**Rebekah Chua**[1,2]
Jing Yang[3], Xiao Yue He[2], Fabio Busolotti[3], P.K. Johnny Wong[4], Kian Ping Loh[1,4,5], Johnson Goh[3,2], Yuli Huang[2*], Andrew T.S. Wee[1,2,4*]
*[1]NUS Graduate School for Integrative Sciences & Engineering (NGS), University Hall, Tan Chin Tuan Wing, 21 Lower Kent Ridge, Singapore 119077, Singapore*
*[2]Department of Physics, National University of Singapore, 2 Science Drive 3, Singapore 117542, Singapore*
*[3]Institute of Materials Research & Engineering (IMRE), A*STAR (Agency for Science, Technology, and Research), 2 Fusionopolis Way, Innovis, Singapore 138634, Singapore [4]Centre for Advanced 2D Materials, National University of Singapore, Block S14, Level 6, 6 Science Drive 2, Singapore 117546, Singapore*
*[5]Department of Chemistry, National University of Singapore, 2 Science Drive 3, Singapore 117542, Singapore*

**E-mail: phyhy@nus.edu.sg; phyweets@nus.edu.sg*

# Controllable 1D line defects in monolayer $VSe_2$ on Epitaxial $MoS_2$

Defects in 2D materials are inevitable and can bring about positive uses. In molybdenum disulfide ($MoS_2$), p-type or n-type conduction can be produced by having either Mo or S vacancies [1], respectively, while ferromagnetism can be induced by vacancies [2] or Mn-doping [3] as well. Herein, we describe a controllable method to fabricate 1D line defects in vanadium diselenide ($VSe_2$) grown via molecular beam epitaxy on a single crystal of $MoS_2$. The line defect density can be effectively controlled by annealing temperature or duration. It is also a reversible process whereby 2D $VSe_2$ can be obtained again through depositing selenium and annealing. Through scanning tunneling microscopy studies, the line defects are found to be selenium vacancies and have similar electronic properties as 2D $VSe_2$. On the other hand, the magnetic property of $VSe_2$ is observed via density functional theory calculations to be quenched with increasing density of line defects. The ability to control the magnetism of $VSe_2$ while retaining its electronic capabilities paves the way for interesting applications in spintronics or memory devices.

## References

[1] McDonnell, S., Addou, R., Buie, C., Wallace, R. M. & Hinkle, C. L. Defect-Dominated Doping and Contact Resistance in MoS2. *Acs Nano* **8**, 2880-2888, doi:10.1021/nn500044q (2014).
[2] Cai, L. *et al.* Vacancy-Induced Ferromagnetism of MoS2 Nanosheets. *Journal of the American Chemical Society* **137**, 2622-2627, doi:10.1021/ja5120908 (2015).
[3] Wang, J. Q. *et al.* Robust ferromagnetism in Mn-doped MoS2 nanostructures. *Applied Physics Letters* **109**, doi:10.1063/1.4961883 (2016)