Ultra-High Gauge Factor in Graphene/MoS_2 Heterojunction Field Effect Transistor with Variable Schottky Barrier

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We demonstrate a highly sensitive strain sensor using a variable Schottky barrier in a MoS_2/graphene heterostructure field effect transistor (FET). The low density of states near the Dirac point in graphene allows large modulation of the graphene Fermi level and corresponding Schottky barrier in a MoS_2/graphene junction by strain-induced polarized charges of MoS_2.

As a result, the maximum Schottky barrier change $\Delta\Phi_{SB}$ and corresponding current change ratio under 0.17%-strain reach 152 meV and 1890, respectively, resulting in an ultra-high gauge factor of 1110087, which is approximately 1000 times higher than that of metal/TMDs junction strain sensors (1160) and 250 times higher than the highest known gauge factor of conventional strain sensors (4036). The ultra-high sensitivity of graphene/MoS_2 heterostructures FETs can open up a new dimension for next-generation electronic and mechanical–electronic devices.

References

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Figures

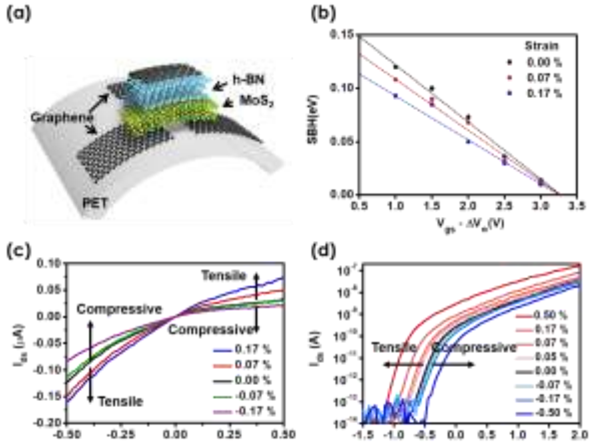
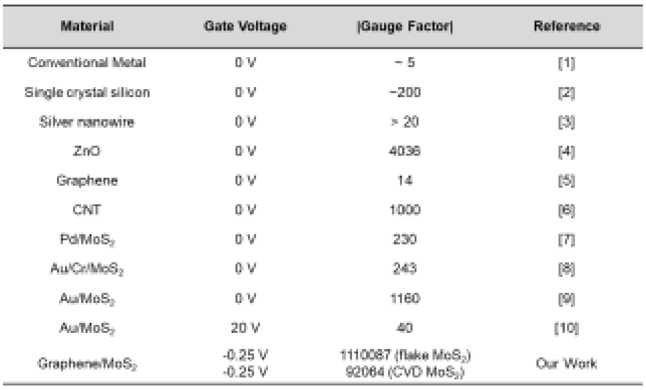


Figure 1: (a) Schematic of the fabrication process of a flexible and transparent graphene/MoS_2 vdWHs FET. (b) Variation of Schottky barrier height with gate voltage under 0%, 0.07%, and 0.17% strain. (c) I-V_{ds} characteristics of graphene/MoS_2 vdWHs FET in a under various strain. (d) Transfer (I-V_{gs}) characteristic of the graphene/MoS_2 vdWHs FETs under no-strain, tensile strain, and compressive strain.



Material	Gate Voltage	|Gauge Factor|	Reference
Conventional Metal	0 V	~ 5	[1]
Single crystal silicon	0 V	~200	[2]
Silver nanowire	0 V	> 20	[3]
ZnO	0 V	4036	[4]
Graphene	0 V	14	[5]
CNT	0 V	1000	[6]
Pd/MoS_2	0 V	230	[7]
Au/Cr/MoS_2	0 V	243	[8]
Au/MoS_2	0 V	1160	[9]
Au/MoS_2	20 V	40	[10]
Graphene/MoS_2	-0.25 V -0.25 V	1110087 (flake MoS_2) 92064 (CVD MoS_2)	Our Work

Table 1: Performance of previous strain sensors and our work.