Controllable p-Type Doping of 2D WSe_2 via Vanadium Substitution

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Project Summary: We report scalable growth and vanadium (V) doping of 2D WSe_2 at front-end-of-line (FEOL) and back-end-of-line (BEOL) compatible temperatures of 800 °C and 400 °C, respectively. A combination of experimental and theoretical studies confirm that vanadium atoms substitutionally replace tungsten in WSe_2, which results in p-type doping via the introduction of discrete defect levels that lie close to the valence band maxima. The p-type nature of the V dopants is further verified by constructed field-effect transistors, where hole conduction becomes dominant with increasing vanadium concentration. Our study demonstrate the first large area p-type doping of 2D WSe_2 with the highest accuracy over the dopant concentrations at FEOL and BEOL compatible temperatures.

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2DCC Role: All synthesis experiments are carried out on a system that is directly affiliated with a 2DCC facility at PSU. Also, an external 2DCC faculty Richard Hennig from the University of Florida has been involved in the work where the provided first-principles calculations by his group helped to elucidate structural and electronic properties of the dopant in the lattice agreeing well with the experimental data.