CARBON NANOTUBE FIELD EFFECT TRANSISTORS FOR BOTH SINGLE CHARGE DETECTION AND PHOTONICS

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Carbon nanotubes were first integrated as field effect transistors (CNFETs) in 1998 [1,2]. Since then, the predominant role of the Schottky barriers at the metal-nanotube contacts was established [3] and their performances were dramatically improved by contact and gate engineering [4, 5].

Carbon nanotubes have a 1D structure that confers them unique electronic, optical and mechanical properties. These specific properties allow implementing CNFETs for various applications, such as chemical sensors, nano-electro-mechanical systems (NEMS) or opto-electronic devices... This talk will emphasize on the versatility of CNFETs by detailing two completely different regimes of operation, a low bias one allowing single charge detection and a high bias one for light emission.

For charge sensing, CNFETs have been completely self-assembled using the Hot Filament assisted Chemical Vapour Deposition (HFCVD) technique, and then functionalized with a gold nanocrystal by a wet process (Fig. 1). The nanocrystal coupled to the nanotube acts as the storage node of a memory. In the Coulomb blockade regime, the charges trapped on this island induce a detectable field effect on the CNFET, down to a single trapped charge. Moreover, this device behaves as a completely self-assembled single electron memory [6].

When operated under high bias, CNFETs exhibit light emission in the infra-red range (Fig. 2) [7]. This effective electroluminescence originates from impact excitation of excitons in the nanotubes. Optical properties of carbon nanotubes have been recently demonstrated to be dominated by excitonic effects. A spectroscopic study of this electroluminescence will be presented. The spectra give insight into the excitonic processes in the nanotubes, giving rise in particular to a quench of the electroluminescence [8].

References:

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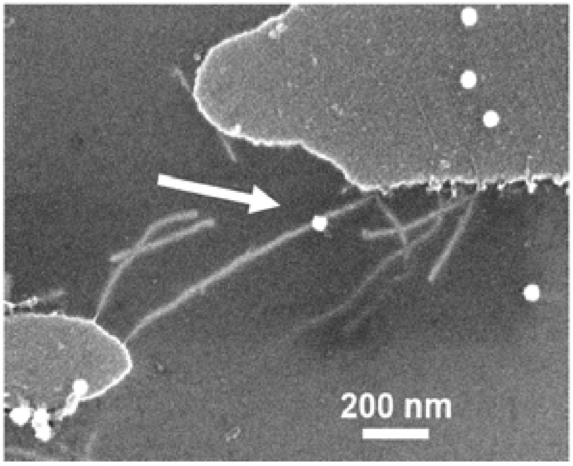

Figure 1: scanning electron micrograph of a self-assembled CNFET implemented as a single electron memory. The nanotube is functionalized with a gold nanocrystal (arrow).

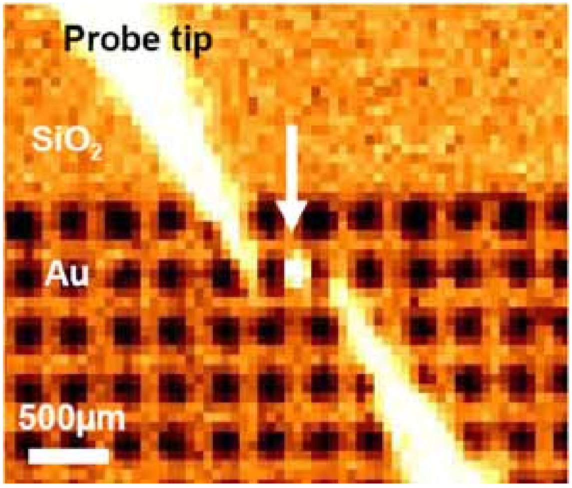

Figure 2: electroluminescence from a CNFET: the light emission from the nanotube is visible on this infra-red image as a bright spot (arrow).