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Pentagonal 2D Layered $PdSe_2$-based Synaptic Device with Graphene Floating Gate

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Supporting Information

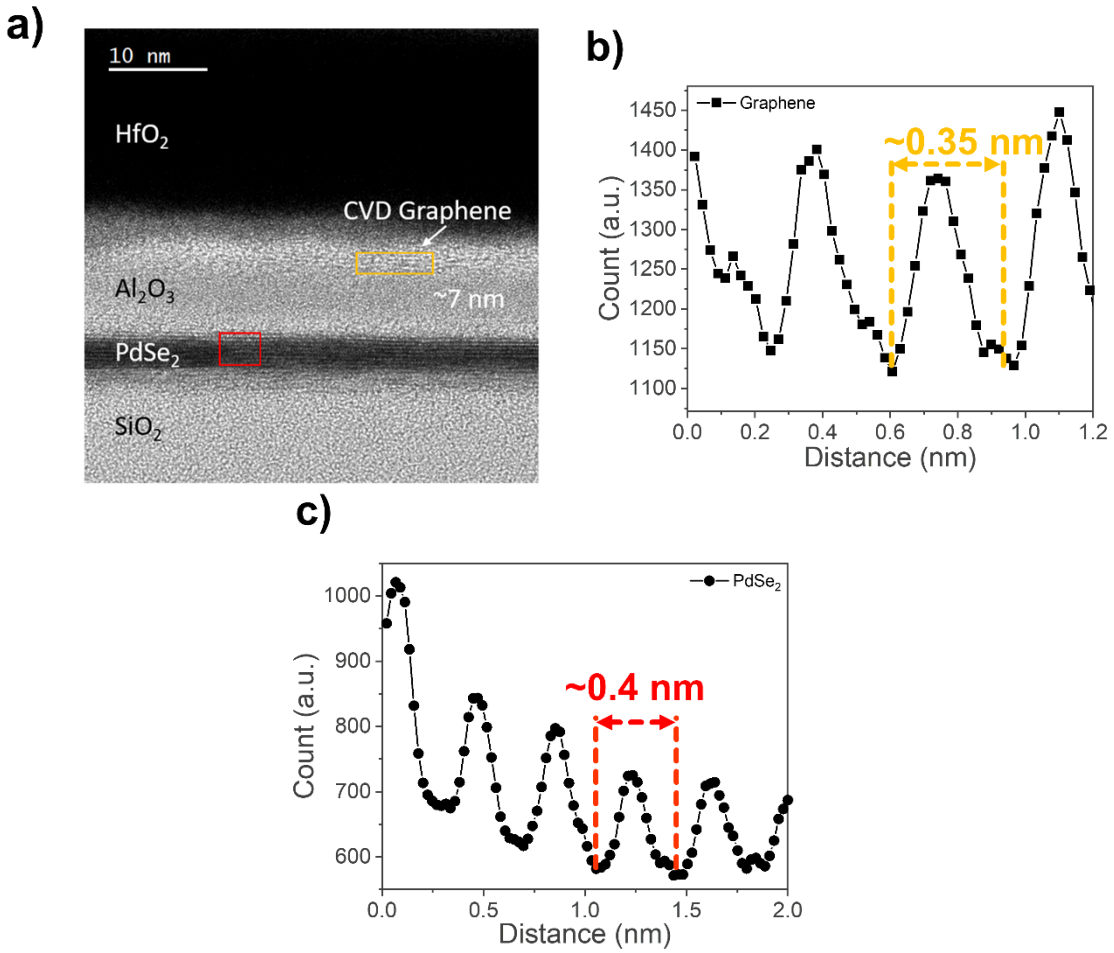

Figure S1. TEM cross-section view with intensity profile of graphene and $PdSe_2$. a) TEM cross-section view image of floating gate memory based on $PdSe_2$. b) The intensity line profile of graphene across the yellow boxed area in Fig. S1a. This shows the layer spacing around 0.35 nm.[1] c) The graph of intensity line profile in red boxed area in Fig. S1a. This presents the $PdSe_2$ have the interplanar spacing around 0.4 nm.[2]

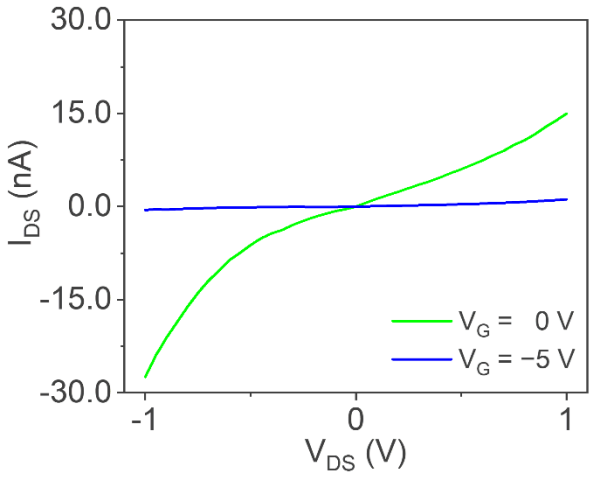

Figure S2. The expanded output curves of Fig. 2a at gate voltages of 0 V and −5 V, respectively.

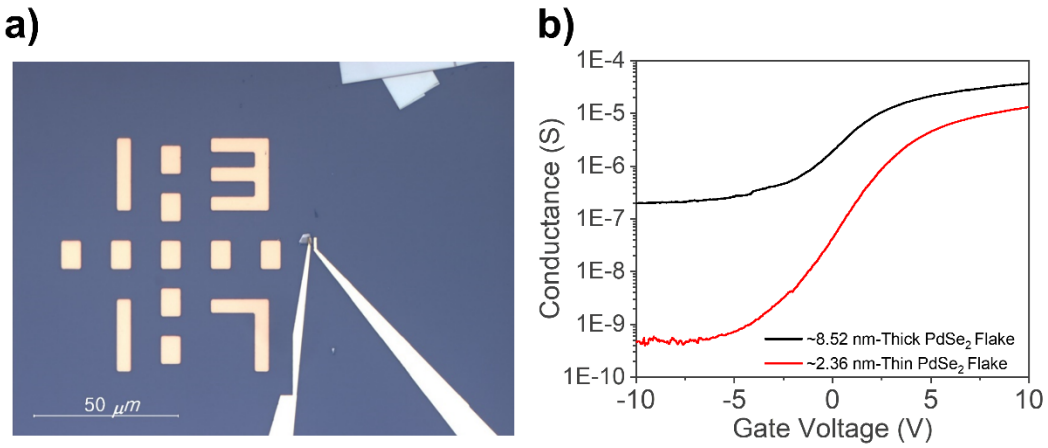

Figure S3. Transfer curves of the fabricated devices with the thin (2.36 nm) and the thick (8.52 nm) $PdSe_2$ flakes, respectively. (a) Optical microscope image of the thick $PdSe_2$ flake before fabricated floating gate memory. (b) Transfer curves of floating gate memory. Black line represents the transfer curve of the thick $PdSe_2$ devices which has smaller On/Off ratio and higher off conductance than floating gate memory based on the thin $PdSe_2$ flake (red line). This result indicates that the thin $PdSe_2$ is a proper selection to fabricate the floating gate memory.

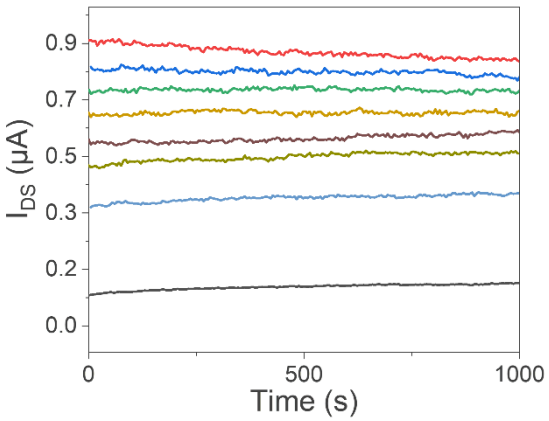

Figure S4. Retention characteristics during 10^3 s are demonstrated at $PdSe_2$ based floating gate memory. The drain currents are measured at 0 V of V_G with 1 V of V_{DS}. Three bits of states are well isolated, indicating the potential usage of $PdSe_2$ floating gate memory for multi-bit memory devices.

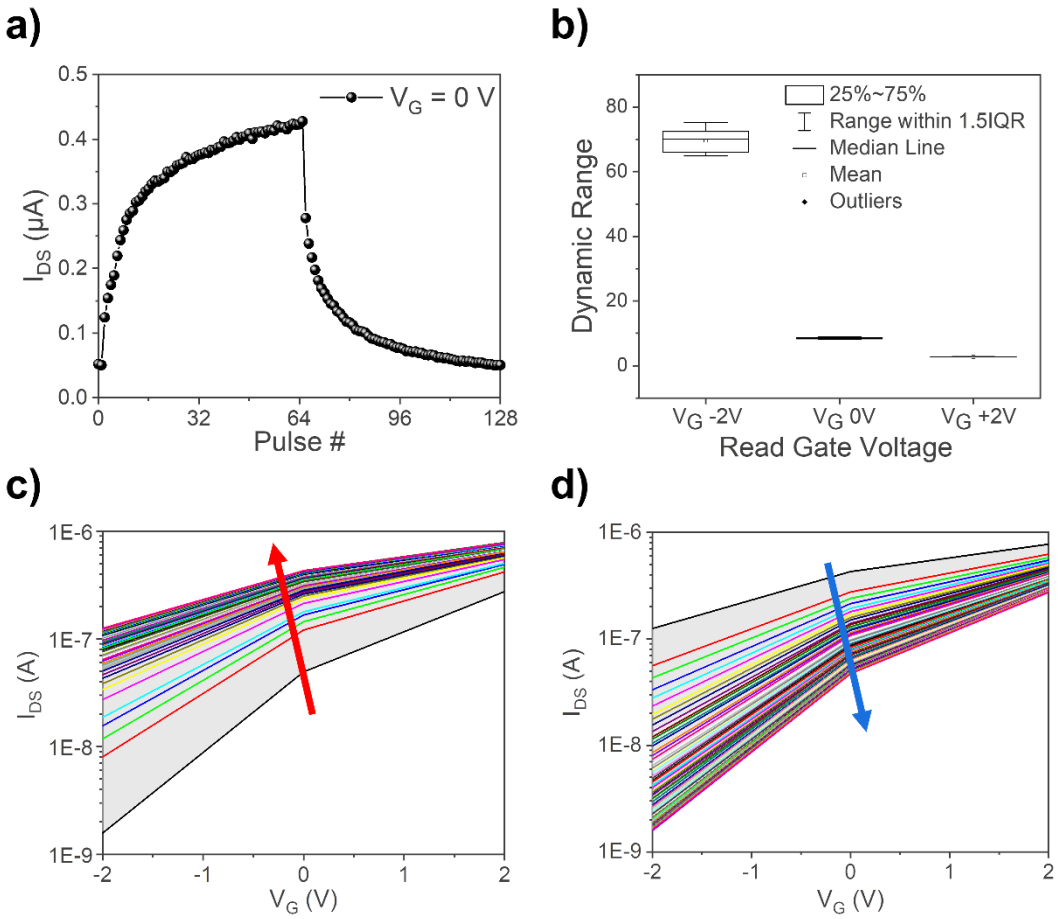

Figure S5. Dynamic range study with various gate voltages. a) A PD curve of $PdSe_2$ based floating gate memory with +13 V, 1 ms pulses. Drain-source currents (I_{DS}) are measured at V_G = 0 V with V_{DS} = 1 V. b) Boxplot of dynamic ranges at three different V_G. 10 times of dynamic ranges were measured at each V_G. c, d) Measured I_{DS} at different V_G during weight potentiation and depression processes, respectively.

REFERENCES

1. K. S. Novoselov, A. K. Geim, S. V. Morozov, D. Jiang, Y. Zhang, S. V. Dubonos, I. V. Grigorieva and A. A. Firsov, *Science*, 2004, **306**, 666-669.
2. A. D. Oyedele, S. Yang, L. Liang, A. A. Puretzky, K. Wang, J. Zhang, P. Yu, P. R. Pudasaini, A. W. Ghosh, Z. Liu, C. M. Rouleau, B. G. Sumpter, M. F. Chisholm, W. Zhou, P. D. Rack, D. B. Geohegan and K. Xiao, *J. Am. Chem. Soc.*, 2017, **139**, 14090-14097.