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