Supplementary Information

Microfluidic Tank Assisted Nicotine Sensing Property of Field Effect Transistor Composed of Atomically Thin MoS_2 Channel

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1. Device fabrication process

The substrate (300 nm $SiO_2/p^{++}Si$) was cleaned by acetone and isopropanol separately through ultra-sonication bath for 5 min. Then it was dried by the N_2 gun and then the substrate was treated under UV-O_3 treatment for 30 min to remove any organic impurities. The MoS_2 flakes were transferred to substrate by the mechanically exfoliated technique. The flake was covered by the MMA (methyl methacrylate) and poly (methyl methacrylate) (PMMA A2) resist. Then electron beam lithography (ELS-700, ELIONIX) was carried out for making the electrode pattern. After developing by the developer solvent, Ti (10 nm) /Au (150 nm) source and drain contacts were formed by EB evaporator. Finally, lift-off was done through wet removal by N-methyl-2-pyrrolidone (NMP)

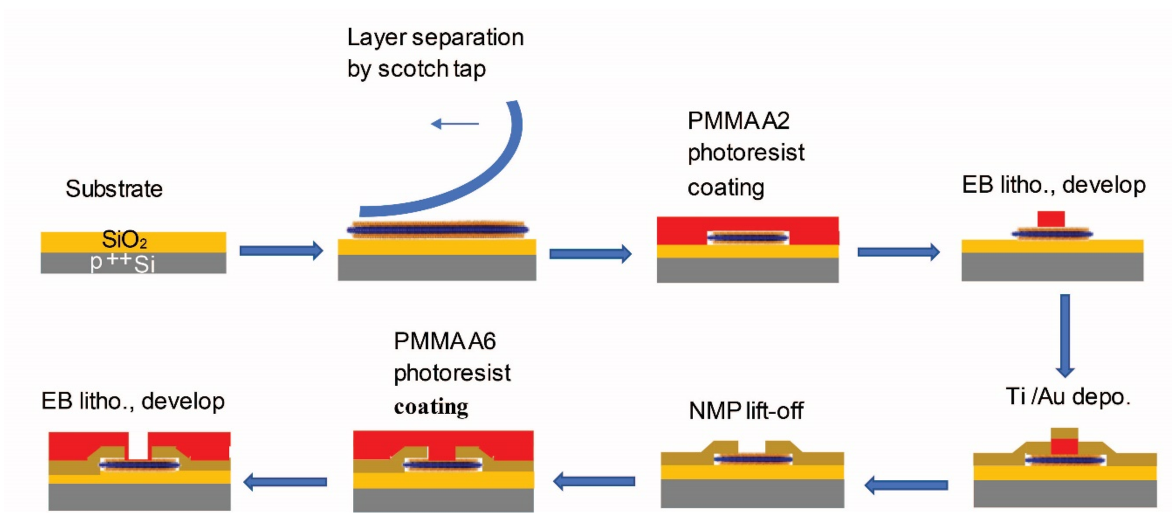

Figure S1. Schematic illustration of the MoS_2-FET fabrication process.

2. Contrast method for the flake thickness measurement

It is possible to estimate the thickness of the MoS_2 layer by measuring the contrast of the reflected light from the SiO_2 surface with and without the presence of the MoS_2 flake.[1] The contrast is defined with the following equation:

$$C(\lambda) = \frac{R_0(\lambda) - R(\lambda)}{R_0(\lambda)}$$

where $R_0(\lambda)$ and $R(\lambda)$ are the intensities of the reflected light without and with MoS_2 for the wavelength of λ, respectively. It was suggested that the use of λ in the red region is more efficient compare to the use of the blue and green lights.[1] For the device used in this report, the *C*(λ) of the red light was found to be 0.5, which indicates the number of the layers of the flake to be four from the table calibrated previously.[1] The optical microscope image of the device is shown in main text Fig. 1a.

3. Scheme of band diagram and fermi level shift

The energy band diagram between pristine MoS_2 and the nicotine, and the direction of electron transfer induced by the nicotine functionalization is shown. Figure S2 (a) shows that Fermi level of the nicotine may be higher than that of the MoS_2 thus can donate electron to the fermi level of MoS_2, similar with the Chen et al. Figure S2 (b) represents the work function (Φ) decreases after nicotine doping. The valence band maximum (VBM) goes above the fermi level (E_F) for pristine MoS_2 after nicotine incorporation indicating the n-type doping of MoS_2.[2] Electron affinity (χ) may increase a little after electron donation from the nicotine to the pristine MoS_2. Here E is defined for the energy gap between the conduction band (E_C) and valance band (E_V).

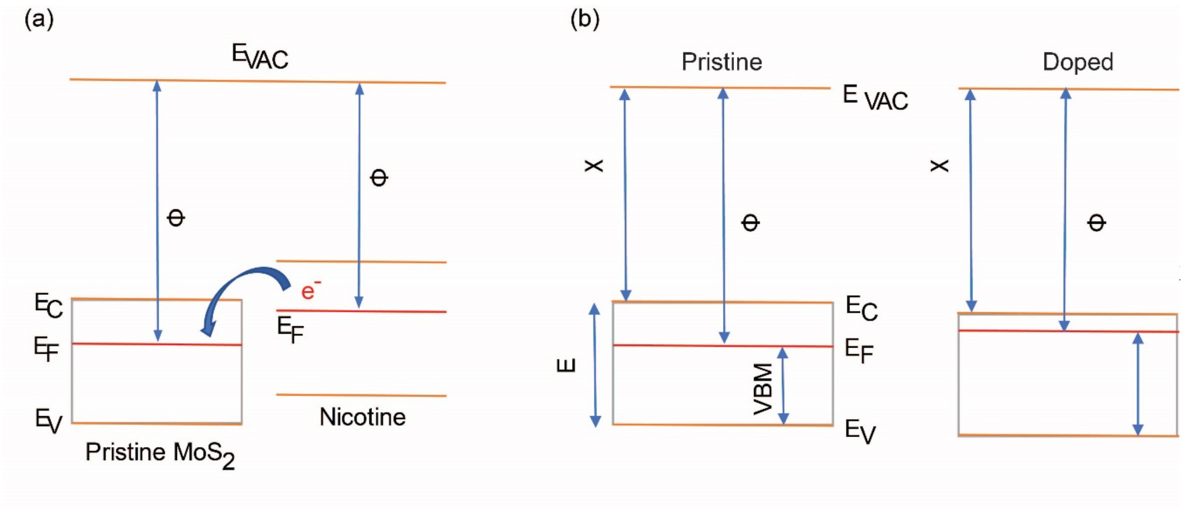

Figure S2. (a) Illustration of electron transfer from nicotine to MoS_2, (b) Energy diagram showing the fermi level changes of MoS_2 after nicotine doping.

1. Y. Y. Wang, R. X. Gao, Z. H. Ni, H. He, S. P. Guo, H. P. Yang, C. X. Cong and T. Yu, *Nanotechnology*, 2012, **23**, 495713.
2. A. Azcatl, X. Qin, A. Prakash, C. Zhang, L. Cheng, Q. Wang, N. Lu, M. J. Kim, J. Kim, K. Cho, R. Addou, C. L. Hinkle, J. Appenzeller and R. M. Wallace, *Nano Lett*, 2016, **16**, 5437-5443.