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Electronic Properties, Band Gap Renormalization, and Doping Effect in Epitaxial WSe_2 thin film YI ZHANG, Stanford University, MIGUEL UGEDA, SU-FEI SHI, UC Berkeley, BO ZHOU, YEONGKWAN KIM, LBNL, YULIN CHEN, University of Oxford, FENG WANG, MICCHAEL CROMMIE, UC Berkeley, ZAHID HUSSAIN, LBNL, ZHI-XUN SHEN, Stanford University, SUNG-KWAN MO, LBNL — As a class of graphene-like two-dimensional materials, the layered metal dichalcogenides MX_2 (M = Mo, W; X = S, Se, Te) have gained significant interest due to the distinct properties in 2D limit. Examples include the indirect to direct band gap transition in monolayer, and giant spin-splitting of the valence band. These properties give MX_2 great application potentials in both optoelectronic and spintronics devices. For practically studying and applying the MX_2, the growth of high-quality MX_2 thin film with precise control of layers thickness is favorable. Here we report the molecular beam epitaxial growth of WSe_2 thin film, with controllable thickness from monolayer to 8 monolayer. By using *in-situ* angle-resolved photoemission spectroscopy, we experimentally revealed the valence band evolution with film thickness. By applying the potassium doping on the surface, we observed the indirect to direct band gap transition in monolayer WSe_2, and the distorted band structure. Combining the *ex-situ* photoluminescence and scanning tunneling spectroscopy, we further presented the giant band gap renormalization and excitonic effects. Our results will enrich the understanding of WSe_2, and bring it more application potential in practical devices.

Yi Zhang
Stanford University

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