HIGH-SPEED MEMORY FROM CARBON NANOTUBE FIELD-EFFECT TRANSISTORS WITH HIGH-K GATE DIELECTRIC

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Single-walled carbon nanotube field-effect transistors (CNT-FETs) are demonstrated to have impressive device parameters. They are extremely fast having a transit frequency as high as 50 GHz [1] and have high sensitivity in monitoring single-electron tunneling events between a gold particle and a nearby nanotube [2]. These CNT-FETs display often some degree of hysteresis in their transfer characteristics. For a transistor this is an unwanted attribute but it opens up new possible applications. By utilizing this hysteresis, CNT-FETs can be used as a memory element. The insulator film between the gate and CNT has here a crucial influence on the operation of the CNT-FET [3]. For an effective capacitive coupling between the CNT and the gate electrode, a thin and dielectrically strong film is required. On the other hand, in order to achieve the desired hysteretic behavior for memory operation, the gate-nanotube coupling has to include charge traps within the gate insulator or at some interface in the system that can be filled or emptied with charges from the CNT.

Here we will present the results on a first high performance charge trap CNT memory element with HfO₂ gate dielectric and operation speed below a microsecond regime [4]. We will also show results on other device parameters. A simple model is constructed to show that fast charging and recharging of the HfO₂ defects by charge carriers from the CNT is likely.