Electronic Supplementary Material (ESI) for Nanoscale.
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Supplementary Information for "Study of lateral Schottky contacts in WSe_2 and MoS_2 field effect transistors using scanning photocurrent microscopy"

Ya Yi[†], Changming Wu[†], Hongchao Liu[†], Jiali Zeng[‡], Hongtao He[‡,*], and Jiannong Wang[†,*]

[†]Department of Physics, The Hong Kong University of Science and Technology, Clear Water Bay, Hong Kong, China

[‡]Department of Physics, South University of Science and Technology of China, Shenzhen, Guangdong 518055, China

** Address correspondence to:* heht@sustc.edu.cn, phjwang@ust.hk

1. Calculation of the photothermalelectric voltage

The Seebeck coefficient can be calculated using the Mott relation as follows[1, 2]:

$$S = \frac{\pi^2 k_B^2 T}{3e} \frac{1}{R} \frac{dR}{dV_g} \frac{dV_g}{dE} |_{E=E_F}$$

where, k_B is the Boltzmann constant , e is the elementary charge, T is absolute temperature, R is device resistance, V_g is gate voltage, and E_F is Fermi energy.

Following Buscema *et al.*[2], we estimate $dV_g /dE = 0.01e$, and calculated Seebeck coefficient for our MoS_2 device from the transfer and output curves is $\sim -3.4\times10^2$ $\mu V/K$ at zero gate bias (Fig. S1). And for our WSe_2 device, the calculated Seebeck coefficients are 23 $\mu V/K$ and -0.1 $\mu V/K$ at – 100 V and 100 V gate voltage, respectively.

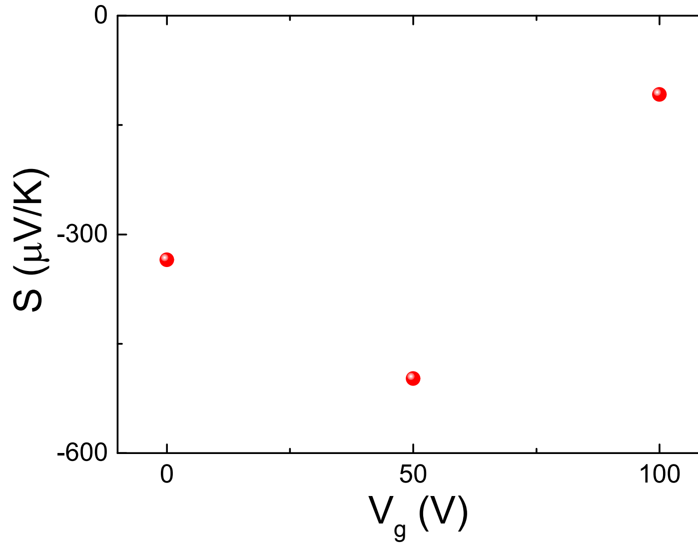


Fig. S1 Calculated Seebeck coefficient of MoS_2 device at different back gate voltage.

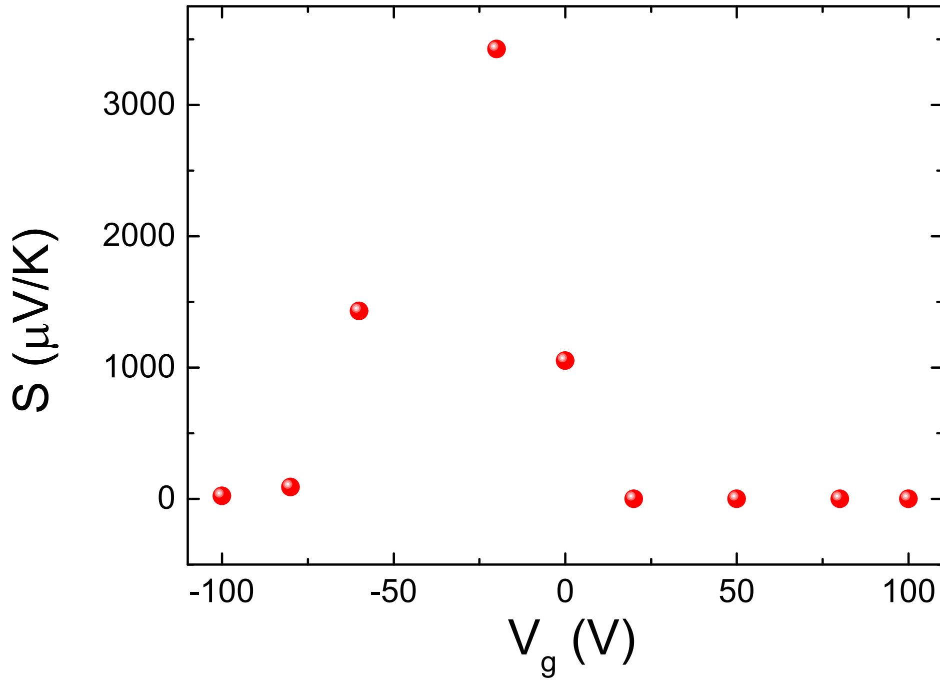
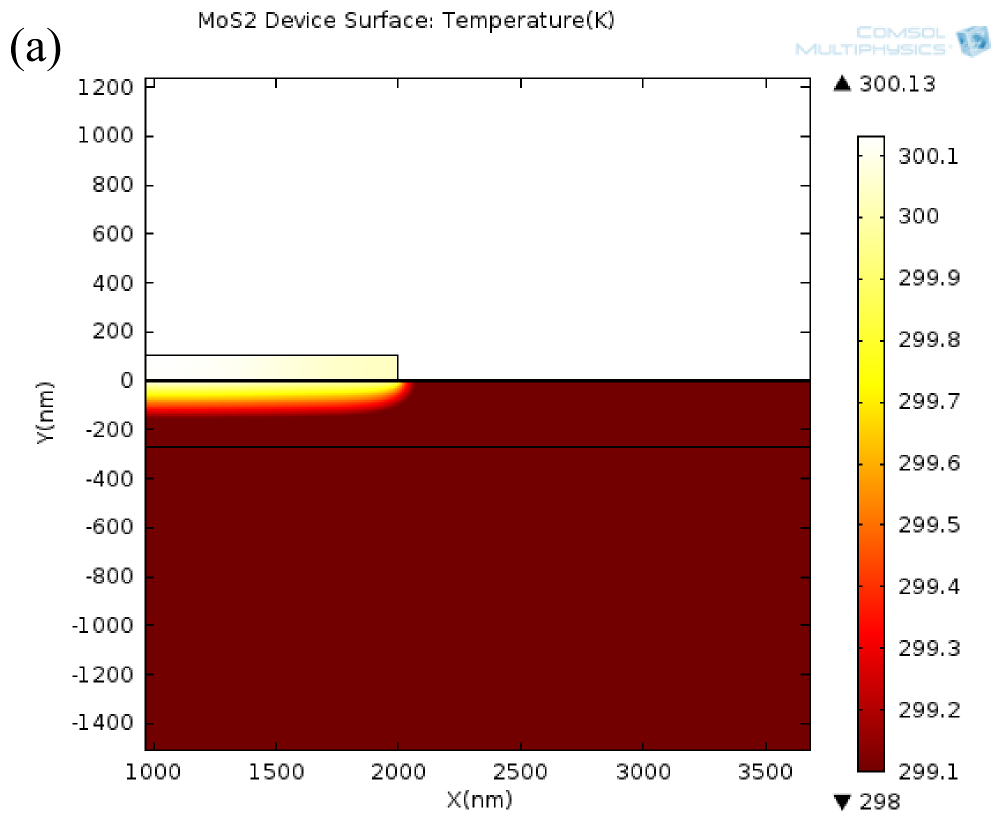


Fig. S2 Calculated Seebeck coefficient of WSe_2 device at different back gate voltage.

Following Buscema's work,[2] the temperature difference between the electrodes and MoS_2 (WSe_2) flake by local laser heating can be simulated by Finite Element Method using COMSOL Multiphysics software. The material property parameters used for simulation are listed in Table S1. The incident laser power is 20 μW and the radius of the spot is ~ $1\mu m$. We assumed that the incident light flux out from the objective lens could all transform into incoming heat flux and penetrated into the gold electrode equally in the laser spot area. Considering a good thermal contact between SiO_2/Si substrate and the mapping stage, also a much larger scale of substrate against that of the channel, temperature of the substrate bottom was fixed at room temperature (298 K). Other boundaries were open boundaries allowing heat exchange with the air environment. Two temperature probe points were set as: one is the center on the top of

the gold electrode and the other is the nearest position to the electrode on the surface of the MoS_2/WSe_2 flake. The simulation was performed in the time domain until the system reached a stable state. Time needed to reach equilibrium in our simulation was less than 100 *ms*. The current recording were set to be 1 *s* after each step of the stage move, suggesting the current were measured at steady state. The simulation results in Fig.S2 show the temperature difference between the electrode and the MoS_2/WSe_2 flake is around 128 mK /110 mK in a steady state (Fig. S3).



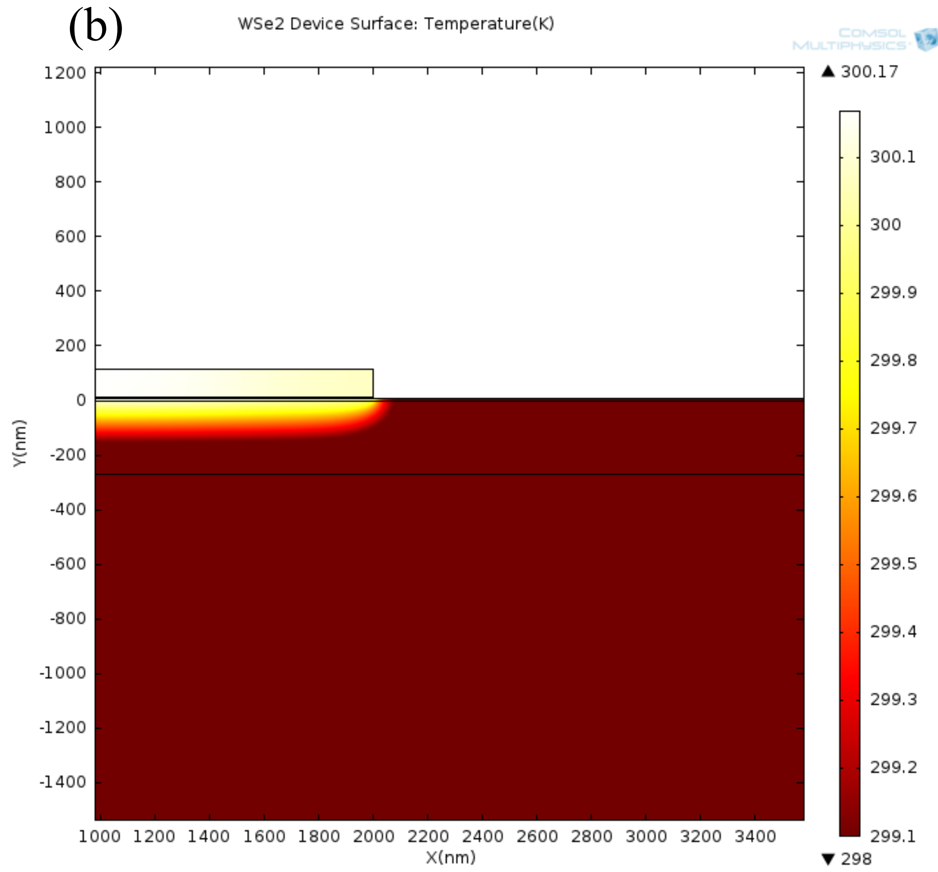


Fig. S3 Simulation of temperature change caused by laser locally heating at steady state. (a) MoS_2 device and (b) WSe_2 device.

Table S1: Material properties values employed for thermal gradient estimation.[2,3]

	Au	Ti	Cr	MoS_2	WSe_2
d (nm)	100	5	5	2.8	9.34
l (um)	2	2	2	5	5
ρ (kg m^{-3})	19300	4500	7190	5000	9320
C (J kg^{-1} K^{-1})	128.74	540	details in software	400	202.8
κ (W m^{-1} K^{-1})	315	21.9	93.9	1.8	1.6

2. Carrier density in MoS_2

The carrier concentration of MoS_2 at $V_g = 0$ V is estimated by formula $\sigma = en\mu$, where σ is conductivity, e is electron charge, n is the carrier density and μ is mobility.[4,5] The

mobility can be obtained from the transfer curve and the conductivity can be calculated from the output curve. For $V_g = 0$ V, the sheet carrier density n_s is estimated to be ~ 9.3×10^{10} cm^{-2}, as shown in Fig. S4.

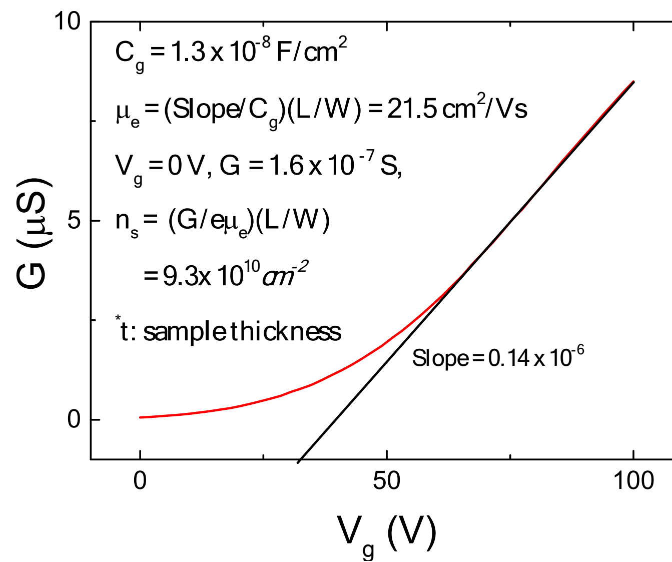


Fig. S4 Transfer curve use to estimate the intrinsic carrier density at $V_g = 0$ V.

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