLABORATION — Monolayer WSe<sub>2</sub> is a 2D semiconductor with a direct bandgap, and is promising for electronics and optoelectronics. Low field effect mobility is the main constraint preventing WSe<sub>2</sub> from becoming a competing channel material for field-effect transistors (FETs). Here, we report that controlled heating in air significantly improves device performance of WSe<sub>2</sub> FETs. After heating at optimized conditions, chemical vapor deposition grown monolayer WSe<sub>2</sub> FETs showed average FET mobility of  $31 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$  and on/off current ratios up to 5108. For few-layer WSe<sub>2</sub> FETs, after the same treatment, we achieved a high mobility up to  $92 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$ . The underlying chemical processes involved during air heating and the formation of in-plane heterojunctions of WSe<sub>2</sub> and WO<sub>3-x</sub>, which is believed to be the reason for the improved FET performance, were studied in detail. We further demonstrated that by combining air heating method developed here with supporting 2D materials on BN substrate, we achieved a noteworthy field effect mobility of  $83 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$  for monolayer WSe<sub>2</sub> FETs. This work is a step towards controlled modification of the properties of WSe<sub>2</sub> and potentially other TMDCs, and may greatly improve device performance for future applications of 2D materials in electronics..

Bilu Liu  
University of Southern California

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