Supplementary Information

Facile route to a high-quality graphene/MoS₂ vertical field-effect transistor with gate-modulated photocurrent response

M. Farooq Khan¹, M. Arslan Shehzad², M. Zahir Iqbal³, M. Waqas Iqbal⁴, Ghazanfar Nazir¹, Yongho Seo² and Jonghwa Eom¹*

¹ Department of Physics & Astronomy and Graphene Research Institute, Sejong University, Seoul 05006, Korea
² Faculty of Nanotechnology & Advanced Materials Engineering and Graphene Research Institute, Sejong University, Seoul 05006, Korea
³ Faculty of Engineering Sciences, GIK Institute of Engineering Sciences and Technology, Topi 23640, Khyber Pakhtunkhwa, Pakistan
⁴ Department of Physics, Riphah International University, Lahore, Pakistan

*E mail: eom@sejong.ac.kr
Figure S1. Device fabrication and electrical transport measurement of planar graphene FET device. (a) Optical image of graphene FET device. (b) Transfer characteristics (resistivity as function of $V_g$) of pristine and DUV treated graphene FETs.
Figure S2. Electrical transport measurement of vertical MoS$_2$ FET device. (a) $J$–$V_{gs}$ transfer characteristics of h-BN/Gr/MoS$_2$/Mo FET. (b) Current density versus $V_{sd}$ of vertical FET device. (c) $J$–$V_{sd}$ curve at $V_{gs} = -20$ V for vertical FET. The ideality factor was identified by linear regression (red line). (d) Transfer characteristics of Gr/MoS$_2$ devices. The ON-OFF ratio was enhanced with h-BN substrate, and then further enhanced after the annealing in a high vacuum (~10$^{-6}$ torr) at 200 °C.
Figure S3. Raman spectrum of FL MoS$_2$ flake in the planar MoS$_2$ FET device. The gap between two peaks is ~22 cm$^{-1}$, which suggests that the flake is not more than 4 or 5 layers.