Pressure-Tunable Ambipolar Conduction and Hysteresis in Thin Palladium Diselenide Field Effect Transistors

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Few-layer palladium diselenide ($PdSe_2$) field effect transistors are studied under external stimuli such as electrical and optical fields, electron irradiation, and gas pressure. The ambipolar conduction and hysteresis are observed in the transfer curves of the as-exfoliated and unprotected $PdSe_2$ material. The ambipolar conduction and its hysteretic behavior in the air and pure nitrogen environments are tuned. The prevailing p-type transport observed at atmospheric pressure is reversibly turned into a dominant n-type conduction by reducing the pressure, which can simultaneously suppress the hysteresis. The pressure control can be exploited to symmetrize and stabilize the transfer characteristics of the device as required in high performance logic circuits. The transistors are affected by trap states with characteristic times of the order of minutes. The channel conductance, dramatically reduced by the electron irradiation during scanning electron microscope imaging, is restored after an annealing of several minutes at room temperature. The work paves the way toward the exploitation of $PdSe_2$ in electronic devices by providing an experiment-based and deep understanding of charge transport in $PdSe_2$ transistors subjected to electrical stress and other external agents.

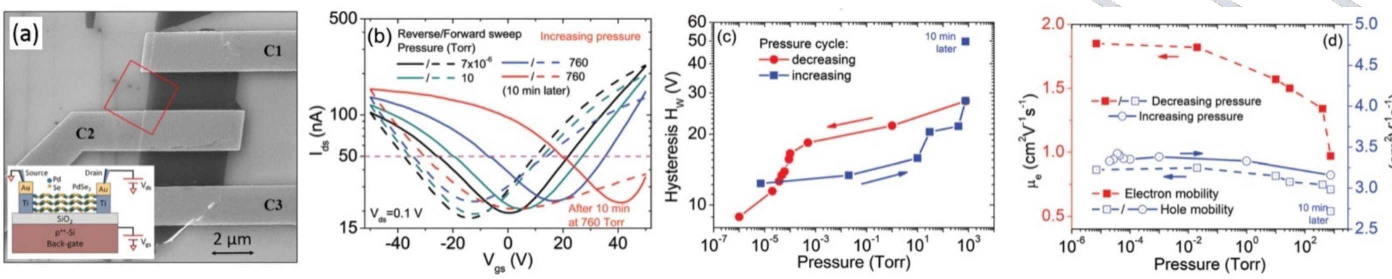

Fig. 1: (a) SEM image of the $PdSe_2$ flake with 5 nm Ti/40 nm Au metal contacts and (inset) schematic of the backgate transistor fabricated with it (not-on-scale). (b) Effects of increasing pressure on the transfer characteristics of the $PdSe_2$ device (for clarity, only a subset of the measured curves is shown here). (c) Hysteresis as a function of pressure. (d) electron–hole mobility as a function of pressure.