Modulating magnetism via Se-vacancy states in WSe_2

Tuan Dung Nguyen
Jinbao Jiang, Bumsub Song, Dinh Loc Duong
Center for Integrated Nanostructure Physics (CINAP), Institute for Basic Science (IBS), Suwon, Korea
Contact@E-mail: dungnt@skku.edu; ddloc@skku.edu

Abstract

Modulation of magnetism using gate bias through insulators is known as the key approach for future low-power spintronics. Although this has been demonstrated in diluted magnetic semiconductors and multiferroic materials, gate-tunable magnetic properties in a system with intrinsic defects is rarely observed. Here, we report, for the first time, the gate-tunable magnetic order via resonant with Se-vacancy states near the conduction band in the WSe_2 multilayer. The Se-vacancy states are probed by photocurrent measurement with gating to convert from unoccupied states to occupied states associated with photo-excited carriers and recombination process. A large spin-spin splitting in Se-vacancy states induced by strong Coulomb interaction combined with strong spin-orbit coupling when the Se-vacancy states are partially occupied. Consequently, the long-range magnetic order is formed and clearly manifested by hysteresis of the magneto-photocurrent, consistent with the density functional calculations. Our results offer a new approach to control magnetic properties of intrinsic defect states for optoelectronic and spintronic devices based on 2D van der Waals semiconductors.

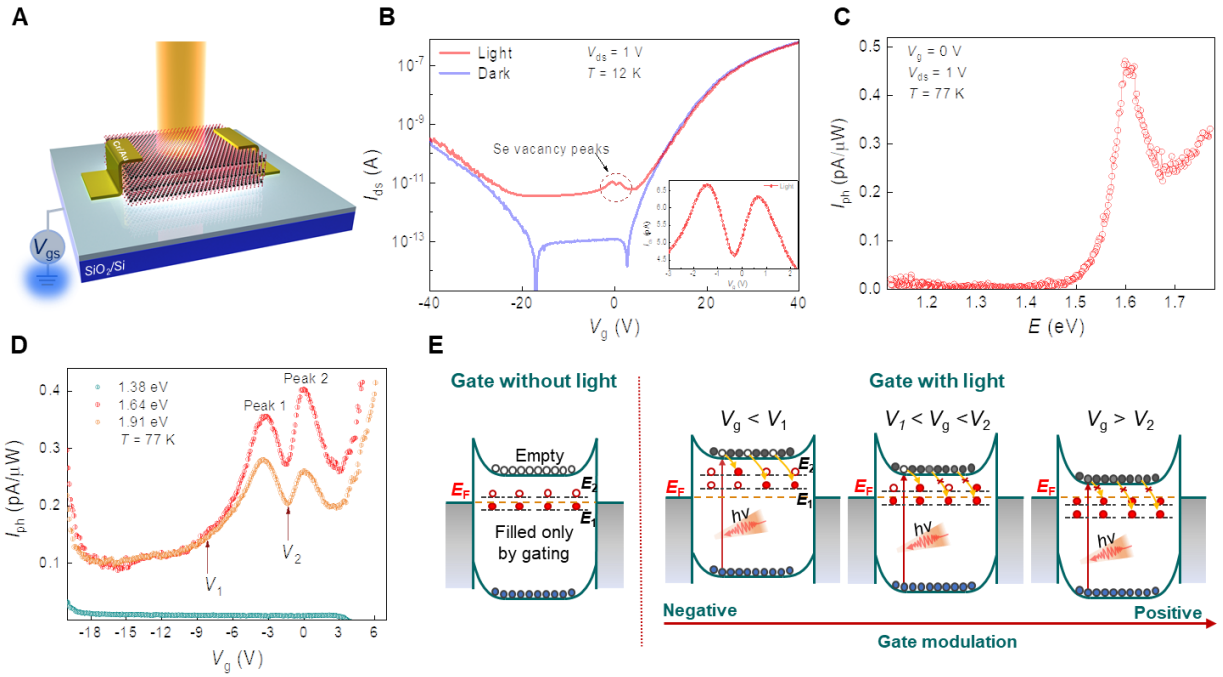

Figure 1: Photocurrent measurement with excitation energies under gate-bias sweep

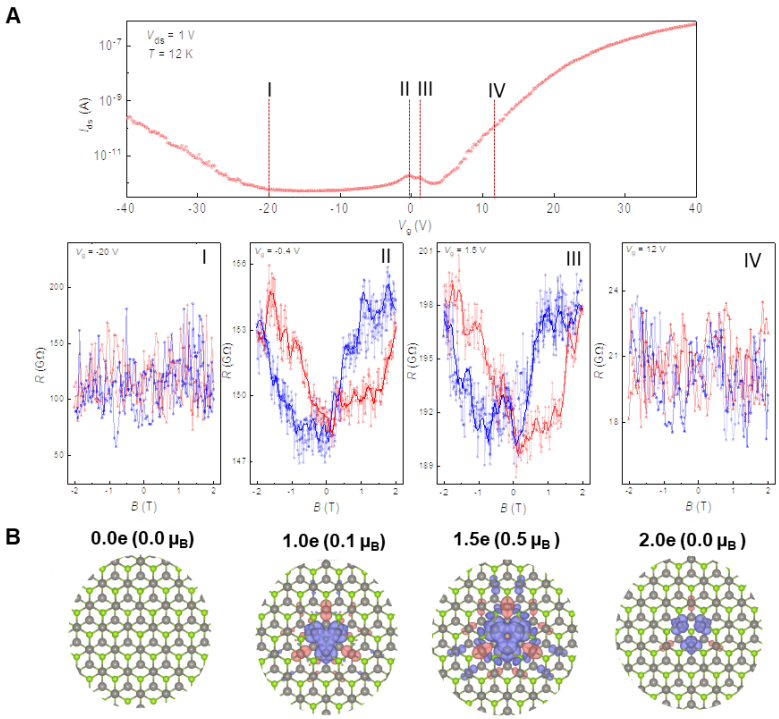

Figure 2: Magnetic order in energy levels with Se-vacancy in WSe2