Charge transport in van der Waals heterostructures and multi-FET architectures

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Van der Waals (vdW) heterojunctions between graphene and transition metal dichalcogenides (TMDs) are a key building block of devices based on two-dimensional crystals. Their stacking sequence is generally believed to crucially affect their behaviour as contacts in field-effect transistor (FET) [1]. We experimentally and theoretically investigate how a TMD can screen graphene even when it would not be expected to. Here, we demonstrate a peculiar architecture consisting of a MoS_2 FET with graphene contacts (1st configuration), where each graphene contact can act itself as a FET (2nd configuration) [2]. In the current study, both MoS_2 and graphene were synthesized by chemical vapor deposition (CVD) in a monocrystalline form. Charge transport measurements were performed in both configurations. MoS_2 FETs show highly linear IV characteristics and a mobility up to 8.6 cm^2/Vs, while graphene stripes display quenched n-type conduction depending on the MoS_2 overlay coverage percentage. Materials properties are tracked at each step of fabrication by photoluminescence (PL), and Raman spectroscopies. The latter reveal a charge transfer within the heterojunctions [3-4]. Ab initio numerical calculations give strong indications that the observed electron transport suppression is caused by a significant density of sulfur vacancies in MoS_2.

References

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[3] A.Michail et al., Appl. Phys. Lett., **108** (2016) 173102.
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Figures

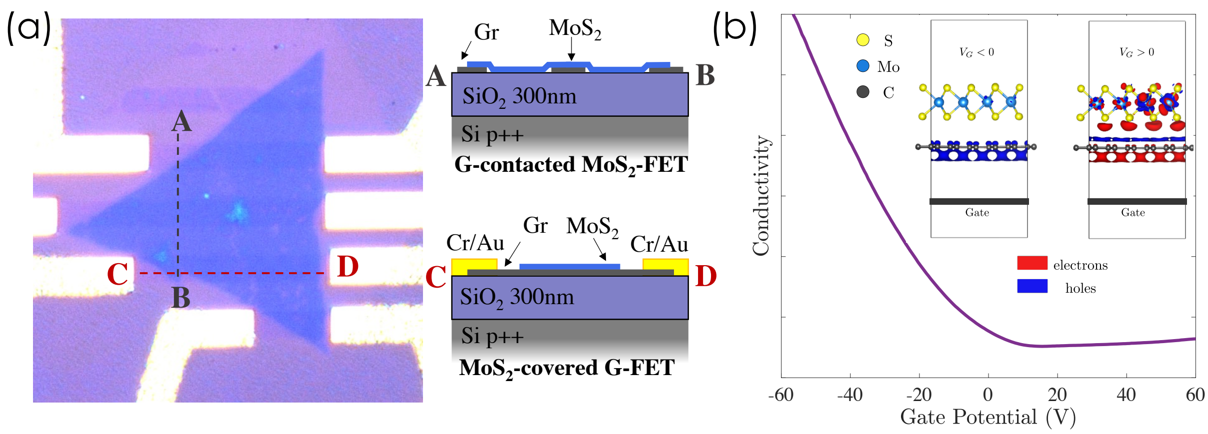

Figure 1: a) Optical image and schematic of the device in both configurations. b) Electron transport suppression. Inset shows ab initio results.