Highlights

ACTIVITY F Electronic and thermal transport from the nanoscale to the macroscale 2020

Field Emission in Ultrathin $PdSe_2$ Back-Gated Transistors

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ADVANCED ELECTRONIC MATERIALS 6 (2020) 2000094

The material research of the last decade has been largely dominated by 2D transition metal dichalcogenides (TMDs), which have been explored for numerous applications in electronics, optoelectronics, sensors, catalysis, etc. Palladium diselenide ($PdSe_2$) has been the first isolated layered material with pentagonal structure that is stable in air. The monolayer has a puckered morphology where each Pd atom is coordinated with four Se atoms and exhibits an indirect bandgap of ≈1.3 eV that vanishes with the increasing number of layers up to the metallic behavior of the bulk material. This study deals with the electrical transport in back-gate field-effect transistors with ultrathin $PdSe_2$ channels. The devices are normally-on and exhibit dominant n-type conduction at low pressure. The electron conduction of $PdSe_2$ nanosheets, combined with the sharp edge and the work function decreasing with the number of layers, opens up new applications in vacuum electronics. This work is the first experimental demonstration of field emission current from few-layer $PdSe_2$ by using a tip shaped anode precisely positioned at small distance from the emitting surface. Field-emission from $PdSe_2$ nanosheets is obtained with a turn-on field below 100 V μm^{-1} and attains currents up to the μA. This finding extends the plethora of applications of this recently isolated pentagonal layered material.

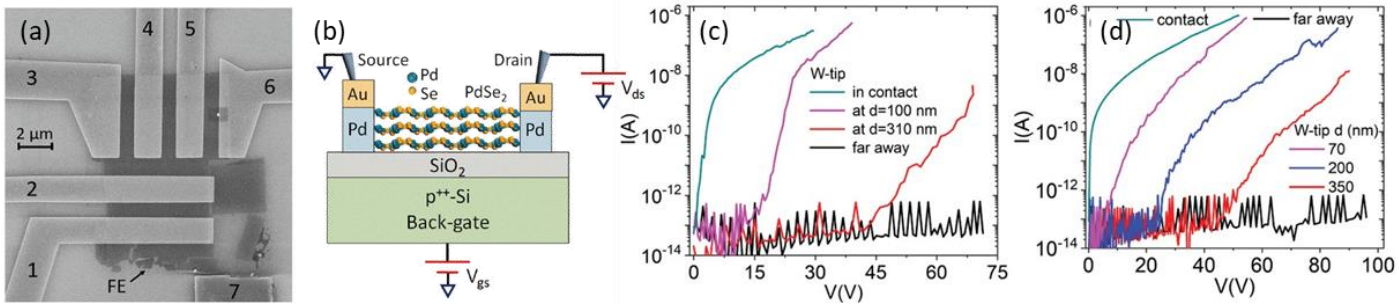

Fig. 1: (a) SEM image of a $PdSe_2$ flake contacted with Pd/Au leads. The FE arrow points to the flake used for field emission measurements. (b) Schematic cross-section and biasing of the $PdSe_2$ field-effect device in common-source configuration. (c) and (d) I–V curves with the anode W-tip at growing distances from the $PdSe_2$ nanosheet showing the evolution from electric contact to FE regime. The substrate back-gate was grounded during all the above measurements.