Graphene nano-electro-mechanical (NEM) devices for advanced applications

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Graphene possesses remarkable electronic and mechanical properties and provides a promising platform to explore future nano-electro-mechanical (NEM) devices for challenging applications. Novel graphene NEM (GNEM) devices are first presented, which achieve room temperature sub-thermal switching ($S < 60 \text{ mV/dec}$) with low switching voltage. A GNEM chemical gas sensor is then presented (Fig. 1), which features a slanted graphene channel with built-in tensile strain. By applying substrate bias to accelerate the CO$_2$ molecule adsorption, we show ‘quantized’ increments in the temporal resistance $\Delta R$, which signifies single molecule adsorption / desorption$^1$.

We then show our recent attempt of patterning single-nanometer-size nanopores in suspended graphene by using atomic-size focused helium ion beam. Arrays of pores of 3 – 4 nm in diameter spanning a suspended ribbon were successfully patterned. Thanks to a very high Young’s modulus and a high Debye temperature of graphene, the phononic bandgaps are expected to be formed in the bandwidth of a few THz. This will enable us to control thermal transport dominated by heat phonons for relatively low temperature ($< 200^\circ$C).

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Reference