Three-Terminal Graphene Nanoelectromechanical (NEM) Switch

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Off-state leakage power increases with the downscaleing complementary metal oxide semiconductor (CMOS) devices. This leakage current directly limits CMOS devices drive current. In order to solve this issue different types of abrupt switches are being studied. These switches are expected to realize a subthreshold slope (SS) smaller than the theoretical limit of 60 mV/decade at room temperature along with a low off-state leakage current. The nanoelectromechanical (NEM) switch is one of such potential candidates to realize abrupt switching with a negligible off-state current. In a NEM switch, an electrostatic force is utilized to mechanically deflect a suspended moving element into physical contact with an electrode, creating the conducting channel in between two elements. The device can naturally provide zero off-state leakage current from the open circuit of an air or vacuum gap in the off-state. Graphene has an ultra-high Young's modulus of 1 TPa due to its high-quality crystal lattice. This unique property makes graphene as a promising candidate for future nanoelectromechanical systems (NEMS) applications. Graphene NEM devices suffers from the strong carbon–metal covalent bonding or unwanted extra electrostatic force caused by charge stored in the tunnel oxide, which leads to stiction problem [1,2].

In this work, we report graphene-based three terminal NEM switch suitable for ultra-low-power logic device applications. This graphene NEM device was fabricated using the two-dimensional materials, graphene and hexagonal boron nitride (Fig. 1(a-b)). The irreversible stiction issue was avoided by employing the weak graphene–graphene van der Waals interaction between the suspended movement element and the electrode. The drain-source conduction switching between the on- and off-states is controlled via the bottom graphene gate. Gate voltage induces the mechanical deflection of the suspended, moveable drain-graphene into physical contact with the bottom source-graphene electrode to form a conducting channel. Our three teriminal graphene NEM switch exhibits remarkable switching characteristics, with a subthreshold slope as small as 11 mV/dec (Fig. 1(c)). Details of the device fabrication processes and other measurement characteristcs will be discussed in detail.

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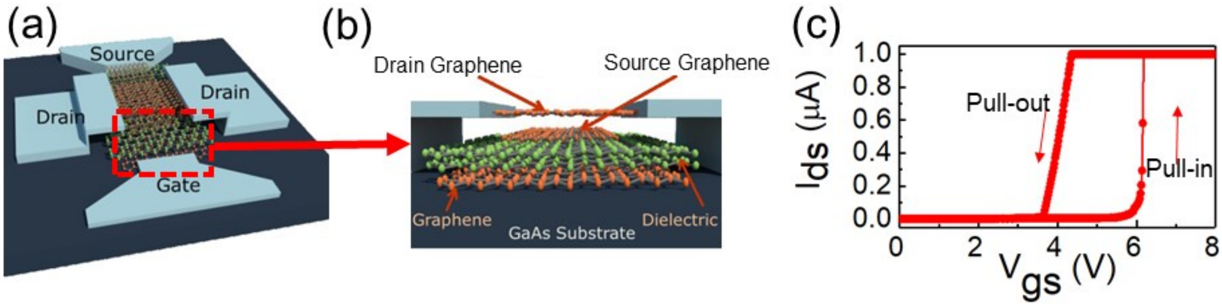

Fig. 1 (a-b) Schematics of the fabricated three-terminal graphene nanoelectromechanical switch (c) Measured switching characteristics of the fabricate NEM switch.

References:

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