Transport and optoelectronic properties of few layer Palladium Diselenide films with Graphene Electrodes

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Two-dimensional materials with tunable band gap in the range of 0.3–1.5 eV are highly desirable for electronic and optoelectronic applications. Palladium diselenide ($PdSe_2$), a less explored group-10 transition metal dichalcogenide, is one such material of particular interest that demonstrates a gradual transition from a semiconductor (monolayer) to semimetal (bulk) [1, 2]. In this work, we report the transport and optoelectronic properties of p-type PdSe2 field effect transistors (FETs) with laterally spaced graphene electrodes. The fabricated devices can be understood as a pair of back-to-back Schottky diodes created at the graphene/$PdSe_2$ interface and a series resistor presented by the $PdSe_2$ channel. The devices demonstrate hole dominated transport with gate tunable Schottky barrier height. Next, the current induced $PdSe_2$ channel decomposition has been studied under various bias conditions. Similar material transitions have been further observed under 532 nm laser irradiation, where the structural transitions have been simultaneously controlled with Raman spectroscopy. The laser annealing has been found to significantly improve carrier mobility leading to an improved performance of the $PdSe_2$ based FET devices.

References

[1] L. Zeng et al. Adv. Funct. Mater. 1806878, 1–9 (2018).
[2] A. D. Oyedele J. Am. Chem. Soc. 139, 14090–14097 (2017)

Figures

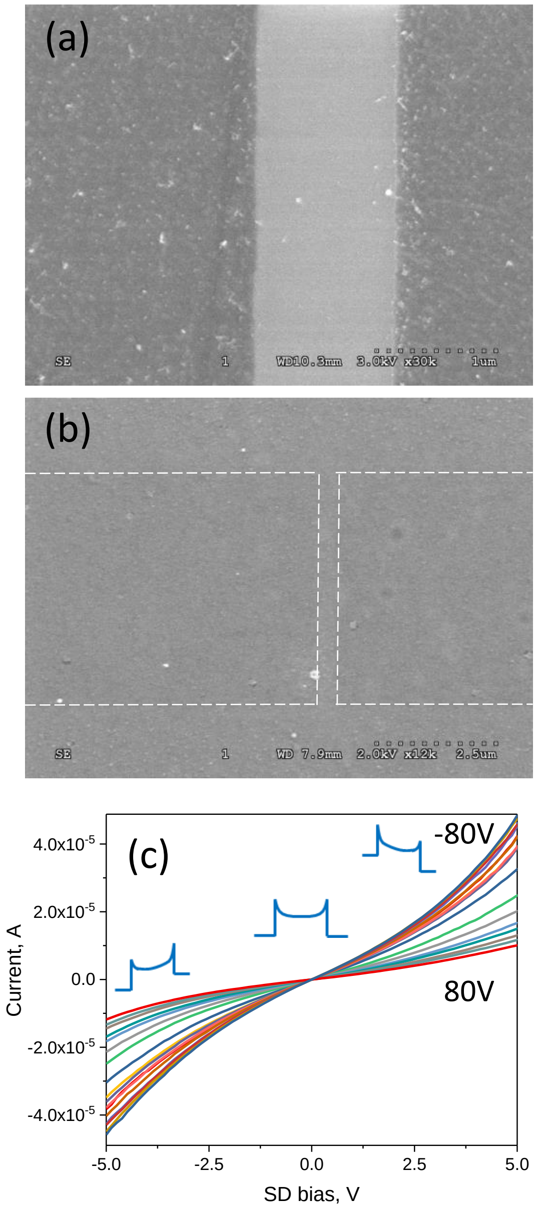

Figure 1: (a, b) SEM images of a typical device with graphene electrodes with/without $PdSe_2$ film. White dot line shows contour of graphene contacts (b). (c) Gate dependent IV curves for the device with 250nm gap and 50um graphene width.