Chalcogen assisted contact engineering: towards CMOS circuit integration of WSe_2 FETs

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Abstract

Despite immunity against short channel effects and surface scattering in 2-dimensional semiconductors (2D SCs), 2D SC technology for electronic applications does not appear trivial because the device fabrication process lacks selective and scalable doping techniques that enable dual polarity (N and P-type) for the same contact metal and channel material. WSe_2 transistors have been shown to exhibit ambipolar behaviour for various contact metals [1], [2]. However, none of the WSe_2 devices could exhibit unipolar (n-type or p-type) behaviour with the same contact metal. Realization of unipolar devices of both polarities with the same contact metal using an industry scalable and selective method is expected to be a great leap towards development of 2D WSe_2 based technology for electronic applications. In this work, we introduce a unique Chalcogen based technique for contact engineering of WSe_2 FETs that has enabled unipolar NMOS and PMOS WSe_2 FETs (Figure 1 & 2) with a single contact metal and hence, it is expected to advance the technological significance of 2D SCs for electronic applications, especially WSe_2. Besides demonstrating the aforementioned contact engineering, this technique enabled us to unveil interesting physics occurring at various metal-WSe_2 interfaces. In fact, fundamental understanding of the interface has led to the remarkable difference in the behaviour of standard and engineered devices. Finally, we project CMOS circuit integration of WSe_2 FETs for System on Chip (SoC) applications.

References

[1] Das S et al, Applied Physics Letters, 103501 (2013), 103.

[2] Liu W. et al, Nano Lett., 2013, 13 (5), pp 1983–1990.

Figures

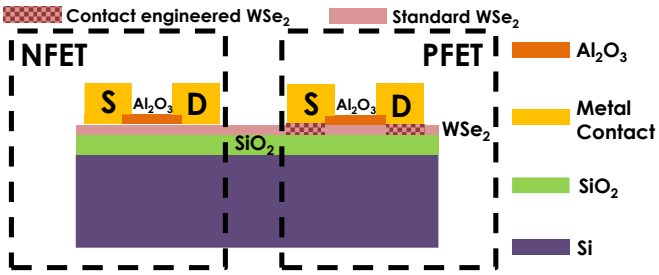

Figure 1: Device schematic for the proposed contact engineered (PFET) and standard (NFET) transistors with same contact metal.

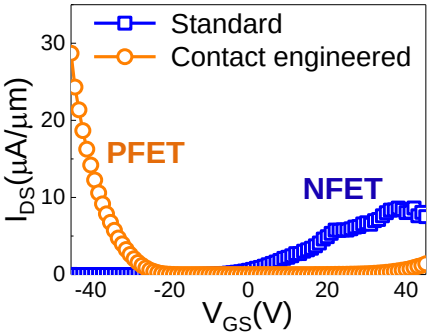

Figure 2: Transfer characteristics for standard and contact engineered FETs.