Single and multilayer graphene and MoS_2 thin-film transistors: 1/*f* noise and gas sensing

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We report on the transport and low-frequency noise measurements of the back-gated graphene and MoS_2 thin-film transistors with "thin" (1–3 atomic layer) and "thick" (7–18 atomic layer) channels. This comparison reveals that the noise mechanisms in graphene and thick MoS_2 are quite different, with the McWhorter model (involving tunneling from trap states in the barrier dielectric layer) applicable to 1/*f* noise only in the thick MoS_2 devices [1]. The normalized spectral density of the low-frequency 1/*f* noise in the "thick" MoS_2 transistors is of the same level as in graphene. The MoS_2 transistors with the atomically thin channels have substantially higher noise levels. The McWhorter model allows estimating the trap density responsible for the low-frequency noise in the thick MoS_2 transistors (~ 10^{18} $cm^{-3}eV^{-1}$).

These devices are superior candidates for sensing applications due to the high surface-to-volume ratio and tunability by the gate bias. Both graphene [2] and MoS_2 [3] have been used for the *selective* detection of ethanol, acetonitrile, toluene, chloroform, and methanol vapors. Gas exposure causes dramatic changes in the device current-voltage characteristics, especially for the MoS_2 devices, allowing us to demonstrate a gas-gated transistor. In addition to these changes in the device current-voltage characteristics, the time dependent response and/or changes in the 1/*f* spectra under the gas exposure provide unique signatures for the selective gas detection.

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