Stacked nanocrystalline graphene-based Nano-Electro-Mechanical (NEM) contact switch architecture with low pull-in voltage

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Graphene possesses exceptional mechanical and electrical properties, and combining these properties makes graphene a promising candidate for Nano-Electro-Mechanical (NEM) contact switches [1]. Graphene based NEM contact switches (GNEM) can offer fast switching response, high on/off ratio and low actuation voltage [2]. Nanocrystalline graphene (NCG) that can be grown at wafer-scale with variable thickness using plasma-enhanced chemical vapor deposition (PECVD) [3] has been demonstrated to be a viable material for two-terminal NEMS switches with metal electrodes [4]. Due to the metal-free growth, it is a candidate for wafer-scale NCG-NCG NEMS contact switches with advanced device architecture.

In this work, we report the stacked nanocrystalline graphene (NCG) nano-electro-mechanical switch architecture, where NCG acts as both the contact material and suspended beam. Two-terminal double-clamped NCG-NCG NEM contact switches are fabricated from ~7.5 nm thin NCG with a ~70 nm air gap. Sharp switching and a low actuation voltage of below 1.5 V is measured. The Fig 1.a shows the schematic of the NCG-NCG NEM contact switch. At ~1.35 V the current abruptly increases to compliance value of 50 µA (Fig 1.c). The current compliance was set to 50 µA to avoid the device failure due to the Joule heating. The switch failed to pull-out after the first forward scan due to thin NCG and low restoring force of the suspended NCG ribbon. We will also discuss how the NEM contact switch could be used to realize single switch AND logic.

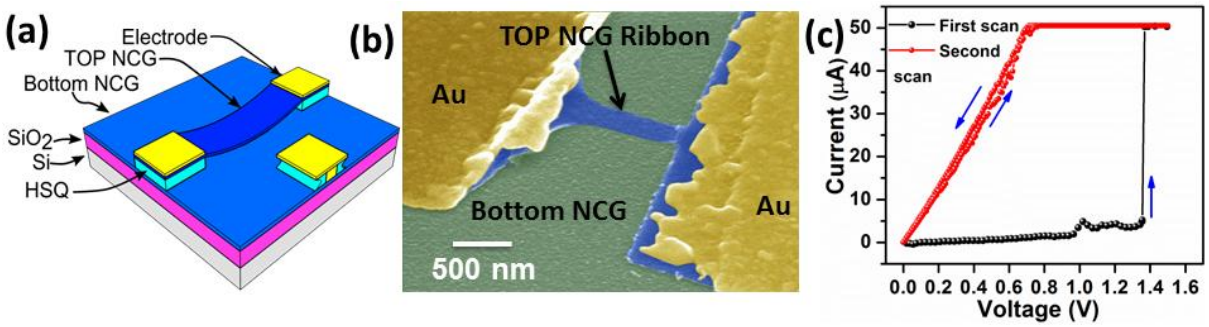

Figure 1. NCG-NCG NEM contact switch device structure. (b) SEM image of the device with a length of 1.35 µm and width of 0.25 µm. (c) Two terminal I-V characteristics of NCG-NCG NEM contact switch showing sharp pull-in at ~ 1.35V.

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